REPUBLIC OF RWANDA

MINISTRY OF EDUCATION

National Curriculum Development Centre (NCDC)

ORDINARY LEVEL SCIENCE CURRICULUM (Biology, Chemistry, Physics)

Revised Edition funded by the Project: "Support to Basic Education in Rwanda: Improving the Quality of Science Teaching and Learning" at Ordinary Level Secondary School - RWA0300811

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GENERAL INTRODUCTION

1. JUSTIFICATION AND GENERAL GUIDELINE FOR THIS REVISION

Rwanda has decided to build a knowledge-based economy, with particular emphasis on science and technology as an engine of development. That's why in its Education Sector Policy Document, the Government of Rwanda promised to review the programs and teaching methods in order to equip the population with knowledge, skills and attitudes for development such as entrepreneurship, practical and psychosocial skills relating to HIV / AIDS, health and wellbeing as well as gender issues. The education policy of Rwanda reserves particular attention, therefore, to the teaching of science and technology.

Moreover, whereas the orientations and general objectives set forth in the introductions to programs which were then in force in Rwanda for the teaching of Biology, of Physics and Chemistry are still relevant and express a valid educational outlook whose purposes cannot be called into question, the specific objectives put too much emphasis on contents and little on methodology. They did not seem to be quite suitable for students in the first three years of secondary school. The effort provided by the designers of these new syllabuses was therefore to produce more suitable study programs. In other words, the designers aimed at reducing to a minimum the discrepancies between the official curriculum and the programs actually in use. The key idea or major guideline adopted by the designers in order to adapt the programs to context was the subject of frequent discussions between the CTB-CNDP joint Project « *Support to basic education in Rwanda: Improving the quality of teaching and learning of Sciences in the first cycle of secondary school – RWA 0300811* » and the program designers throughout the process of elaboration.

2. THE PRINCIPLES, NATURE AND GOALS OF ORDINARY LEVEL TEACHING

Teaching at ordinary level secondary school is in response to the principle aim of raising the educational level of the citizen in order to increase capability to participate in the values of culture, civilization and communal life and to contribute to the development of those values. It helps, therefore, in promoting the development of the individual and citizen in accordance with the principles of the Constitution and helps to orient young persons in making their career choices.

Education of the individual for living in community is, therefore, of undoubted fundamental importance. It expresses itself in an individual's spirit of solidarity, awareness and promotion of the common good through proposing cultural perspectives that enhance the individual's contribution to social development.

3. ROLE OF THE SCHOOL IN SHAPING THE INDIVIDUAL AND THE CITIZEN

Ordinary level education shapes the individual in as much as it is concerned with providing opportunities for development of the person in all aspects of life: intellectually, ethically, socially, emotionally, etc. It also promotes the development of logical, scientific, operational and creative capabilities through acquisition of fundamental and specific knowledge with attendant skills as well as growth in self-awareness and relations with the outside world.

4. A SCHOOL WELL ADAPTED TO THE AGE AND THE PSYCHOLOGY OF THE STUDENT

The ordinary level student is at the stage of preadolescence and adolescence. In fact, the students to whom ordinary level teaching is addressed undergo, within their varying personal situations, psychophysical rhythms and levels of maturity, the passage from childhood to adolescence. The individual progressively gains more defined self-awareness, better capacity for structured abstraction and new relations with the world and society.

Teachers must be constantly aware of the psychological stage of the students, in which the social capabilities of correlation and collaboration develop and the formation of individual personality and responsibility begins, so that the students may attain the required framework for learning and self-orientation.

Given the fact that ordinary level students come from diverse social and cultural backgrounds, the teaching at this stage should aim at reducing the negative effects of this diversity and those of social conditioning. They should also try as much as possible to overcome socio-cultural handicaps. The main goal is to maximize the development of every student and of the community.

5. TOWARDS AN INDIVIDUALISED APPROACH

To make sciences more appealing, this revision of the science curriculum for the ordinary level gives priority to a methodological approach that is student-centred with particular emphasis on Learning situations as well as achievement of education objectives and systematic treatment of contents through learning/teaching activities.

Individualised learning methods allows the student to participate in his/her own intellectual and social development enabling the student to carry out social obligations in terms of acquiring knowledge and development of personal abilities.

Within this context, students with disabilities will require special attention with regard to their educational and technical development needs.

6. PROMOTION OF INTERPERSONAL RELATIONSHIPS.

Understanding the role of education in the interpersonal relationships of students is of utmost importance. This includes the rational, emotional and ethical aspects. This is particularly important at this sensitive stage of physical and psychological changes in an individual: adolescence, self-assertion, independence, acceptance by peers, etc.

Teachers must continuously asses the appropriateness of their behaviour, basing themselves on their knowledge of the psychological, individual and social factors, keeping in mind that understanding personal growth and maturity of preadolescents and adolescents is essential in this stage of the educational process.

7. SIGNIFICANCE, AIMS, AND STRUCTURES OF PRESENT PROGRAMS

In order to define clearly their teaching plans, teachers must refer to the curricula of all subjects, in relation to the situation of the class and students.

Unlike before, the present programs take into account the adaptation of contents to be taught to the age of learners and their previous knowledge as well as specific requirements and aims of each subject within the broader scope of the general educational plan. They suggest a methodological approach that gives every teacher autonomy in his/her teaching. They clearly define objectives and material to be taught and propose flexible Learning situations.

8. EDUCATION AS A UNIFIED PROCESS

All subjects contribute to promoting the student's knowledge, skills and attitudes, offer solutions to problems, require the student to give verifiable results and require that conceptual organization and verification of what was learnt be consolidated by correct use of appropriate terminology.

All subjects in their variety and particularities form a tool and an opportunity for unified development of an individual, articulate and capable of carrying out diverse functions, with indispensable knowledge, capacities and orientation essential for maturation into a responsible person capable of making reasonable choices.

Besides, it has to meet the needs of the preadolescent and an adolescent who has moved from a general undifferentiating culture in primary school to more articulate and specific knowledge from a large number of subjects, each having its contribution.

Through their particular methods and content, Mathematics, chemistry, physics and natural sciences develop logical capacities of abstraction and deduction and a scientific approach to problem solving through constructive and dynamic relations with reality, supported by basic knowledge and appropriate tools for methodical thinking.

The student will therefore be oriented to an understanding of interactions between mathematical/scientific knowledge and human society which will prepare him/her to make good judgment and proper choices.

Physical and mental health education is an integral part of this process. It aims at instilling awareness of personal and community factors that determine the health of an individual and his environment as well as promote and support it.

9. STUDY TECHNIQUES AND GRADUAL INTEGRATION OF EXPERIENCE AND KNOWLEDGE.

The degree of development attained at the end of primary school has been integrated into the teaching at ordinary level secondary school. It is necessary to see to it that the transition to secondary school is made in a gradual manner and that the student is not subjected to too much pressure. It is also necessary to restart the process which requires the student to efficiently carry out all possible experiments to provoke in him/her interest and motivation to learn.

The scientific method of education which makes up one of the basic aims of teaching at ordinary level will be accomplished by techniques that are rooted in curiosity through easily comprehensible and attainable exercises that enhance the student's ability for abstraction and formalisation.

The inductive method is not separable from deductive one, the two being logical operations in the mental *modus operandi* which is necessary for the development of logical-formal abilities. Certain methodological tools such as individual research and group work must be seen in this perspective. Therefore, at this level, research (preferably to be carried out in class) will be based primarily on adherence to certain points that are particularly useful for learning:

- The definition of the hypothesis to be verified by experiment
- The objective to be attained
- The method chosen and tools to be used

A correct methodological process will continuously approach the material to be taught in a practical, gradual and consistent manner.

The teaching will aim at making the students understand and use subject-specific terminology.

10. FROM INTEGRATION TO DIFFERENTIATION WITHOUT COMPARTIMENTALISATION.

In primary school, Sciences are not differentiated into distinct subjects but are taught as Elementary Science and Technology (EST) using an integrated approach. In primary school, pupils have been taught various scientific concepts, principles, theories and scientific practices without taking into account that they have been observed and formulated by and for man on one hand and that they are in continuous interaction with each other in nature. Even if at the start of the ordinary level, students are taught three scientific subjects separately (Biology, Chemistry and Physics), the risk of studying science in compartments independent of each other will have been removed by the experience of EST. However, such a misconception can occur if care is not taken. It is in this perspective that the revision of the Biology, Chemistry and Physics programs was done in order to avoid compartmentalisation

So, a teacher of one science subject can always refer to another science subject. (Examples: states of matter in Chemistry and Physics, vision, reflection and refraction of light in Biology and Physics; etc). On the other hand, science teachers at ordinary level are advised to avoid teachings that may bring about confusion by supporting interrelation and interdependence between these three sciences in the minds of students .In this regard, there should be an initiative aimed at organizing seminars at which students would gather information, carry out empirical researches and experiments in the three sciences, and present their findings.

11. OUTLINE FOR PRESENTATION OF THE REVISED CURRICULAM

For the presentation of revised curricula, the following outline was adopted for the three science subjects:

1. **General orientation**
2. **General objectives at Ordinary Level**
3. **Approaches to Evaluation**
4. **Program of each year of study**
   5.1 Topics and/or chapters and suggested time allocation
   5.2 General objectives
   5.3 Detailed program

For every topic or chapter:

- The suggested **time allocation** has been taken into consideration,
- **Teaching aids** have been proposed,
- One or more **'Learning situations**' have been suggested, from which the contents of each chapter are deduced
- the curriculum has been broken down into its details by organizing it in columns as follows:

Specific objectives drawn up in terms of skills or know-how and attitudes	Contents or what is to be learnt	Suggestion of teaching-learning activities (experiments / practical demonstrations to be carried out by the pupils under the teacher's guidance in order to reinforce learning)
-		
-		
Etc.	Etc.	

12. MODALITIES FOR IMPLEMENTING THE REVISED CURRICULUM

It should be noted that the outline above for the revised curriculum was adopted on the understanding that **a detailed teacher's guide** would be made for each of the science subject on the curriculum (Biology, Chemistry and Physics) in order to facilitate teaching and learning. This guide will suggest to the teacher, among other things, the **specific components** of each subject curriculum and **methods as well as didactic strategies** considered most appropriate for the teaching and learning of the subject.

Lastly, in order to achieve efficiency in these programmes, we cannot overemphasise the indispensability of the various laboratory materials and equipment and the need for qualified science teachers which can be satisfied only if there is adequate initial training and regular refresher courses. In any case, it goes without saying that the revised curricula cannot be efficiently implemented without first training ordinary level science teachers so that they understand them well and use them appropriately.

PART ONE: ORDINARY LEVEL BIOLOGY PROGRAM

1. GENERAL ORIENTATION

The aim of teaching Biology to young adolescents is to help them understand themselves and to help them understand and live in perfect harmony with the environment. They will have met various values and norms concerning the preservation of health, physical integrity and the environment from their families. In primary school, they will certainly have developed everyday life skills from subjects such as Civics, Science and Elementary Technology which involve concepts of preservation of life and nature. It is certain that age, life experience and knowledge of these principles, acquired by the ordinary level students will prepare them for a degree of independent thought, in the perceiving concepts and in making judgments.

One of the concepts encountered by students on a daily basis is the campaign for environmental protection led by the Rwandan society. One look at the actions undertaken by the politico-administrative authorities as well as the citizens in the hills is enough to prove it. With regard to the Government's options faced with the problem of ecosystem deterioration, it is clear why Ordinary Level Biology mostly involves the preservation of nature and environmental protection. The growing seriousness toward environmental problems and the necessity to prepare the future generation to understand and properly manage their living environment requires that the students be informed on these problems and understand their significance. Therefore, teaching-learning Biology will emphasize on the issues that sensitize the students about man's place in the biosphere and make them think of man's behaviour in nature. An environment sensitive culture among the students is one of the main goals of teaching-learning Biology.

The Biology introduced in this program, leads the students to understand the diversity of living things whose interaction and interrelation makeup the biosphere and also man's place among the animals and plants. It also leads the students to understand the functioning of their own bodies and to subsequently adopt responsible attitudes toward their bodies. It is especially intended to sensitize the students about the risks and scourges faced by humanity and the youth more particularly, for example the AIDS Pandemic, sexually transmitted diseases, drug abuse and others consequences of self destructive behaviour.

Ordinary level Biology is based on a discovery methodology. This is why the program demands practical exercises and various activities to be carried out while learning each topic. This leads the student to discover natural and human facts by observation and experimentation. Therefore, the active group methodology is greatly recommended as long as it favours the discovery of positive information through communication and cooperation. Any methodology adopted by the teacher during his/her teaching should contain simple, clear, comprehensible concepts that are adapted to the students' reality.

2. GENERAL OBJECTIVES OF TEACHING BIOLOGY AT ORDINARY LEVEL

By the end of ordinary level the students should be able to:
- Apply a scientific approach to biological problems;
- Precisely, clearly and logically state biological concepts from the covered topics;
- Observe phenomena, perform research, experiment, analyze results and draw conclusions;
- Respect life and the natural equilibrium;
- Appreciate the mutual relationship between plants and animals and between man and his environment;
- Use the local equipment, basic techniques and available information to improve quality;
- Prevent, avoid and fight against certain endangering practices and diseases such drug abuse, AIDS and STDs

3. SUGGESTED APPROACH TO EVALUATION

The current evaluation approach is partly continuous, during the scholastic year, and partly accumulative for the term, the academic year or the level. Every teacher should have the competence to set improvised or standardized questions, class exercises or home work, general tests or exams, in order to prove whether the methodological goal of knowledge, understanding, application, analysis, synthesis and of evaluation have been attained. Nevertheless, though this practice is unquestionably beneficial, it does not take into account the emotional aspect of certain objectives.

The nature of this Biology program offers many opportunities which favour methodologically complete evaluation. For instance the practical exercises provide a dependable opportunity for analytic and predictive evaluation. Attitude changes among the students as a result of the repeated lessons on the preservation of health and physical integrity can be assessed by simple observation. The gestures or oral expressions made by students when faced with distasteful practices such as the torture of animals during laboratory experimentation is a clear indicator of the emotional state of the student when faced with disregard for ethical principles. The behavioural adaptation to the school's sanitation standards, maintenance of the school garden, sanitation of living quarters and protection of the environment, can be assessed by objectively verifiable indicators.

Generally speaking, the school environment provides the students with the opportunity to integrate Biology concepts. The Biology teacher should always keep that in mind and be sure to assess the students' intellectual, technical and behavioural aspects. This Ordinary Level Biology program demands that the teacher avoid the routine of numbered individualized and standardized evaluation of the cognitive aspect and evolve to levels of evaluation which indicate the variations of individual and/or collective performance, not only in relation to cognitive objectives, but especially on the emotional and psychomotor aspect. It is recommended that graphs be made to indicate the performance evolution.

4. ORDINARY LEVEL FORM 1 PROGRAM

4.1. Topics and their time allocation

Living things	8 periods
Plants	12 periods
Animals	20 periods
The human body	22 periods
TOTAL	**62 periods**

4.2. Form 1 general objectives

The student should be able to:

- Differentiate the 5 groups of living organisms
- Explain the economic importance of micro organisms
- Describe the structure of a flowering plant and the functions of its various parts
- Classify flowering plants as Monocotyledonous (Liliopsida) and Dicotyledonous (Magnoliopsida)
- Give the general characteristics of vertebrates and distinguish between vertebrates from invertebrates
- Identify, locate and describe the organs in the various systems of the human body

4.3 Detailed program

Topic 1: Living Things **(8 periods)**

Teaching aids: beans, pots, prepared sections, charts, diagrams, photographs, pebbles, chalk, hay, **yeast plasticin**, nodules, audio-visual equipment, microscopes

Learning situations Is all that exists alive? Explain
Do all living things share the same characteristics?
Are all living things visible? Explain
Can we live without micro-organisms?
Are all living things useful to man? Why?

General objective 1: Distinguish between the 5 groups of living organisms

Specific Objectives	**Contents**	**Activities or experimentation of Teaching-Learning**
- Identify the characteristics of living things	**Characteristics of living things** Organisms : - are composed of cells - use energy - react to stimuli - reproduce - adapt to the environment - move - excrete - grow and develop	Have the students observe and conclude: - that living organisms have characteristics which rocks, chalk and water do not have ; - how do plants move. Experiment : plant a bean seed in a pot in the class and water it regularly ; Observe how it grows toward the window that brings light into the classroom : this is phototropism - …that organisms need : • energy • raw material

-identify the five groups of living things - identify the different groups of micro-organisms with examples	**Groups of organisms** monera, protista, fungi, plants, animals - Monera : bacteria -Protista : amoeba, mould - Fungi: ex. : edible mushrooms - Plants : Ex. : beans, Eucalyptus - Animals : sheep, man **Micro-organisms** <u>Bacteria</u> : size 0.3-2.5 micrometers, visible only under a microscope; example; fermentation bacteria <u>Algae</u> : visible under microscope ; bleu, brown, red, green algae Microscopic fungi : visible under microscope ; example : ikimeme, an infection between the toes caused by a microscopic fungus <u>Virus</u> : visible under electronic microscope ; example : the HIV AIDS virus	• water and minerals By using questions and answers, demonstrate the characteristics of living things in tree format Explain the groups of living things starting with animals and ending with bacteria, i.e. from largest to smallest Prepare a culture from hey then after 4-5 days observe the growth of paramecia, amoeba and euglena Use charts, diagrams, photos, microscopic slides

General Objective 2: Explain the economical importance of micro-organisms

Specific Objective	**Content**	**Activities or experimentation (practical demonstration) of Teaching-Learning**
- Give examples of micro-	**Useful micro-organisms**	Make a yeast culture to illustrate the

organisms useful to man -Give examples of micro-organisms harmful to man	- Fermentation of beer : fungus; *Saccharomyces cerevisiae* - Recycling of organic waste : fungus and soil bacteria - enrichment of soil : Nitrogen fixing bacteria; *Rhizobium* **Harmful micro-organisms** <u>Sleeping sickness</u> caused by two micro-organisms, *T. brucei rhodesiense* and *T. brucei gambiense* after a person is stung by a tsetse fly. Symptoms : - frequent sleep - headaches - fiver - profuse sweating Prevention : - Measures against the insects <u>Amoeboid dysentery</u> Transmitted by ingestion of *Entamoeba histolytica* cysts. Symptoms : - blood-stained diarrhoea - abdominal cramps - fiver Prevention : Drinking boiled water <u>Measles</u> Very contagious viral disease. Symptoms : - fiver, cough - conjunctivitis - sensitivity to light Prevention Routine immunization AIDS AIDS is the final stage of infection with HIV which causes	fermentation agent (38-39°C) Demonstrate the nodules in leguminous plants Use charts to show the life cycle and mode of transmission

	serious damage to the immune system. Transmission : - sexual relations : oral, vaginal and anal - contaminated blood via blood transfusion or sharing of needles - a pregnant woman can transmit the virus to the foetus by exchange of circulating blood, or a mother can transmit AIDS to her baby through breast feeding Prevention : - abstinence - use of condoms during sexual relations - do not abuse intravenous drugs - HIV positive mothers should not breast feed their children and should avoid pregnancy - post contamination prophylaxis <u>Taenia</u> Disease caused by a microscopic fungus Symptom : - skin and scalp infection - formation of round patches of hair loss, covered in thin fine films - itching of the patch Prevention : Bodily hygiene (especially of the head) Treatment Antifungal Treatment <u>Potato Mildew</u> Caused by a fungus; *Phytophtora infestans* Symptoms : - yellow patches on leaves - tubercle decay	Use available charts, photos, films, video projections *Emphasize that abstinence is the most efficient and sure method of prevention against AIDS* Have the students listen to radio and television programs Encourage discussion and exchange about experiences of AIDS consequences in the family and society level Encourage positive attitudes toward AIDS patients and HIV positive people
- Give examples of micro-organisms harmful to plants		

	Prevention : - sulphate spraying on plants after each rain and in good time - - uprooting of infected plants	

Topic 2: Plants (12 periods)

Teaching aids: plants, Hibiscus flowers , tomatoes, bean pods, male and female *Cupressus*/*Pinus* cones, maize cobs , bean seeds, maize stem, Eucalyptus stem, charts

Learning situations:

- What are the characteristics common to the surrounding plants?
- What are the elements that distinguish them from each other?
- Do all the surrounding plants have flowers?
- Are all parts of a plant useful?
- Do all plants produce similar fruit?

General Objective 3: Describe the structure of a flowering plant and the functions of its various parts

Specific Objectives	**Contents**	**Activities or experimentation (practical demonstration) of Teaching-Learning**
- Describe and draw the various parts of a flowering plant - Identify the characteristics, types and functions of the various parts of a flowering plant	**Parts of a flowering plant**: leaves, flowers, stem, roots and fruits **Characteristics, types and functions** <u>Roots</u> Characteristics : - develops from the radical; - it end with a cup and has absorbing hairs ; - have no leaves and no buds , Types : - main/tap root develops from seminal root and has secondary roots; E.g.: carrot - fibrous roots : there is no main root all roots are of the same thickness E.g.: sorghum - adventitious roots : grow along the stem E.g.: grass, sorghum Function: - support plant on the ground; - absorb water from the soil as well as the substances dissolved in the water; - transport nutritive elements absorbed in the soil (raw sap) toward the stem <u>Stems</u>: Characteristics: - its axis is usually aerial and continuous with the root; - holds the leaves and buds; - it has branches Types :	Have the students collect a flowering plant ; observe, describe and draw the various parts Have the students collect various plants with roots ; classify the roots according to their similarities; ask the students what function the roots have Collect stems and leaves

	- erect : avocado stem - underground (rhizomes, bulbs tubercles) : are found in the soil ; -woody stem: tree stem, shrubs,… - herbaceous stems : grass stems, ishinge Functions : - support aerial portion of plant; - growth organ - holds leaves and buds; - transports nutritive elements absorbed by the roots (raw sap) toward the leaves as well as substances synthesized in the leaves (processed sap) toward the lower parts <u>Leaves</u>: Characteristics: - specialized for photosynthesis; - attached to stem at the nodes; - it has a lamina and a petiole; - has veins (mid rib and veins) - has stomata for transpiration and respiration Types: - simples leaves: the lamina is continuous and whole; e.g.: avocado or Eucalyptus leaves -compound leaves: the lamina is composed of many small leaves or leaflets. E.g.: the bean leaf has three leaflets Function: - site of photosynthesis; - site of transpiration and respiration <u>Flowers</u>: Characteristics: - contain the male or female reproductive organs; - are sometimes hermaphrodite (Hibiscus) ; - develop into fruits	Dissect, identify, draw and give the function of the various parts of a *Hibiscus* flower

	- parts of a flower: calyx (sepals), corolla (petals), stamen (male), ovary with style and stigmata (female) Types : - unisexual flowers: have only male sex (unisexual male) or female (unisexual female) - bisexual flowers : have both sexes -flowers are either solitary or in groups (inflorescence) Function : - reproduction in plants; - attract pollinating insects (or contain repulsive substances) ; - used as decorations <u>Fruits</u> : Characteristics: - develops from the transformed ovary; - usually edible - dispersal organ (maize, sorghum) Types : - dry fruits (dehiscent, indehiscent); e.g. : bean pods are dry dehiscent fruits - fleshy fruits (berries, drupes) e.g.: a tomato is a berry, an avocado is a drupe Function: - protects seeds - fruits are edible - some are poisonous <u>Seeds</u>: Characteristics: - develop from fertilized ovule - dispersal organ -is comprised of the endosperm or cotyledons (stores), the embryo and the testa	Give examples of dry fruits (bean pod) and fleshy fruits (tomato, avocado)

	Types - monocotyledonous seeds; contain stores for the embryo in the endosperm; e.g.: maize seed - dicotyledonous seeds: contain stores for the embryo in the cotyledons; e.g.: bean seed Function: - plant dispersal - germination ; - some seeds are edible - contain stores for the embryo	

General Objective 4. Classify flowering plants into Monocotyledonous (Liliopsida) and Dicotyledonous (Magnoliopsida)

Specific objectives	**Content**	**Activities or experimentation (practical demonstration) of Teaching-Learning**
- identify the groups of flowering plants	**Groups of flowering plants** Gymnosperms: plants with exposed seeds, not protected by the flower ; flowers have cones E.g.: *Pinus*, *Cupressus* Chlamydosperms: plants whose seeds are more or less protected; flowers with no cones ; Example : *Welwitschia*, a plant found in Namibia Angiosperms: plants whose seeds are protected by the fruit; E.g.: Bean, Avocado. Angiosperms are further divided into Monocotyledonous (Liliopsida) and Dicotyledonous (Magnoliopsida)	Have the students observe the morphology and the males and female *Cupressus* /*Pinus* cones Observe the bean fruit ; the seeds are enveloped in a pod

- Identify the characteristics of monocots (Liliopsida) and dicots (Magnoliopsida) and give examples	**Characteristics of Monocots and Dicots** Monocots (Liliopsida): have parallel leaf veins, a single cotyledon, herbaceous stems, fibrous roots; (E.g.: maize) Dicots (Magnliopsida) : have non- parallel leaf veins, two cotyledons, woody stems, well formed roots (Ex. : E*ucalyptus*)	Soak maize and bean seeds in water; dissect them and observe the cotyledon(s) Observe et compare the veins in the bean and in the maize Press a maize stem and a *Eucalyptus* branch between the fingers and recognize the herbaceous consistency and the woody consistency

Topic 3: Animals (20 periods)

Teaching aids: freshly killed animal specimen, fixed specimen, charts, diagrams, plastic models, formol

Learning situations:

- What are the similarities and differences between animals?
- Here are seven animals : millipede, earthworm, mouse, lizard, spider, fish, cockroach; classify them into two categories and give the criteria used in the classification
- Identify organs that have the same function?

General objective 5: Give the general characteristics of vertebrates and distinguish between vertebrates and invertebrates

Specific objectives	Content	Activities or experimentation (practical demonstration) of Teaching-Learning
- Define and describe the main characteristics of vertebrates - Identify the characteristics of the different classes of vertebrates and give examples Give a general view of the external morphology of one representative from each group	**Vertebrates** Vertebrates: animals that have a vertebral column Characteristics : notochord, dorsal spinal cord, pharyngeal cavity, post anal tail, cartilaginous or bony endoskeleton Fish: Tilapia, cat-fish Amphibians : frogs, toads Reptiles : Chameleon, snakes Birds : fouls, eagle Mammals : man, gorilla, rabbit	Use the available charts diagrams and prepared specimens to illustrate the characteristics of each class Observe the external characteristics of a tilapia and a toad to show the morphological characteristics *Sensitize the students on the ethical implications of killing the animals with disregard. An effort should be made to diminish the animal's suffering as much as possible.* Kill the animal with a single blow to the head
- Draw and interpret the external morphology of a fish, a frog or a lizard	Include the different body parts and skin appendages (scales, hairs,..) in each drawing	Use models, charts or specimens

-Identify the general characteristics invertebrates - Identify the characteristics of the various invertebrate groups (classes) - Explain the importance of invertebrates to man	**Invertebrates:** Invertebrates: animals that have no vertebral column Characteristics: solid ventral notochord; absence of endoskeleton Arthropods : - Insects (e.g. flies, cockroaches) - Arachnids (e.g. spider) - Myriapods (ex. : millipedes) - Crustaceans (crabs, lobsters) Molluscus (e.g. snails) Annelids (e.g. earthworms) Simple worms : - round worms (e.g. ascaris) -flat worms (e.g. taenia) Useful invertebrates: Arthropods – *Daphnia magna* (toxic taste) for assessment of risk and screening tests - butterfly, moth, bees - bees produce honey and wax - bee stings have medical significance - Silk worms produce silk Crabs and lobsters are pricey dishes Molluscs : marine molluscs are used to assess the toxic effect of marine pollutants - fresh water and marine molluscs are a source of nutritive appetizing dishes - the shells are used for decoration and jewels Les Annelids -Earthworms- prolong the fertility of land (natural soil labourers)	Point out some characteristics of each group (phylum and class) Discuss the importance of bees

	Harmful invertebrates: Arthropods - wasps, termites and scorpions cause dermatological allergic reactions and neurological reactions that are sometimes fatal - ticks and mites are parasites, they feed on blood and spread diseases - insects damage harvests, clothing and wood (fixed or mobile) - Molluscs- snails feed on plants and damage harvests some snail species are hosts to parasites that infect man	Discuss the importance of arthropods and molluscs

Topic 4: The human body (22 periods)

Teaching aids: charts, model diagrams, long bones, vertebrae, ribs, histological sections, microscopes, models, magnifying glasses, fresh goat, sheep and cow organs, microscopic blood slides, human skeleton model

Learning situations:

- What are the structural differences between man and domestic mammals?
- What proves that you are really alive? Justify
- What will your reaction be if your friend faints?

General objective 6: Identify, localize and describe the organs of the various systems in the human body

Specific objectives	Content	Activities or experimentation (practical demonstration) of Teaching-Learning
Identify the five parts of the human body - Identify the various internal and external organs associated with each body part - Describe the general structure of the human skeleton and identify the bones of the central and peripheral parts	**Parts of the human body** Head Neck Trunk : thorax, abdomen Upper limbs Lower limbs Head : eyes, nose, ears, mouth, chin Neck : oesophagus, trachea Thorax : breasts, sternum, shoulder, lungs, heart, ribs Abdomen : navel, pelvic region, pubic region, lumbar region, buttocks, stomach, intestines, liver, kidney, ovary, bladder **The skeleton** Parts : central, peripheral The central skeleton consists of the skull, the vertebral column and thoracic cage - The skull consists of cranial bones forming the cranium or cranial box, as well as facial bones which support the jaws, eyes and nose - The vertebral column: is composed of 26 bones (vertebrae) of which the most are fused in the pelvic region forming the sacrum. The terminal vertebrae are fused forming the coccyx - Thoracic cage**:** if formed by 12 pairs of ribs and the flat sternum	Show the various parts on a volunteer student ; use charts, models, diagrams Show the students a long bone, a vertebra, and ribs Use charts and the skeleton models Use charts, skeleton models and diagrams

- Describe the various components of the digestive system	The peripheral skeleton is composed of bones of the upper and lower limbs, the shoulders and the pelvic belt Bones of the upper limbs : - humerus (supports the arm) - radius and ulna (support the forearm) - carples, metacarples and phalanges support the hand (27 bones) **Digestive system** From the anatomical and functional point of view, the system is divided in two : the alimentary canal and the accessory organs -The alimentary canal is composed of the buccal cavity, the pharynx, the oesophagus, the stomach, the small and large intestines The accessory organs consist of the teeth, tongue, salivary glands, liver, gallbladder and pancreas - movements include the following : • ingestion (food in the mouth) • chewing (chewing and mixing of food with saliva) • swallowing • peristaltic movement (peristaltic contraction of the GIT) - secretion • exocrine (gastric and intestinal tract) • endocrine (hormones) - digestion (breakdown of food) - absorption- passage of nutrients into the blood - defecation	Draw and label the digestive system and have the students give the importance of chewing and regular defecation

- Describe and identify the parts of the respiratory system and associated organs - Describe the main components of the circulatory system - Describe the location and structure of the kidneys and the constituents of the urinary system	**Respiratory system** The respiratory system is divided into two : - respiratory canals; conduction of air toward the respiratory tissue ; composed of nasal and buccal cavity, the pharynx, the larynx, the trachea and the bronchi - respiratory tissue ; site for gaseous exchange ; composed of alveolar canals, alveoli and alveolar sacs **Circulatory system** - the heart : a double pump with four chambers exerting the needed pressure to pump blood in the vessels toward the lungs and body cells -blood vessels: arteries and veins - blood : composed of a liquid portion called plasma and other components (red blood cells, white blood cells and platelets) **Urinary system** Kidneys : - they are bean-shaped - are found between the dorsal part of the body wall and the peritoneal wall - each kidney weighs about 75g - average dimensions: 2cm long, 6 cm high et 3cm wide -each kidney contains about 1 million nephrons or plasma filtration units - each nephron consists of a glomerulus, a proximal and a distal convoluted tubule, and a collecting duct **Reproductive system** Components of the male reproductive system : - testicles : produce spermatozoa and are located in the	Draw and label the various parts of the respiratory system in particular the trachea, larynx, and the lungs Use the available charts Dissect a goat, sheep or cow heart to observe the chambers, valves and associated vessels Use available charts and diagrams to show the organization of the heart and major blood vessels Observe microscopic slides of human blood and distinguish between white blood cells and red blood cells Use charts and diagrams to show the organization of the urinary system

	scrotum	
- Describe and localize the constituents of the male and female reproductive systems	- the epidydimus is located above the testicles where the spermatozoa acquire mobility - the vas deferens is a canal through which spermatozoa pass from the testicles to the urethra - the urethra : conducts sperms into the vagina ; it also conducts urine Accessory glands of the male reproductive system: Seminal glands, prostate gland, bulbo- urethral gland and the penis Constituents of the female reproductive system : - ovaries : are located on each side of the uterus and contain tiny eggs called ova or oocystes surrounded by follicular cells - fallopian tubes : pathway for ovules from the ovaries to the uterus - uterus : it is located anterior to the rectum, it has thick walls whose function is to receive, retain and nourish the blastocyst - vagina : receives the penis; opening through which the baby passes during child delivery	Use charts and diagrams to show the organization of the various parts of the male reproductive system Use charts and diagrams to show the organization of the various parts of the female reproductive system
- Identify the main constituents of the nervous system	**Nervous system** The central nervous system- brain and spinal cord An adult brain weighs about 1.5kg and comprises about a hundred billion neurons Parts of the brain : cerebrum, thalamus, hypothalamus, mid-brain, pontus, cerebellum**,** mesecephalus Peripheral nervous system: sensory, motor and mixed nerves (12 pairs)	Use the charts to show the constituents of the human nervous system

- Distinguish between the central nervous system (CNS) peripheral nervous system (PNS)	**Distinguish between the CNS and the PNS** - In the CNS the neurons are collectively known as nuclei; in the PNS neurons are collectively known as ganglia - In the CNS, neurons are collectively known as tracts ; In PNS, neurons are collectively known as nerves	Draw and label the various parts of the brain

5. ORDINARY LEVEL FORM II PROGRAM

5.1. Topics and their time allocation

Nutrition	16 periods
Circulation	8 periods
Respiration	6 periods
Excretion	4 periods
Non flowering plants	8 periods
The cell	8 periods
Protozoa	4 periods
Immunity	4 periods
Organisms and the environment	4 periods
TOTAL	**62 periods**

5.2 Form II general objectives

The student should be able to:

- Identify the nutrients in food and determine the basics of a complete and balanced diet
- Describe the successive transformations of food during digestion
- Explain the conditions, function, and product of photosynthesis
- Locate and describe the elements and functioning of the circulatory system in man
- State some diseases transmitted through blood, preventive measures and practices that favour the health of the circulatory system
- Explain the constituents and functioning of the respiratory system
- State the common diseases of the respiratory system and the preventive measures and practices that favour the respiratory health
- Define excretion, the organs of excretion and excretory waste
- Describe the organization of the urinary system in man and the function of its constituents
- Differentiate and classify non-flowering plants and determine their importance (useful and harmful)
- Describe the constituents and functioning of an animal cell and a plant cell
- Describe the protozoan mode of life and identify the main kinds
- Explain the human mechanism of defence against pathogenic microbes with emphasis on natural and artificial immunity
- State the interrelations between the living things in a natural environment

5.3 Detailed program

Topic 1: Nutrition (16 periods)

Teaching aids: Alimentary pyramid, charts, audio-visual equipment, potato flour, test tubes, saliva, iodine, green plants, black plastic, water, aquatic plant, beaker with lid, matchbox

Learning situations:

- Why do we need to eat?
- Do you think a very fat man or woman is feeding well?

- Do plants feed? How?
- Is it necessary to eat a variety of foods? Why?

General objective 1: Identify the composition of foods and determine the basis of a complete and balanced diet

Specific objective	Content	Teaching-Learning activities
- Give the nutrients of foods, identify their source and their functions	**Food nutrient** Carbohydrates : bread, potatoes, legumes, rice, spaghetti, fruits and vegetables ; Function : production of energy for the organism Proteins : fish, meat, eggs, beans ; function : construction and repair of tissues Fats : butter, margarine, fish, meat, walnuts, vegetable oil, milk and milk products; function : source of energy Vitamins : vegetables, fruits, milk; functions : growth, various body functions Vitamin A : carrot, spinach, milk, liver, cassava leaves Vitamin B1 : peas, beans, green vegetables Vitamins C : fruits (orange, lemon, tomato), vegetable leaves Vitamin D : butter, eggs, cheese, fish, liver, sunshine Mineral salts : Calcium (milk, milk products) ; functions : growth, reinforcement of bones and teeth Sodium : vegetables, legumes, fruits, fish, meat, salt	Ask the students what meals they have at home or at school Using questions and answers, determine the nutrients of these foods Determine the functions of each nutrient Draw a table indicating each nutrient and its function *Emphasize the limitation of daily consumption of red meat (beef, goat meat, mutton) and of avocado* *Regularly expose young children to the morning sunshine (solar rays are involved in the formation of vitamin D in the skin)* *Avoid heavy consumption of rock salt*

	function : regulation of fluid equilibrium in the body Potassium : cereals, vegetables, legumes and fruits ; function : body fluid balance Iron : liver, beef, grapes, dates ; function : formation of red blood cells Phosphorus : milk products, fish, meat ; function : reinforcement of teeth and bones Zinc : rye bread, peanuts, almonds, melon seeds **;** function : normal growth, increases immunity Molybdenum : tomato ; function : excretion of uric acid and utilization of iron	*It is advised for pregnant women to consume iron rich foods.*
- Give the definition, composition and functions of a balanced diet	**Balanced diet** : A diet containing an adequate quantity of each nutrient necessary for healthy growth and activity Composition : (1) milk group : milk, cheese, yoghurt (2) meat group : meat, legumes, walnuts (3) fruit and vegetable group : fruits and vegetables (4) grain group : bread and cereal Function : a balanced diet offers optimum energy, growth and development	Ask about the food in their daily meals Assess the presence of food groups in those meals Explain the importance of consuming the food groups in the proportions portrayed in the food pyramid (*appendix 1, food pyramid model*)

- Give guidelines for good feeding habits - Name diseases caused by nutritional deficiency or excess	**Good feeding habits** - take three meals a day : consistent breakfast, lunch and supper - eat foods of each group - drink enough water during the day **Diseases** Diseases due to nutritional deficiency : Marasmus : malnutrition in children and adolescents caused by severe calorie deficiency ; dry skin, thin body Kwashiorkor : severe protein deficiency Goitre : swelling of the thyroid caused by iodine deficiency Night blindness : vitamin A deficiency Disease cause by nutritional excess : Obesity : excess calories stored in the body	Have the students propose healthy feeding practices and sensitize them about the following practices : - *Eat fruits and vegetables in each meal* - *Avoid drinking too much water during meals* - *Do not exchange forks while eating* Use the available charts and photos (images from the web, FAO,…) *Sensitize the students on the possibility of preventing these diseases by having a balanced diet*

General objective 2: Describe the successive transformations of food during digestion

Specific objective	Content	Teaching and Learning Activities
- Explain the various stages of food digestion	**Digestion** mechanical digestion -chewing (mouth) - Swallowing (pharynx) - peristaltic movement (stomach and intestines)	Use charts to show the various parts of the digestive system where the stages take place

	Chemical digestion: Carbohydrates - salivary amylase in saliva initiates the breakdown of carbohydrates - pancreatic amylase partially reduces digested carbohydrates into simple sugars <u>Proteins</u> - rennin coagulates milk in the stomach - pepsin breaks down proteins into peptides - trypsin and chymotripsin in the pancreatic juice break down proteins into amino acids Lipids - gastric lipase initiates the digestion of fats - bile emulsifies fats in the duodenum - pancreatic lipase reduces fatty food into simpler form	Experiments showing: - the breakdown of starch by saliva: put potato flour in a test tube and add saliva; notice that iodine does not cause a blue coloration
- Define digestion and explain its importance	**Importance** Digestion is the process by which food and drinks decompose into simpler particles useful for the building and nourishment of cells and the provision of energy - the food we eat is in complex form that can not be assimilated - digestion breaks them down into simpler forms for assimilation	With help from the elements above, have the students define and give the importance of digestion using questions and answers
- Name the practices that favour good functioning of the digestive system	**Good practices** - brushing of teeth after meals - consume fresh food and drink enough clean water - eat regularly and on time to speed up gastric secretion and avoid gastric ulcers	Have the students propose practices that maintain digestive health

	- use clean utensils - regular defecation - avoid excessive feeding	

General objective 3: Explain the conditions, function and product of photosynthesis

Specific objective	Content	Teaching and Learning activities
- Define photosynthesis and state its conditions	Photosynthesis Photosynthesis is a metabolic process by which green plants use light energy to synthesize organic compounds (carbohydrates) from the surrounding water and carbon dioxide. Conditions for photosynthesis: - atmospheric carbon dioxide - water and mineral salts absorbed from the soil - sun light - chlorophyll - temperature: temperatures between 30 and 40°C favour photosynthesis in tropical environment Where does photosynthesis occur: in the green parts of a plant, especially the leaves The chemical reaction of photosynthesis: $6CO2+6H2O \rightarrow C6H12O6 + 6O2$ in the presence of light and chlorophyll	Experiment: Cover a leaf with black plastic and observe its colour after 48 hours; notice the bleach on the leaf; test for the presence of starch in the bleached leaf and in a green leaf Explain the absence of starch in the bleached leaf
- Identify the primary products of	the primary products are therefore glucose and oxygen which diffuses into the atmosphere	Experiment: Put an aquatic plant in a beaker that is ¾ full of water, cover the beaker but

photosynthesis		leave an opening in which a test tube containing water is inverted Notice the bubbles rise into the tube then light a flame into tube (emptied of water); the tube will flame because it contains some oxygen
- Identify other products formed from glucose	Other products formed from glucose: proteins, lipids, vitamins, carbohydrates	*Explain to the students that these products are formed from glucose and that the mechanism of their synthesis will be explained in upper classes*
- Explain the importance of green plants	Importance: - nourishment for man and animals - Atmospheric oxygen balance by diffusing oxygen into air - Protection against atmospheric pollution by absorption of atmospheric carbon dioxide	Have the students discuss the importance of green plants in everyday life Have the students explain the necessity to keep plants in the living room
- Define and distinguish between autotrophic and heterotrophic organisms	**Autotrophic and heterotrophic organisms** autotrophic organism: synthesizes the organic matter it needs for its metabolism by itself in the presence of light, water, carbon dioxide and mineral salts Heterotrophic organism: does not synthesize the organic matter it needs for its metabolism Difference: An autotrophic organism carries out photosynthesis where as a heterotrophic	Ask the students how plants acquire the organic matter on which they feed Ask the student how goats acquire the organic matter on which they feed Come up with the definition and difference between autotrophic and heterotrophic organisms from the given answers

	organism feeds on organic matter produced by plants	

Topic 2: Blood circulation (8 periods)

Teaching aids: charts, models, diagrams, blood artery and vein sections, fresh goat or sheep heart

Learning situations:

- How does the food we eat reach the various parts of our bodies?
- How does a paracetamol tablet cure a headache when swallowed?
- Can one receive blood transfusion from anyone? Why?

General objective 4: Locate and describe the constituents and functioning of the human blood circulatory system

Specific objective	Content	Teaching and Learning activities
- Describe the location and anatomy of the human heart - Explain the difference between the main blood vessels types: arteries, veins and capillaries	**Anatomy of the heart** thoracic cavity between the lungs Chambers: 2 atriums, 2 ventricles Direction of the blood flow through the various chambers and the function of the valves **Blood vessels** Artery and vein walls are composed of three layers - arteries: thick muscles and small lumen; contain elastic fibres - veins: finer muscles and wider lumen; some veins have valves but no elastic fibres - capillaries: composed of a single layer of	Use charts, models and diagrams to show the structure of the heart in longitudinal section Dissect a goat or sheep heart to show the heart chambers

	endothelium; no muscles, no connective tissue	
- Give the composition and function of blood	**Composition and function** - Liquid part (plasma 55 % of the total blood volume) - Solid elements (45 % of the total blood volume) - Red blood cells (erythrocytes, about 4,5 million cells / ml); function: oxygen transportation - White blood cells (leucocytes, about 5.000-9.000 / cm3) function: defence of the organism - platelets (150.000-400.000 / cm3); function; prevention against bleeding	Use charts / diagrams to explain the composition of blood, and the structural difference between red blood cells and white blood cells
- Identify the direction blood flow through the heart and differentiate pulmonary circulation form systemic circulation	**Direction of blood flow** Pulmonary circulation: Lungs, the pulmonary arteries transport deoxygenated blood from the right ventricle to the lungs; four pulmonary veins transport the oxygenated blood from the lungs to the left artery systemic circulation: Composed of all other vessels including the aorta	Use charts / diagrams to show the direction of blood circulation
- Explain the concept of ABO blood groups	**Blood groups** Antigen: a living or non living substance recognised by the immune system as foreign body	Explain the concept of blood donor and recipient with the aid of an (ABO) blood group card

	Antibody: protein molecule present in blood plasma Group A: red blood cells contain the A antigen ; plasma contains the anti-B antibody Group B: red blood cells contain the B antigen plasma contains the anti-A antibody Group AB: red blood cells contain antigens A and B; plasma contains neither the anti-A antibody nor the anti-B antibody Group O: red cells contain neither antigen A nor antigen B; plasma contains both antibodies; anti-A and anti-B	

General objective 5: Identify some diseases transmitted through blood, the preventive measures and propose practices which favour the health of the circulatory system

Specific objective	Content	Teaching and Learning activities
- Identify the common diseases transmitted through blood and the preventive measures	**Diseases and prevention** Hepatitis B: disease of the liver caused by the hepatitis B virus(HBV); virus found in the blood of infected people, generally transmitted through unprotected sex Prevention - avoid unprotected sex - vaccination Hepatitis C: diseases of the liver caused by the hepatitis C virus (HCV); virus transmitted by injection with contaminated blood	

- Name the practices that favour the health of circulatory system	Prevention - avoid unprotected sex HIV / AIDS: has neither cure nor vaccine **Healthy practices** - physical exercise, games, jogging - avoid oily, cholesterol rich diets - avoid stress and anxiety - avoid alcohol and tobacco - avoid extremely tight clothing	Compare students' pulse-rates at rest and after a race

Topic 3: Respiration (6 periods)

Teaching aids: Charts, models

Learning situations:

- Stop breathing. How do you feel?
- How does a man with asthma breathe? Why?
- Why do classrooms have many windows?

General objective 6: Explain the constituents and functioning of the respiratory system

Specific objective	Content	Teaching and Learning activities
- Give the composition of inhaled air and of exhaled air	**Composition of air** Inhaled air contains more oxygen than carbon dioxide Exhaled air contains more carbon dioxide than	

- Explain the respiratory movements and gaseous exchange in the lungs (alveoli) - Identify the main function of respiration	oxygen **Respiratory movements** - inspiration movement: movement of intercostal muscles and descent of the diaphragm - expiration movement: movement of intercostal muscles and relaxation of the diaphragm **Function** Transport of oxygen Transport of carbon dioxide Energy production by the breakdown of glucose in tissues / cells	Ask the students to make inspiration and expiration movements and observe the enlargement and shrinking of the chest

General objective 7: Identify the common respiratory diseases and the preventive measures and propose practices that favour respiratory health

Specific objective	Content	Teaching and Learning activities
- Identify some common respiratory diseases, their causes and prevention	**Diseases, symptoms and prevention** flu: over 200 viruses cause the symptoms of influenza; rhinovirus causes 30-35 % of all adult influenza cases Symptoms: - running nose - difficult nasal breathing - cough - headache - fever - throat irritation	Have the students identify some respiratory diseases and discuss measures of prevention

- Identify practices that favour respiratory health	- sneezing Prevention: - avoid infected people - cover the nose and mouth if infected in order to avoid the contamination of others Asthma: results from several agents such as cold air, pollen or allergens like dust, moths, cats, dogs, mushrooms, … Symptoms: difficult breathing, congestion of lungs Prevention: - avoid domestic dust, mildew, pollen - try to identify the allergen and avoid it - avoid contact with furry animals - avoid smoking and smoke <u>Pneumonia</u>: infection or inflammation of lungs; caused by: microbes, viruses, chemicals, contagious agents such as mushrooms, etc pneumonia caused by pneumococci results in a sudden high fever, cold, breathing difficulty, chest pain Prevention: vaccination <u>Lung cancer</u>: often linked to cigarette smoking and is a terminal disease Symptoms: persistent cough, husky voice, chest pain, fever, recurrent bronchitis or pneumonia Prevention: - avoid smoking; quitting cigarette smoking reduces mortality **Healthy practices** - Regular morning walk - avoid smoking - breathe through nose	Keep the house and classroom well ventilated

	- cover the mouth from dust - ventilate homes, offices, and classrooms	

Topic 4: Excretion (4 periods)

Teaching aids: Charts, models, diagrams

Learning situations;

- Why do we sweat after running or after much physical effort?
- People think faeces come from the food they ate and urine comes from the drinks they had. What do you think of this?

General objective 8: Define excretion, excretory organs and excretory waste

Specific objective	Content	Teaching and Learning activities
- Define excretion - Identify the excretory organs and their products	Excretion: Elimination of the toxic products of the metabolism Excretory organs - Skin: sweat - lungs: carbon dioxide - liver: bile - kidney: urine	Have the students run around the school and ask them to taste their sweat then explain why it is salty

General objective 9: Describe the organization of the human urinary system and the functions of its constituents

Specific objective	Content	Teaching and Learning activities
- Identify the location of the kidneys, ureter,	Urinary system	Use charts and models to explain the

bladder and urethra, and give their functions - Draw a longitudinal section of the kidney and label the main parts (cortex, medulla, renal pelvis, ureter) - Identify the common urinary diseases - Propose practices that favour urinary health	Kidney: behind the peritoneum, on each side of the vertebral column Function: filter nitrogenous wastes from blood plasma to form urine Ureter: located on the medial border of each kidney Function: passage of urine from the kidney to the bladder Bladder: located anterior to the rectum; function: store urine temporarily Urethra: conducts both semen and urine in males; conducts urine in females Diseases Dysuria: pain during urination: sign of urinary infection Polyuria: urinate large quantity (often in case of diabetes) Incontinence: inability to retain urine, normally seen in infants and children Blockage of the urinary system caused by the formation of kidney stones Healthy practices - drink water - avoid retaining urine for long periods - sanitation of school and home toilets - use toilet paper	organization of the urinary system Use the available charts to draw a longitudinal section of the kidney

Topic 5: Non-flowering plants (8 periods)

Teaching aids: fresh plants, microscopes, microscopic sections, charts

Learning situations:

- Do all plants have flowers?
- Have you noticed irregular patches on tree trunks? Are they plants or not? Justify

General objective 10: Differentiate and classify non-flowering plants and determine their importance (useful and harmful)

Specific objective	Content	Teaching and Learning activities
- Identify the various groups of non-flowering plants - describe the vegetative structures in the various groups	Various groups: Pteridophytes, Bryophytes, Algae, Lichens **Vegetative structure** Pteridophytes: e.g.: Ferns - rhizome (underground stem), roots, leaves or fronds; - rolled and crossing young leaves; - sap conducting vessels Bryophytes: e.g.: moss - stem, tiny leaves; no roots but the rhizoides fix the plant on the substrate; - no sap conducting vessels Algae and lichens:	Use living material from the school gardens to illustrate the vegetative structures of non flowering plants Collect algae and observe the filaments under a microscope with small magnification and draw

- Determine the importance of non-flowering plants	- no stem, no leaves and no roots; nondescript vegetative structure called the thallus consists of algae, fungi (mushrooms), lichens Algae: e.g.: *Spirogyra* Green filamentous algae: thallus composed of closed filament or not Lichens: association of an algae and a mushroom composed of a mixture of fungus filaments (mycelia) and algae cells **Importance** - Algae: fixation of atmospheric nitrogen by the blue algae; - certain algae are edible (*Spirulina*) - Lichens: certain lichens are used for medicine (*Lobaria pulmonaria* used for pulmonary diseases) Bryophytes: - participate in turf formation - used in medicine and in pharmaceuticals - animal feed - pollution indicators Pteridophytes - used for decoration (Selaginella) - medicine: male fern used for digestive disorders - used to increase the fertility of rice fields (Azolla live in symbiosis with nitrogen fixing cyanobacteria) - food for fish	Collect specimens of lichens on tree trunks or rocks, observe the vegetative structure Discuss the uses of some non-flowering plants in everyday life *Avoid eating a mushroom before you are sure that it is edible*

Topic 6: The cell (8 periods)

Teaching aids: microscopes, microscopic slides of animal and plant cells, charts, diagrams, audio-visual equipment

Learning situations:

- The basic unit of a house is a brick; what is the basic unit of an animal / plant?
- How do plants and animals grow?
- How do human beings and trees remain alive?

General objective 11: Describe the elements and functioning of an animal cell and a plant cell

Specific objective	Content	Teaching and Learning activities
- Define a cell	**The cell:** - the structural and functional basic unit of living organisms	
- Identify and describe the main parts of an animal cell in general and give their functions	**Main parts of an animal cell** Cell membrane: external part of animal cell Nucleus: structure that contains chromosomes (hereditary information of the cell) and which controls the growth and reproduction of the cell Mitochondria: respiration Lysosomes: breakdown of food and destruction of microbes Centrioles: cylindrical structures that arrange microtubules during cell division	Use charts and diagrams to identify the main structures
- Identify and describe the main parts of a	**Main parts of a plant cell** Cell wall: composed of cellulose and proteins,	

plant cell in general	and in several cases it is composed of lignin, covering the cell membrane Nucleus: contains chromosomes (hereditary information of the cell) Mitochondria: respiration Cell membrane : is found under the cell wall Vacuole: store of water and other substances Plastids: contain chloroplasts useful in photosynthesis among other things	Use charts and diagram to identify the main structures of a plant cell
- Distinguish between an animal cell and a plant cell		Draw a table of comparison between an animal cell and a plant cell
- Define: tissue, organ, system, organism	**Tissue, organ, system, organism** Tissue: group of cells with a common structure and function e.g.: epithelial tissue, sclerenchyma Organ: is composed of a group tissues E.g.: root, stem System: formed by a group of organs E.g.: a plant's reproductive system consists of all the male and female organs Organism: composed of all the systems	
- Briefly describe the phases of mitosis and define cytoplasm division	**Mitosis and cytoplasm division** Prophase: chromosome is visible Metaphase: chromosomes are arranged along the equatorial region Anaphase: chromosomes separate toward opposite poles	Use charts and diagrams to illustrate the various phases

- Explain following processes: plasmolysis, osmosis, phagocytosis, turgidity	Telophase: chromosomes assemble in new nuclei Cytoplasm division: division of the cytoplasm that occurs after nuclear division **Plasmolysis, osmosis, phagocytosis, turgidity** Plasmolysis: detachment of the protoplasm from a plant or bacterial cell wall due to water loss by osmosis Osmosis: movement of water molecules from a less concentrated solution to a more concentrated solution across a semi-permeable membrane Phagocytosis: engulfing, ingestion and assimilation of bacteria or other foreign bodies by phagocytes Turgidity: the expansion of a cell resulting from the absorption of water	Compose experiments that illustrate plasmolysis, osmosis, turgescence

Topic 7: Protozoa (4 periods)

Teaching aids: microscopes, microscopic slides, charts, diagrams
Learning situations:

- Can a single celled organism carryout all its vital functions?

General objective 12: Describe the protozoan mode of living and identify their main groups

Specific objective	Content	Teaching and Learning activities
- Draw and label an amoeba	**Amoeba** Drawing of an amoeba with labels: cell membrane, nucleus, food vacuole, contractile vacuole, pseudopodia	Use charts and diagrams to explain the structure of an amoeba Ask the students to draw an amoeba
- Describe the mode of living of an amoeba	**Mode of life** Locomotion: movement by pseudopodia (false feet) Nutrition: feed on microbes, on fine filamentous algae and on ciliates; Excretion: accomplished by contractile vacuole Reproduction: binary fission, multiple division	Use diagrams drawn as tables, illustrate the locomotion and feeding of an amoeba
- Name the characteristics of Sarcodina, Ciliates, flagellates and Sporozoa with examples	**Classification** Sarcodina (Rhizopodes): locomotion by pseudopodia (example: amoeba) Ciliophora (Ciliates): locomotion by cilia (example: Paramecium) Zoomastigina (Flagellates): locomotion by flagella (example: Trypanosoma, Giardia) Sporozoa: no known locomotion (example: Plasmodium)	Draw a table classifying the various phyla

Topic 8: Immunity (4 periods)

Teaching aids: charts, diagrams, audio-visual equipment

Learning situations:

- How come one of two people who live together and share the same bed can be infected by malaria while other remains healthy?
- Why use antiseptic soap to bathe?

General objective 13: Explain the human defence mechanism against pathogenic microbes and put special emphasis on natural and artificial immunity

Specific objective	Content	Teaching and Learning activities
- Define natural immunity and acquired immunity	**Natural and acquired immunity** Natural immunity is inborn (for instance, the acidic gastric juice kills many micro organisms capable of infecting the human body) Acquired immunity: everyone acquire protection against a pathogenic microbes after prior contact with these microbes Artificial immunity: by vaccination, inoculation of the microbe (heated to reduce its harmfulness) into the patients	Discuss the mechanism by which the human body protects itself against infections Discuss the reasons why a child who previously contracted measles usually does not contract it again Ask the students what vaccinations they have had and why they had these vaccinated
- Define the terms: asepsis, antisepsis and chemotherapy	**Asepsis, antisepsis, chemotherapy** Asepsis: mechanism of destruction of pathogenic micro organisms (sterilization, disinfection using chemicals) Antisepsis: prevention of infection by inhibiting or stopping the growth and multiplication of germs Chemotherapy: use of chemical substances to destroy cancer cells	Ask the students to give examples of asepsis and antisepsis

Topic 9: Organisms and the environment (4 periods)

Teaching aids: charts, audio-visual equipment, diagrams

Learning situations:

- In a given environment that has are plants, herbivorous animals, carnivorous animals. In order to have balance in this environment, which organisms should be most present? Why?
- What happens to a cow faced by food shortage?
- Is environmental balance essential? Is it always respected by man?

General objective 14: Identify relationships between the living things in a natural environment

Specific objective	Content	Teaching and Learning activities
- Distinguish between primary producers, consumers, decomposers	Primary producers: - plants are the primary producers in the biosphere **Consumers:** - heterotrophs - heterotrophs feed on autotrophs and thereby ingest the carbohydrates produced by autotrophs Types of consumers: herbivores: animals that feed on plants carnivores: animals that feed on other animals omnivores: animals that that feed on plants and on animals (including man) **Decomposers:** - feed on dead organic material and break it down into inorganic material	Use charts diagrams to explain the concepts

	- play a key role in the recycling of matter and the flow of energy **Food chain** - food link between the various organisms in a community - transfer of energy and nutrients from one organism to another	Explain why the use of polythene bags is not advisable Give examples of a food chain in the school
- Explain the food chain and give its importance		

General objective 15: Identify man's effects on the environment

Specific objectives	Content	Teaching/learning activities
- Explain man's harmful effect on the environment	- poaching in game reserves - forest fires - soil erosion - soil, water and air pollution - deforestation	Use charts and audio-visual equipment Discuss various anti-erosive measures used in the school area
- Name man's actions that favour the protection of the environment	- fight against erosion: terraces, drainage of rain water radical terraces, anti-erosive fences, afforestation … - creation of national parks and game reserves: protection of fauna and flora; maintenance and reestablishment of ecological equilibrium -fight against pollution: purification of wastewater, decrease of exhaust emission from vehicles and industries, … - reforestation: nursery gardens to grow seedlings for planting	Ask the students the importance of national parks and game reserves Ask the students how seedlings are prepared for reforestation *Have the students participate on the day of the tree*

6 .ORDINARY LEVEL FORM III PROGRAM

6.1. Topics and their time allocation

1. The nervous system and sensory organs	16 periods
2. Endocrine glands	6 periods
3. Reproduction	28 periods
4. Sexually Transmitted Diseases and AIDS	6 periods
5. Basics of genetics	6 periods
TOTAL	**62 periods**

6.2 Form III general objectives

The student should be able to:

- State the structural components of the central nervous system and their functions
- Demonstrate and suggest practices that preserve the health of the nervous system
- State the various sense organs, their functions and hygienic practices that can preserve them
- State the main endocrines glands in man and give their functions
- Differentiate and explain the different modes of reproduction of living things
- Describe the structure and function of the human reproductive system
- Give a general overview of fertilization and the formation and development of the embryo including conception and contraception
- Name the sexually transmitted diseases including HIV AIDS and suggest ways and methods of prevention
- Describe the reproductive organs in flowering and non flowering plants as well as their functions
- Define some basic concepts and theories in genetics and state their application

6.3. Detailed program

Topic 1: The nervous system and sensory organs (16 periods)

Teaching aids: Charts, diagrams, models, microscopic slides, microscopes, audio-visual equipment, magnifying glasses, quinine tablets, match box

Learning situations:

- How does the student find his/her way to school?
- How does the student distinguish between the objects he/she uses every day?
- Discuss this phrase: « Everything we know first came through our senses »
- Can a deaf and dumb individual take care of him/herself? How? What of a completely paralyzed person?
- How come a patient under anaesthesia does not react during a surgical operation?

General objective 1: Identify the structural elements of the nervous system and their functions

Specific objective	Content	Activities
- Name the characteristics of the central nervous system	**Central nervous system** - CNS: brain and spinal cord - The CNS is protected by the skull and the vertebral column - The CNS is suspended in cerebro-spinal fluid - The CNS is enveloped by the meninges	Use charts and diagrams to illustrate the CNS
- Identify the main parts / structures of the brain and give their functions	**Parts of the brain** Cerebral trunk - medulla oblongata: controls autonomic functions - Pontus: regulates the sleep cycle; integrates and coordinates central and peripheral information	Use models, charts and diagrams *An attached diagram showing the parts of the human cerebrum (Appendix IV)*

	- Mesencephalon or midbrain: integrates sensory (incoming) and motor (outgoing) information Cerebellum: coordination of muscles Diencephalon: - Thalamus: relays sensory information towards higher centres - Hypothalamus: regulates temperature, water balance and emotions - epithalamus: secretion of melatonin cerebrum or cerebral hemispheres: Information processing centre; contains 50-100 billion neurones; is divided into the frontal, parietal, occipital and temporal lobes	
- Draw and label the structure of a typical nerve cell (neurone) and describe its main elements	**Constituents of a neurone** Cell body or soma: contains cell nucleus and cytoplasmic organelles Dendrites: branching processes which conduct impulses towards the cell body Axon: fine and simple process which conducts electrical impulses away from cell body Terminal dendrites: processes with many branches originating from the final branch Myeline sheath: a discontinuous sheath that acts as an electrical insulator to the axon to allow rapid conduction of nervous impulses nodes of Ranvier: parts of the axon with no myelin sheath	Use charts and the available microscopic slides to draw the structure of a neurone *A diagram showing the typical structure of a neurone is in appendix V*
- Give a brief view of the constituents of nervous tissue	Grey matter: composed of cell bodies White matter: composed of nerve fibres	Use charts to show a section through the cerebrum and distinguish between the grey matter and the white matter Use charts and available prepared sections

- Describe the location and structure of the spinal cord and list its main functions	**Spinal cord:** - cylindrical structure about 45 cm long - extends from the medulla oblongata to the first or second lumbar vertebra - 31 pairs of spinal nerves emerge through the inter vertebral foramen **Spinal cord structure:** - composed of grey matter and white matter - cerebro-spinal fluid flows through a central canal **Function of spinal cord:** - links nerves of the peripheral nervous system with the brain - controls some reflexes, reflex actions, not involving the brain	Experiment: ask a student to sit on the table then knock his/her knee using the duster (the non wooden part); the student with experience an immediate reaction of the leg

General objective 2: Suggest and demonstrate practices that favour the health of the nervous system

Specific objective	Content	Teaching and Learning Activities
- Identify practices that favour the health of the nervous system	**Healthy practices** - Avoid stress - do breathing exercises to reduce stress - 8-9 hour sleep at least every night - consume foods rich in potassium and calcium - wear a protection helmet while riding - avoid consuming alcohol, illicit drugs or smoking	Have the students suggest means and methods of relaxation; relaxation of the nervous system is paramount for healthy life Discuss the importance of these healthy practices

	- carryout relaxation activities : music, puzzles, reading, - be cooperative and nice toward the teacher and other classmates, especially the boys toward the girls	

General objective 3: Identify the various sensory organs, their functions and hygienic practices that favour their health

Specific objective	Content	Teaching/Learning Activities
- Name accessory secondary structures of the eye and their functions	**The eye** Eyebrows: protect eyes against sweat Eyelids and eyelashes: cover the eyes during sleep, protect eyes from light and foreign bodies Conjunctiva: fine protective membrane located anterior to the eye Extrinsic muscles (6): movement of the eye ball in all directions Lachrymal gland: produces tears which moisten the eye and protect it against microbes Include: cornea, aqueous humor, iris, lens, vitreous humor, retina, optic nerve Lens: refraction of light to the retina Rod: vision in low light Cone: vision of colour during the day Optic nerve: fibre consisting of over one million axons from the ganglionic cells which transmits visual signals from the eye to the brain Function: vision	Use models, charts, diagrams, sections of the eye showing the accessory structures of the eye Use a section of the eye to identify the various parts of the eye Use a biconvex magnifying glass to illustrate refraction; the teacher emphasises how refraction follows the rules of refraction (see
- Draw and label the parts of a human eye in longitudinal section		
- Give a general view of the lens,		

retinal photoreceptor and optic nerve functions - Identify the function of the eye - Define short-sightedness and long-sightedness - Identify common infections and diseases of the eyes and healthy practices that favour eye health - Describe the parts of the human ear and their function	Short sightedness: the affected person cannot clearly distinguish distant objects; Correction: wear concave lens spectacles Long sightedness: the affected person cannot clearly distinguish close objects; Correction: wear convex lens spectacles Conjunctivitis: conjunctival inflammation due to infection or sunstroke Cataract: common in the elderly: the lens becomes hazy causing obscure vision Healthy practices - avoid exposing eyes to strong sunshine - do not look at a solar eclipse with unprotected eyes - do not scratch eyes when exposed to dust or in case of a foreign body in the eye; wash eyes with clean water - consult ophthalmologist in case of eye disease - avoid reading under low light **The ear** <u>The outer ear</u>: - Pinna: conducts sounds into the auditory canal - External auditory canal stretches from the pinna to the ear drum - Tympanic membrane (ear drum): receives sound <u>The middle ear</u>: contains three bones which conduct sound towards the inner ear <u>The inner ear</u>: consists of two parts: - semicircular canals (balance) - cochlea (organs of Corti) – (hearing) Include: pinna, external auditory canal, eardrum, middle	Optics lesson in Physics) Discuss eye defects with the students; Ask how a student sees after taking off his/her spectacles. *Avoid scratching the eyes; if necessary, use clean water to wash the eye* Use charts, models and diagrams to show the

- Draw and label the parts of the ear in longitudinal section	ear, bones of the ear, semicircular canals and cochlea	various parts of the ear Use charts to draw the parts of the ear
- Identify the common diseases of the ear and propose healthy practices to favour ear health	Deafness: - Causes: rupture of the tympanic membrane, infection of the ear, blockage of the auricular canal, regular exposure to loud deep noises, - Treatment: surgery, ear care Healthy practices: - avoid loud music or sources of deep noises - use cotton buds to clean ears	Have the students identify diseases of the ear and propose methods to avoid them *Sensitize the students on the importance of the hearing and consequences of the hearing loss* *The teacher explains the danger of using sharp objects to clean the ears*
- Locate and describe the taste organ (tongue) and its receptors - Identify different taste types and their sites on the tongue - Suggest appropriate practices that keep the tongue healthy	**The tongue** Sensory function of the tongue: taste Location: lower part of the oral cavity; Sweet: tip of tongue Sour: sides of the tongue Bitter: back of the tongue Salty: almost the entire tongue - avoid drinks that are too hot or too cold - regularly clean the tongue using a metallic or plastic scraper	Use charts of a tongue to show the sites of different taste types Experiment: Put a quinine tablet at the tip of the tongue and explain its taste

- Give a general view of the location, structure and the function of the smell organ	**The nose** Location: on the arch of the nasal cavity Structure and dimension: part of the yellowish olfactory epithelium (pseudo stratified), Function: sensitive to variations in smell due to the olfactory epithelium composed of epithelial olfactory cells	Use charts to learn the parts of the smell organ Discuss the various smells which the students can identify
- Locate and identify the different parts of the skin	**The skin** The skin is the largest organ of the human body; it has many cutaneous sensory receptors 2 main layers of the skin: - epidermis - dermis	
- Draw and label a cross section of human skin	Section including the main layers, hairs, receptors and glands of the skin	Use charts and prepared sections to elaborate the parts of the skin
- Identify the various sensory receptors of the skin	Sensory receptors: - tactile receptors (to touch) - pressure receptors - thermal receptors - pain receptors (free nerves ends)	Test the various feelings by touching skin hairs, exerting pressure on skin, passing fire near the hand and pricking the skin
- Name the sensory function of	Touch, pressure, temperature and pain	Discuss diseases of the skin and methods of

the skin - Identify the common diseases of the skin - Propose practices that favour skin health	Burns: caused by thermal, radioactive or chemical agents Acne: usually begin during puberty, caused by blocked skin pores of the glands underneath Dermatitis: allergic reaction in sensitive people manifested by itches, redness of the skin and/or formation of blisters Ringworms: very contagious fungal infection Skin cancer: in form of a tumour or skin lesions on parts exposed to light Healthy practices: - bathe every day with soap - avoid a prolonged exposure in the sun - wear shoes especially outdoors	prevention

Topic 2: Endocrine glands (6 periods)

Teaching aids: charts, audio-visual equipment

Learning situations:

- What do the boys get husky voices and moustaches and the girls grow breasts during adolescence?
- What causes the throat to swell in certain person's?
- When a person is scared, what causes the fight or flee reaction?

General objective 4: Identify the main endocrine glands in man and give their functions

Specific objective	Content	Teaching/Learning Activities
- Define: endocrine gland,	**Endocrine gland:** gland with no ducts, they secrete their	

hormone	products directly into blood **Hormone:** a chemical substance produced in an endocrine gland and secreted into the blood circulation to produce an effect in a specific organ	
- Name and locate the main endocrines glands in the human body	**Main endocrine glands** Pituitary gland: located underneath the brain Thyroid gland: located in the neck Adrenal gland: attached to the kidney summit Ovary: located on the posterior abdominal wall Testicles: in the scrotum Pancreas: between the stomach and the duodenum	Introduce a chart showing the location of the various endocrines glands in a man and a woman
- Identify main hormones secreted by the mentioned endocrines and the main reactions of the organism	**Main hormones** Pituitary gland: several hormones, particularly growth hormone Thyroid gland: thyroxine; controls metabolism and growth	
	Adrenal gland: adrenalin; prepares the body to «fight or flee» Ovary: oestrogen; control the growth of the uterus and secondary sexual characteristics in females Testicles: testosterone; control secondary sexual characteristics in males Pancreas: insulin, glucagon; control sugar equilibrium in blood	Ask the students what causes pubic hair and beards in boys and breasts in girls
- Identify some endocrine disorders	**Endocrine dysfunction** Pituitary gland: - Deficiency causes the dwarfism - Excess causes gigantism Thyroid gland: - Thyroid dysfunction causes goitre	Ask the students if they know goitre and explain its cause

- Identify healthy practices that favour thyroid and pancreatic health	Pancreas: - insufficient insulin production causes diabetes **Healthy practices** - use iodised table salt - avoid over consumption of sweet foods or products	Why is iodised table salt recommended?

Topic 3: Reproduction (28 periods)

Teaching aids: Youth science journals (New Scientists, National Geographic), charts, audio-visual equipment (video tapes and CD-ROM), fresh plants, diagrams, computers, models

Learning situations:

- How are bamboo, banana trees and potatoes propagated?
- How is cactus propagated (ngabo)?
- Can you multiply chicken in a poultry farm without cocks? How?
- Why are there men and women in human populations?
- You plant a single bean and harvest several seeds. How do you explain this phenomenon?

General objective 5: Distinguish and explain the various modes of asexual reproduction in living things

Specific objective	Content	Teaching/Learning Activities
- Identify the various modes of asexual reproduction in animals - Identify modes of asexual reproduction in plants	**Asexual reproduction:** Asexual reproduction in animals - Fragmentation (e.g.: Planaria): organism breaks up and each fragment forms a new individual - Budding (Hydra): - Parthenogenesis (honeybee) Asexual reproduction in non-flowering plants - Binary fission: the content of one cell is divided into two; - division of the thallus (Thallophytes): each fragment forms a complete individual (algae) - Spore formation: formation of spores which germinate into new individuals Asexual reproduction in flowering plants - Vegetative propagation • Natural layering: A complete fragment (root, stem, leaves) breaks loose from the mother-plant and forms a new individual (e.g.: grass) • Natural cutting: branch breaks loose from the mother plant and gets roots (e.g.: Opuntia) • Stolon: horizontally growing branch whose terminal bud gets roots and forms a new individual (e.g.: strawberry plant) • Bulbs: buds	Show, with the aid of charts or diagrams, fission and budding Use charts and diagrams to illustrate binary fission, fragmentation and spore formation Collect plants that manifest vegetative propagation to illustrate their mode of reproduction

	Adventitious buds ensuring vegetative propagation (e.g.: garlic, onion) • Rhizomes: stems underground growing horizontal stems with buds that form erect or sucker stems • Tubers: buds Potato axillaries each forming a stem - Induced or artificial vegetative propagation • Cuttings: buried Cutting from a plant with no root (cutting); (e.g.: cassava, *Pennisetum*) • Layering: the cutting remains attached to the mother plant until it develops roots • Grafting: implantation Implant a bud or cutting containing buds (graft) into plant tissue (host) {e.g.: Arabusta coffee = arabica coffee x robusta coffee }	Discuss the most common methods of artificial vegetative propagation in Rwanda

General objective 6: Describe the structure and function of the human reproductive system

Specific objective	Content	Teaching/Learning Activities
- Locate and describe the main parts of the male reproductive system and give their function	**Male reproductive organs** Testicles: formation of spermatozoa and testosterone Epididymus: maturation of spermatozoa Vas deferens: conducts spermatozoa from the epididymus to the ejaculatory duct Seminal vesicles: secretes a substance which increases the motility and life span of spermatozoa Prostate: increases the motility of spermatozoa, its alkalinity protects spermatozoa in the acidity of the vaginal	Use charts and diagrams to show the parts of the male reproductive system

	environment Ejaculatory duct ejects spermatozoa into urethra Urethra: common pathway for both the urinary and the reproductive system Penis: copulation organ of the male reproductive system	
- Draw and label the structures of the female reproductive system	**Female reproductive organs** Include: the ovary, fallopian tubes, uterus and vagina	Use charts and diagrams to draw and label the structures of the female reproductive system
- Locate and describe the main parts of the female reproductive system and give their function	Ovary: solid and ovoid; produces ova and female hormones Fallopian tubes: conduct the ova from the ovary to the uterus Uterus: pear-shaped; normal site of blastocyst implantation; plays an active role in child birth Vagina: receives spermatozoa from the penile urethral during the coitus Vulva: female genital organs; main structure consists of the labia majora, the labia minora and the clitoris	
- Define menstruation and briefly explain menstrual cycle	The menstrual cycle **Menstruation:** periodical shading of the internal layer of the uterine wall accompanied by loss of blood Duration of the menstrual cycle: about 28 days Stages of the menstrual cycle: - follicular phase - ovulation - luteal phase	Illustrate the stages of menstruation using charts *The teacher emphasises the variability of the menstrual cycle duration*
- Define spermatogenesis and ovogenesis	Spermatogenesis and Ovogenesis Spermatogenesis: mechanism of male gamete (spermatozoa) formation	Illustrate spermatogenesis and ovogenesis using charts

	Ovogenesis: mechanism of female gamete (ovum) formation	

General objective 7: Give a general view of fertilization, the formation and development of an embryo, including conception and contraception

Specific objective	Content	Teaching/Learning Activities
- Define fertilization, locate the site and name the product of fertilization	**Fertilization:** fusion of the male and female gametes Site: the upper part (1/3) of the fallopian tubes Result: - activate the egg - restore the diploid chromosome number - determination of the zygote's sex (sex determination by chromosomes)	*Emphasise the haploid and diploid chromosome numbers; a human being has 46 chromosomes among which two; the X and Y chromosomes determine the sex (XX=female, XY = male*)
- Explain implantation and identify the development period of the embryo and foetus	**Implantation:** - implantation of the blastocyste in the uterus wall	
- Briefly explain the process of child birth	**Process of child birth** - Initiated by labour - uterine wall contraction triggered by the pituitary - expulsion of the baby - expulsion of the placenta	Show charts and films illustrating the different stages of child birth
- Define contraception and explain the common contraceptive	**Contraception:**	Organise debates about wanted and unwanted

methods	prevention of pregnancy Natural method: abstinence Artificial methods: Man: - vasectomy - condoms Woman: spermicidal vaginal gel; intra-uterine device; feminine condoms; contraceptive pills prescribed by a doctor	pregnancies and how to avoid the later *Sensitize the girls about the dangers faced by the mother and baby in cases of adolescent pregnancy*

Topic 4: Sexually transmitted diseases and AIDS (6 periods)

Teaching aids: Audio-visual equipment, charts, journals

Learning situations:

- What do you know about AIDS?
- Are you sure you do not have the AIDS virus? justify
- If unfortunately you learnt that you have AIDS, what would your reaction be and your future behaviour?
- Can ordinary level students contract the AIDS virus?
- Did you know people with other sexually transmitted diseases are more likely to get AIDS?
- Can you play a role in the fight against AIDS in your community? How?

General objective 8: Identify the sexually transmitted diseases including HIV AIDS and suggest preventive measures

Specific objective	Content	Teaching/Learning Activities
- Explain AIDS and its mode of transmission - Explain how the virus attacks the organism - Propose methods of prevention against AIDS - Name the other common sexually transmitted diseases and identify their main symptoms	**AIDS:** Acquired immune deficiency syndrome is an incurable disease caused by Human Immunodeficiency Virus HIV Transmission: - unprotected sex - use of contaminated sharp objects, especially syringes for illicit drugs - blood transfusion with contaminated blood - mouth to mouth with an infected person misconception: one cant be infected by kissing or shaking hand **Mode of action of the virus** The virus attacks certain white blood cells which normally protect the organism from infection then destroy the organism's immune system **Healthy practices** - sexual abstinence - fidelity - use of condoms Gonorrhoea (Gonorrhoea): Symptoms: pus from the penis and the vagina, abnormal bleeding fallopian tube Syphilis: Symptoms: painless ulcer on the penis or clitoris or the labia minora, fever; anaemia Vaginitis: Symptoms: painful intercourse; itches on the genitals; foul discharge	Have the students do group research assignments on AIDS, the mode of transmission, and methods of prevention Discuss the group assignment results in class and make a summery *Have the students discuss about attitudes to adopt toward AIDS patients, the impact of the scourge at family, socio-economic and national level and to propose solutions to limit its spread*

		Have the students do group research assignments about the other sexually transmitted diseases, the modes of transmission and methods of prevention Discuss the results of the assignment in class and make a summery

General objective 9: Describe the reproductive organs of a flowering plant, of a non-flowering plant and of fungus and their functions

- Identify the male reproductive organs of flowering plants and their functions	**Reproductive organs of flowering plants** Male reproductive organ: the stamens - each stamen has an anther at the tip of a filament - each anther has four pollen sacs - pollen grains are formed in the pollen sacs Function: formation of pollen	Collect a common flower (Hibiscus) and dissect it, then observe the various parts of the male and female reproductive systems Compare the dissected flower with the flowers in the charts then draw the various parts of the male and female reproductive system

- Identify the female reproductive system of a flowering plant and their functions	Female reproductive organ (pistil): the carpel (ovary, style, stigmata) - the ovule consists of: One or two protective layers The nucleus: ovoid cell mass Embryo sac: Consists of eight cells (the egg cell with two synergids, two polar nuclei, three antipodal cells) Function: formation of ovules	
- Draw and label the structure of a flowering plant ovule	Include the cells of the embryo sac	Use the available charts to identify the ovule structure and make a drawings
- Define pollination, name the main types of pollination, agents of pollination and the flower's adaptation for pollination	**Pollination:** Dispersal of pollen grains Types of pollination: Self-pollination: pollination of a plant by itself Cross-pollination: pollination involving separate plants Main agents of pollination - Wind pollination: Adaptations: small petals; no nectar; anthers and stigmata are visible; flexible anther filaments; small and light pollen grains - Insect pollination: Adaptation: big and coloured petals; nectar present; anthers and stigmata are partly enveloped; rigid anthers filaments; larger pollen grains	Ask the students why flowers with no colour and no nectar are not dispersed by insects Compare the characteristics of a wind pollinated flower (maize) and an insect pollinated flower (cassava, rose)
- Explain fertilization in flowering	**Fertilization**	Use charts or diagrams to illustrate the

plants	- Pollen is transported to the stigma - formation of pollen tube - formation of two male nuclei - one of the formed nuclei fuses with the egg cell to form a zygote which will develop into an embryo - the other male nucleus fuses with the polar nuclei to form cotyledons, a store for the embryo There is therefore double fertilization	different stages of fertilization in flowering plants
- Explain the formation of fruits and seeds	**Formation of fruits and seeds** After fertilization of the ovule, the ovary is transformed into a fruit and the ovule is transformed into a seed	Use bean pods to show the fruit that originates from the ovary and the seeds that originate from the ovules
- Identify the reproductive organs of non flowering plants and their functions	**Reproductive organs of non-flowering plants** Pteridophytes: Example: fern - sporangium: on the under surface of the leaf function: contains spores - prothallus: underground vegetative organ of the spore function: male reproductive organs (antheridia)and the females organs(archegonia) - fertilization of the egg cell by the sperm cell forms a new fern Bryophytes: Example: moss - the male moss has antheridia on their summit while the female moss have archegonia - zygote: function: if found on the female moss, it forms a sporangium composed of a peduncle and a capsule	Use the available charts to observe the sporangium and prothallus of a fern Also use of plants to observe sporangia on the under surface of the leaf Collect moss specimens within the school and observe the silk and capsule of the sporangium Use charts to show the sporangia and the protonema Observe prepared sections showing sexual

- identify the reproductive organs of mushrooms	- capsule: is held on a peduncle called the sorus function: contains spores - the protonema: organ that arises from spore germination function: forms new male and female moss Algae: formation of male and female gametes which fuse to form new algae Lichens: only the mushrooms reproduce sexually **Reproductive organs of mushrooms** Mushroom: formation of male and female gametes - zygote has filaments that hold spores - spores germinate into new mushrooms	reproduction in algae (*Oedogonium*) Observe prepared sections showing reproduction in fungi (Ascomycetes and Basidiomycetes) Observe small slides containing spores on the under surface of the cap

Topic 5: Introduction to Genetics (6 periods)

Teaching aids: charts, blood group cards, texts on genetics, audio-visual equipment (videotape and CD-ROM)

Learning situations:

- Why do brothers and sisters have similar and dissimilar traits?
- Can a dog reproduce with a cat? Why?
- What practice is applied in Rwanda to improve cattle breeds? Why?
- Use of fertilizers gives improved agricultural yield. What other method can be used? Why?
- How do you explain the fact that some families have boys and girls while others have only boys or only girls? Who is responsible, the father or the mother?

General objective 10: Define some concepts and basic theories of genetics and identify their application

Specific objective	Content	Teaching/Learning Activities
- Define the basic terms on heredity	**Key terms** Heredity: transfer of the parents' traits to their progeny Pure breeding: an organism whose offspring are similar to each other and to their parents Allele: a form of a gene; alleles separate into the gametes during meiosis Homozygote: if the two alleles are the same Heterozygote: if the two alleles are different Multiple alleles: certain traits are controlled by more than two alleles (in man, blood has three alleles) Genetics: is the study of the influence of alleles on descendant generations Genetic engineering: technology of gene manipulation Sex-linked gene: gene located on the sex chromosomes Genome: all the genes of a species Species: a group of similar individuals that can reproduce to give fertile offspring Phenotype: physical traits resulting from a particular genotype Genotype: genetic constitution of an organism	Have the students discuss the morphological aspects which can demonstrate parental relation between brothers in order to explain heredity
- Explain single-factor inheritance with examples	**Single-factor inheritance:** - heredity linked to a single trait (for example; the height of a plant) - involving two alleles of a single gene Dominance: when an allele prevails over the other Co-dominance: when both alleles are expressed in the offspring;	Use charts explaining the crossing of a large pea with a tiny pea Do exercises years on single-factor inheritance After this activity the students should know that the dominant allele is represented in capital letters and the recessive allele in small

- distinguish between complete and dominance and co-dominance with examples - Explain the criteria for genetic distinction between the sexes in man - Identify the application of genetics in everyday life	**Genetic distinction of the sexes** - the X and the Y chromosomes in human beings, contain sex determining genes - a woman has two X chromosomes; a man has one X and one Y chromosome - the fertilization of an ovum by a spermatozoon containing the X chromosome will give a girl - the fertilization of an ovum by spermatozoa containing the Y chromosome will give a boy **Applications** - Seed selection to improve yield, shorten the vegetative cycle, increase resistance to diseases, … - Animal selection to improve milk and meat yield and to increase the production of eggs and chicken meat	letters Use (ABO) blood group card to show dominance and co-dominance *The students should be informed against the misconception that women are responsible for the birth of girls*

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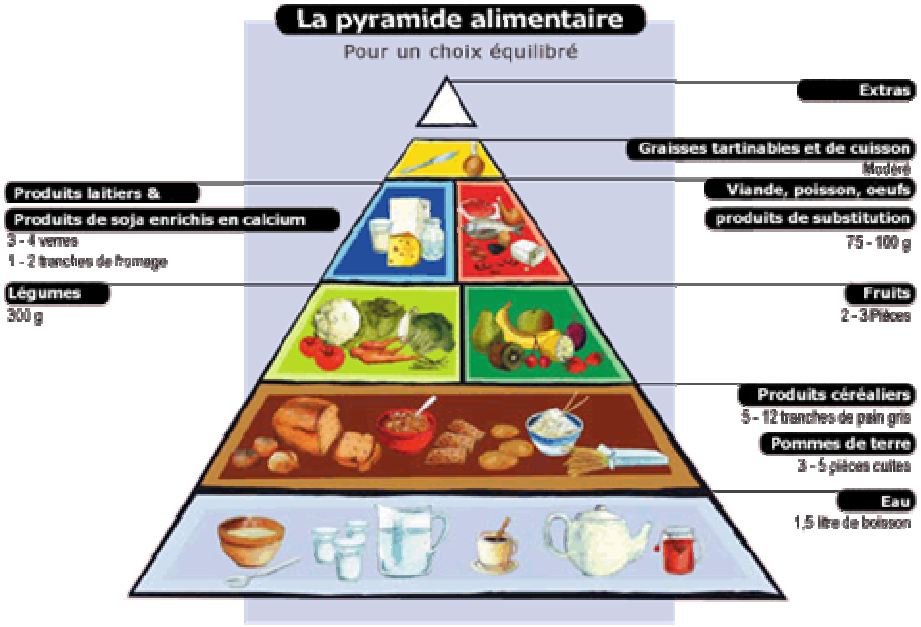
BIOLOGY APPENDIX

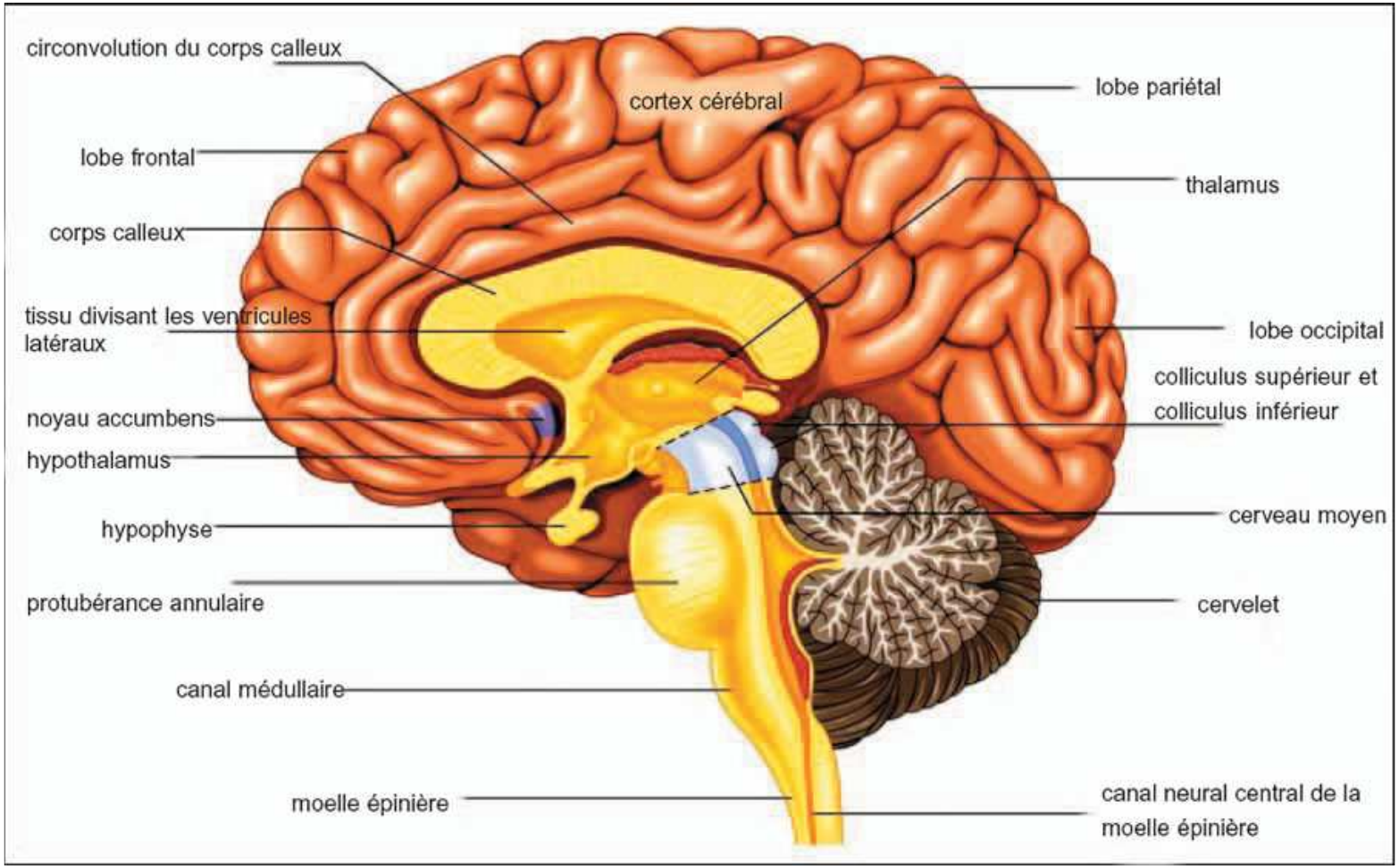
Appendix - I



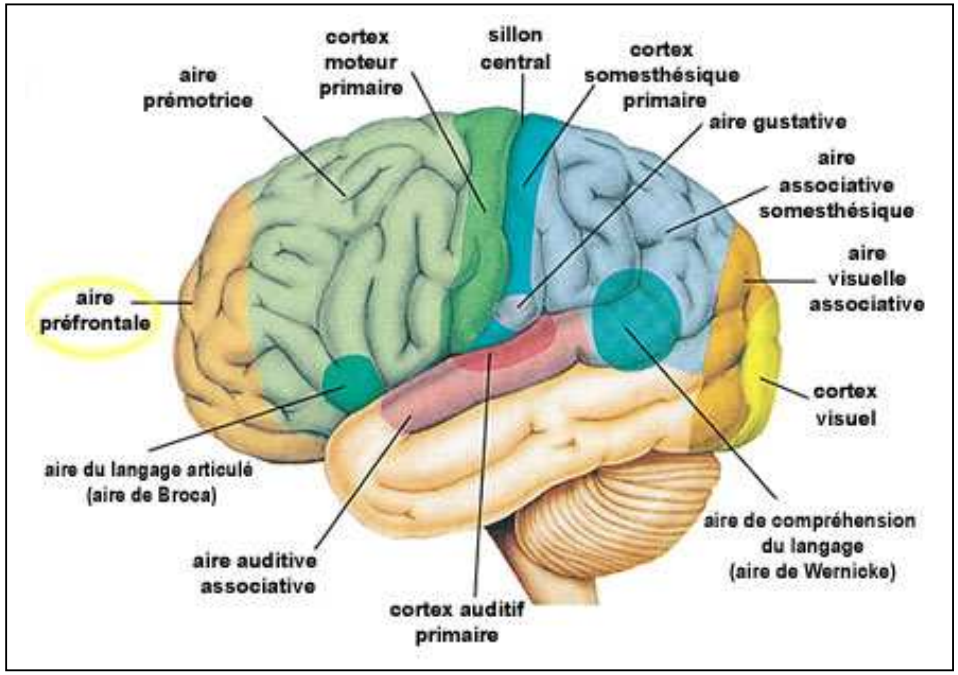
Food Pyramid

Ref. URL : http://www.omega3.be/consumenten/fra/images/voedingsdriehoek.gif

Appendix II


circonvolution du corps calleux
cortex cérébral
lobe pariétal
lobe frontal
thalamus
corps calleux
tissu divisant les ventricules latéraux
lobe occipital
colliculus supérieur et colliculus inférieur
noyau accumbens
hypothalamus
hypophyse
cerveau moyen
protubérance annulaire
cervelet
canal médullaire
moelle épinière
canal neural central de la moelle épinière

Appendix - III



Human Brain – Principal Functional Areas
Ref. URL: http://www.gecos.dz/religieuse/images-article/cerveau.jpg as of November 2005

PART TWO: ORDINARY LEVEL CHEMISTRY PROGRAM

1. GENERAL ORIENTATIONS

Teaching of sciences at Ordinary level must constitute the basis for scientific development in Rwanda and the revision of the ordinary level Chemistry program has taken this into account. It also takes into account the fact that it's at this level that all the students of secondary school have an opportunity to study chemistry without forgetting that at the end of this level most of them turn to non-scientific courses of study. As a result, teaching chemistry at Ordinary level must encourage students to think, ask and answer questions in a way that satisfies their curiosity on natural phenomena by observing and experimenting.

The new format of program presentation allows better implementation by teachers because it presents specific objectives of a chapter, contents as well as suggested study activities in the same table.
This program also gives content limits, taking into account the intellectual level of a student at ordinary level and the study level concerned.
Unlike the previous program, it targets active teaching centred on learning. It recommends Learning situations at the start of every chapter that awaken learning curiosity and ensure motivation.
Specific objectives are drawn up in terms of technical and behavioural knowledge. To attain this, the program offers activities which help to provide relevant knowledge which appears in program contents.
Suggested activities in well prepared activity plan will be accomplished by students in groups or individually with the teacher's guidance.
However, Learning situations and suggested activities can be supplemented and/or modified by the teacher according to the equipment and material available. A list of suggested teaching aids is not exhaustive, certain chemicals will have to be directly produced in the laboratory (example: CL_2, O_2, CO_2). In brief, the teacher is encouraged to be innovative and improvise accordingly.

The program also offers timing for each chapter. Upon completion of Ordinary level there is a summing up of the academic content of this level.

Generally, it reorients chemistry teaching towards stimulated and guided observation through direct experience of learners.

It stresses on the practical aspect which allows learners to gain knowledge in handling of chemicals and laboratory equipment to adopt positive behaviour towards science in general and chemistry in particular.

2. GENERAL OBJECTIVES FOR ORDINARY LEVEL

At the end of this level, the student should be able to;

- Explore and understand his or her natural environment
- Make scientific observations and draw accurate conclusions from experiments
- Interpret symbols, formulae and chemical equations
- Use basic chemistry knowledge to get higher education or professional training.
- Use his or her knowledge to promote development of the society
- Use the experience acquired in manipulations and concepts learned to solve problems.
- Identify ordinary and standard products particularly their quality, nature and preparation
- Show a spirit of critical thinking and scientific understanding.
- Show vigilance and caution in handling laboratory products and materials.
- Show vigilance and caution in environmental protection.
- Carryout elementary chemistry experiments using the theoretical material covered and the available instruments.

3. EVALUATION APPROACH.

To measure the level of objectives attained the teacher will have to give an evaluation. The evaluation approach will depend on the objective to be assessed .In this program, the teacher will put more of emphasis on continuous and accumulative evaluation.

In continuous evaluation , the teacher will use small oral and written tests, small experiments structured on class content to find out how his or her teaching is being understood (for example verify if the learners are having certain study errors**,** lacunas or wrong understanding) and adjust accordingly.

In accumulative evaluation, the teacher will give general tests and exams which will cover a big part of the study content to confirm if the students have attained the general objectives. It is in the same scope that at the year end, an exam which covers the entire study content of the year will be given.

Practical laboratory exercises will be part of the evaluation. The teacher will have to give practical tests in the laboratory in a continuous manner to confirm if the students have mastered the technical and behavioural knowledge in this program
At the end of the third year, students will take national ordinary level exams. To prepare them, the teacher will give a final exam covering the entire content of ordinary level chemistry.

All evaluations will involve closed questions (which need memorizing and direct use of acquired knowledge) and open questions (which need the student's point of view, interpretation and solving problems).

4. FORM I PROGRAM.

4.1 CHAPTERS

Chapter	
1. Chemistry objectives, states of matter, change of state	11 periods
2. Simple classification of substances	7 periods
3. Water	7 periods
4. Air	6 periods
5. Acids and bases	9 periods
6. Atoms and elements	11 periods
7. Molecules: elements and compounds	11 periods
Total	**62 periods**

4.2 GENERAL OBJECTIVES

At the end of Form I a student should be able to:

- Explain the usefulness of chemistry in everyday life
- Interpret the change of state in matter
- Differentiate a chemical change from a physical change in daily life
- Show a simple classification of substances
- Choose and use some simple methods of separation of mixtures commonly used in everyday life.
- Prevent water pollution and avoid the dangers of polluted or contaminated water.
- Explain the importance of air and participate in its protection against pollution

- Identify acidic, basic and neutral medias in the environment
- Give properties of acids and bases
- Describe the simple structure of an atom
- Correctly apply the security regulations learnt during experiments in class
- Differentiate elements from compounds
-Write formulae of elements and compounds

4.3 DETAILED PROGRAM

CHAPTER 1: THE SCOPE OF CHEMISTRY, STATES OF MATTER, CHANGE OF STATES (11 periods)

Teaching aids

- A Chemistry laboratory equipped with basic equipment, ice cubes or grease, thermometer, Bunsen burners or hotplates, pair of tongs, beakers, test tubes, box of matches or lighter, washing bottle
- Magnesium ribbon, pentahydrate copper sulphate, cobalt chloride, ammonium chloride, diiodine, sugar, water

Learning situations

- Heat an ice cube which becomes liquid then steam
- Condense the water vapour in humid air using a bottle or a cooled glass
(Call to mind dew formation)
- Burn a magnesium ribbon, a paper, a piece of wood and observe
- Explain the difference between chemical and physical changes
- Show that physical and chemical changes take place regularly around us

Specific Objectives	Contents	Teaching/learning activities
At the end of this chapter the student should be able to:		
- Explain what chemistry is giving examples - Show the importance of chemistry	1.1. Introduction to chemistry - Definition -Chemistry objectives - Importance of chemistry	-Using a transformation experiment of matter (ex :Burning a magnesium ribbon, dehydration and rehydration of copper sulphate or cobalt chloride) and proceed to brainstorming to classify and show (Physical and chemical changes) other transformations in everyday life. -Draw and label materials commonly used in a laboratory and how to handle them.
-Identify and use simple material in a chemistry laboratory -Mention conduct and safety rules in a laboratory -Show the safety rules when using chemical products or laboratory material	1.2. Materials and safety in the laboratory -Rules of conduct and safety in a laboratory -Simple material used in a chemistry laboratory (demonstration, diagram and handling)	-Using a case study encourage a student to respect safety rules in a laboratory
- Differentiate the three states of matter giving examples - Explain the process of changing from one state to another.	1.3. States of matter -Solid state -Liquid state -Gaseous state 1.4. Change of state of matter : boiling condensation sublimation etc ; 1.5 Differentiate between solids	-Using an ice cube show that water can exist in three states (solid, liquid, gas) -Heat iodine or ammonium chloride to show sublimation -Show freezing and boiling points of water -Carry out an experiment of dissolving sugar in

Specific Objectives	Contents	Teaching/learning activities
- Differentiate physical changes from chemical changes - Identify physical and Chemical changes in everyday life.	liquids and gases by the kinetic theory. (motion and arrangement of particles) 1.6 Physical changes and chemical changes.	water and then evaporate the water. Compare the results with those of directly heating sugar.

CHAPTER 2: SIMPLE CLASSIFICATION OF SUBSTANCES (7 periods)

Teaching aids

- Collection of different objects from the environment, filter paper, sieve, funnel, settling bottle, a simple distillation set, washing bottle, manual centrifuge or « igisabo »,beaker, test tubes ,stopper « intara »

Learning situations.

- Present the student with the different objects that he is familiar with.
- Classify these objects using a criteria of your choice.
- Explain the classification criteria used.
- Introduce some classification criteria such as: pure substances/mixture, physical states,…

Specific objectives	Contents	Teaching / learning activities.
At the end of this chapter the student should be able to: -Classify matter in pure substances or mixtures	2.1. Pure substances. 2.2. Mixtures	-Carry out a classification of substances. Name some pure substances and mixtures

Specific objectives	Contents	Teaching / learning activities.
-Differentiate a pure substance from a mixture -Identify different kinds of mixtures	2.2.1 Type of mixtures homogenous (Solution) and heterogeneous.	-Carry out a classification of mixtures Name homogenous or heterogeneous mixtures
- Give a separation method and explain it.	2.2.2 Separation of mixtures Sieving, Filtration, settling, Simple distillation, Fractional distillation Centrifugation (gucunda), Levigation, paper chromatography.	-Carry out a separation of mixtures using the sieving method ,filtration, settling, simple distillation fractional distillation and centrifugation (gucunda), levigation, Paper chromatography

CHAPTER 3: WATER *(7 periods)*

Teaching aids

- Filter paper, a distillation set, funnel, test -tubes, test -tube holders, beaker, washing bottle.
- Anhydrous copper sulphate, cobalt chloride, unclean water.

Learning situations

-Show that water is an important substance in everyday life.
-.Show the difficulty in obtaining pure water (It easily dissolves in many other substances).
- Show the positive and negative results associated with the capacity of water to dissolve other substances (Water dissolves mineral and nutritive substances that are useful to living organisms, however unclean water can cause many diseases like cholera, dysentery....).
-Conclude that a clean water supply is essential for good health..

Specific objectives	Contents	Teaching/ learning activities
At the end of this chapter the student should be able to:		
- Identify natural sources of water	3.1. Natural sources of water. -Underground water. -Surface water. -Atmospheric water.	-Conduct a brainstorming to name different natural sources of water. -Carry out an identification test for the presence of water using anhydrous copper sulphate or anhydrous cobalt chloride.
-Show properties of water	3.2. Physical properties of water : -Pure water -Clean water	
- Explain the importance of water.	3.3. Importance of water: -For living things -Universal solvent	
- Identify the dangers of contaminated water.	3.4 .Dangers of contaminated water.	
- Explain purification and treatment methods of water. - Use some simple treatment and purification methods of water	3.5. Treatment and purification of water : Flocculation, Filtration, Disinfection, Distillation	-Carry out water treatment by filtration and its purification by distillation.
- Explain the water cycle	3.6. The water cycle Evaporation-condensation-precipitation-infiltration	-Draw a diagram of the water cycle.
- List some water pollutants. - Prevent water pollution and contamination	3.7. Water pollution -Pollution source -Pollution control.	

CHAPTER 4: AIR *(6 periods)*

Teaching aids

- Candle ,box of matches, test-tubes ,calibrated test –tubes, test-tube holders, beakers ,nails, balloon, water beaker, glass tube., Rubber tube, washing bottle
- Oil, Lemon juice, vinegar, cotton or cotton-wool, desiccant (Calcium Chloride.), water

Learning situations.

-Observe demonstrations of suffocation, fainting, asphyxia ..... in a closed area
-Show that air is very important in our everyday lives.
-Show that air is a mixture of many gases. (The presence of water vapour, different odours)

Specific Objectives	**Contents**	**Teaching / learning activities**
At the end of this chapter the student should be able to:		
- Identify air composition, the active and inactive parts. - Show the importance of oxygen in air. Show important reactions of oxygen in air. -Point out the natural source of oxygen in air. - Explain air pollution.	4.1.-Composition of air: active part (oxygen) and the inactive part. -Oxygen reactions: combustion, oxidation, rust -Importance of oxygen in everyday life. - Oxygen production by plants. (photosynthesis)	-Carry out simple experiments to show the active part of air. Identify the active part of air: -combustion of a candle in an inverted glass. - Combustion of a candle in an inverted test tube fixed on water. -Carry out an experiment on rusting of nails under different conditions

Specific Objectives	Contents	Teaching / learning activities
-Give causes of air pollution. -Show risks of air pollution. -Participate in avoiding air pollution.	4.2. Air pollution.	

CHAPTER 5: ACIDS AND BASES *(9 periods)*

Teaching aids

-Universal indicator, litmus paper, pipettes, beakers

-Acidic, basic and neural solutions (vinegar, lemon juice, tonic, quinine, saliva, urine, Hydrochloric acid, Sodium hydroxide …), Plant indicators (red cabbage, flowers, leaves, tea), phenolphthalein

Teaching situation

-Classify different solutions according to their tastes (acid: vinegar, lemon juice, tonic; basic: quinine, liquid soap).

-Confirm their classification by their reaction to plant colorants (leaf discoloration of red cabbage…) or an indicator.

Specific objectives	Contents	Teaching / learning activities
At the end of this chapter the student should be able to : - Identify an acidic, basic and neutral medium. -Give some properties of acids and bases. - Define colour indicators. - Show the existence of indicators in nature.	5.1-Proprieties of an acidic, basic and neutral medium. 5.2 – Definition of an acido-basic indicator.	-With an aid of an indicator test the acidity or alkalinity of different solutions. -Prepare coloured indicators from plants (red cabbages, red onions and other

Specific objectives	**Contents**	**Teaching / learning activities**
- Show the existence of acids and bases in nature. -Give uses of acids and bases. -Indicate the dangers of acids and bases -Prevent risks associated with acids and bases.	-Natural source of coloured indicators - Indicators (phenolphthalein, litmus, methyl orange, bromothymol blue, Universal indicator) 5.3 Existence of acids and bases in plants and animals 5.4 .Some acids and bases and their uses Sulphuric acid Hydrochloric acid , Acetic acid (vinegar), Sodium hydroxide (Caustic soda), Potassium hydroxide (potash), Ammonium hydroxide (ammoniac) Acidity and fertility of soil Enrichment of soils: liming 5.5 Dangers of acids and bases. Dangers of excess acid in the stomach and its treatment.	flowers) -Test acidity and alkalinity of various extracts. -Give uses of the listed acids and bases in everyday life

CHAPTER 6: ATOMS AND ELEMENTS *(11 periods)*

Teaching aids

- Pipettes, beakers, calibrated test-tubes, balloons, atomic models, plasticine, periodic table, washing bottle.
-Potassium Permanganate and water.

Learning situations

-Dissolve potassium permanganate in water (solution 1)
-Successively dilute a solution of potassium permanganate (take a few drops of solution 1 and dilute to give solution 2, take e few drops of solution 2 and dilute to give solution 3 and so on.....)
-Show that a grain of potassium permanganate is made up of many particles.,
-Show that each drop taken from the diluted solutions contains fewer particles and at a certain limit we will have a daughter solution with only one particle.

Specific objectives	Contents	Teaching / learning activities
At the end of this chapter the student should be able to :		
-Define an atom and an element. -Explain the difference between an atom and an element.	5.1. Atom and element (group of atoms having the same atomic number)	
-Describe a simple structure of an atom.	5.2. Atomic structure -Nucleons (protons, neutrons) and electrons	-Draw a table showing atoms with different sizes
-Identify parts of an atom : electrons, neutrons et protons	**N. B. the parts of an atom are identical for all atoms**	-Draw the structure of an atom.
-Explain the nature of these particles	5.3. Characteristics (mass and charge) of neutrons, protons, electrons	-Carry out exercises on symbols and names of elements
	5.4. Definition of an atomic number (number of charges) and mass numbers	
	-Isotopes	-Carry out exercises on writing electronic configurations of the first 20 elements.
	-Chemical symbols of elements	
-Explain isotopes	5.5. Symbolic representation of parts of an atom and isotopes.	
-Write symbols of elements	- An atom as a neutral particle.,	
	5.6. Energy levels and shells (n=1, 2, 3… or K, L, M…)	
-Write the formulae of common elements and compounds. -Write and explain the arrangement of electrons (configuration) in terms of energy levels and shells (n= 1, 2, 3, or KLM…..)	The electronic configuration of the first20 elements **(avoid orbital models)**	

CHAPTER 7: ELEMENTS AND COMPOUNDS *(11 periods)*

Teaching aids
- Periodic table, atomic models, plasticine, stalks

Learning situations
-Prepare atomic models (Use plasticine or balls of different colours)
-Show the different combinations with the balls
-Conclude that a combination of two or more balls forms a molecule.

Specific objectives	**Contents**	**Teaching / learning activities.**
At the end of this chapter the student should be able to : -Define a molecule, a valency -Use the Octet (duet)law to determine the valency of elements. -Explain gain and loss of electrons by atoms. -Identify valency electrons and those that are not. -Explain how a molecule is formed. -Explain the difference between an element and a compound. -Write the formulae of common elements. - Draw a table of names and formulae of simple compounds.	7.1 Valency (number of free electrons) 7.2. Electronic structures and valencies of rare gases 7.3. Instability of atoms 7.4. Ion formation (cations and anions) 7.5. Definition of valency electrons and electrons that do not have valencies, 7.6. Free electrons and paired electrons 7.7. Molecule (simple molecules and compound molecules) 7.8. Nomenclature and chemical	-Write formulae for compounds using symbols and valencies. -Draw a table of molecules. -Carry out exercises on constructing tables with valencies of some atoms or group of atoms

Specific objectives	Contents	Teaching / learning activities.
-Draw a table of the valency of atoms or group of atoms -Construct formulae of simple compounds using the table of valencies	formulae of some oxides, chlorides, bromides, iodides, acids, carbonate nitrates and phosphates.	- Carry out exercises in naming some oxides ,chlorides, bromides, iodides acids bases (hydroxydes), carbonates, nitrates and, phosphates

5. FORM II PROGRAM

5.1 CHAPTERS

Chapter	Duration
8. Reactions and chemical equations	10 periods
9. Periodic table of chemical elements	7periods
10. Chemical bonding	12 periods
11. Oxygen and oxides	10 periods
12. Acidic and alkaline solutions	6 periods
13. Salts and their formation	6 periods
14. Mole concept	11 periods
Total	**62 periods**

5.2 GENERAL OBJECTIVES.

At the end of Form II the student should be able to:

-Interpret an equation of a chemical reaction
-Explain periodic classification of elements
-Know how to use the periodic table.
-Describe and illustrate a chemical bond
-Explain physical and chemical properties of oxygen and its derivatives
-Explain acidity and alkalinity of a solution as well as acide-base neutralisation.
-Understand salt preparation and identify anions and cations
-Understand the interpretation and the use of mole concept.

5.3 DETAILED PROGRAM

CHAPTER 8: CHEMICAL REACTIONS AND EQUATIONS *(10 periods)*

Teaching aids
-Bunsen burner, deflagrating spoon, beakers, inflatable balloons (igipurizo), elastic cord, weighing scale and washing bottle
-Iron fillings, sulphur, copper sulphate, silver nitrate, hydrochloric acid, vinegar, yeast, calcium oxide or hydroxide, sodium hydroxide, water.

Learning situations.

- Carry out a reaction of vinegar and chemical yeast (ex: Bakers yeast or bicarbonate) in a closed medium
-Place the vinegar in beaker and weigh it
-Place the yeast in an inflatable balloon and weigh it.
-Fix the ball on the beaker with the elastic cord without mixing them and weigh the mixture
-Mix the yeast in the beaker and observe until the balloon stops inflating and then weigh

Specific objectives	**Contents**	**Teaching/Learning Activities**
At the end of this chapter, the student should be able to:		
-Explain a chemical reaction	8.1. Chemical reaction(combination and rearrangement of atoms)	-Give the difference between a physical and chemical change. -Carry out certain experiments : combination (Fe + S) ; combustion, action of acid on bases or oxides, displacement reaction, Precipitation reaction.
-Write simple balanced chemical equations in sentences and symbols	8.2 Chemical equations : presentation of chemical reactions through balanced equations in sentences and in symbols	

Specific objectives	**Contents**	**Teaching/Learning Activities**
	(indicate the physical states of the reactants and products)	-Carry out exercises on balancing chemical equation
-Explain the law of conservation of matter	8.3 The law of conservation of matter	-Carry out simple experiments to illustrate the law of conservation of matter (example : Fe + S =FeS)
-Explain the action of heat to certain substances.	-Action of heat on certain substances	-Carry out experiments to study change in mass of a substance following heating of a substance (example :dehydration of $CuSO_4.5H_2O$ by heat.)
- Identify certain chemical reactions	-Types of chemical reactions combination , decomposition and displacement	

CHAPTER 9: PERIODIC TABLE OF CHEMICAL ELEMENTS *(7 periods)*

Teaching aids
- Periodic table of chemical elements, a pair of tongs, knife, beakers, Bunsen burners, deflagrating spoon.
or melting pots, grains of sorghum, wheat, maize, rice, beans, soya, peas…
-Calcium, water, magnesium, sodium, dilute hydrochloric acid.

Learning situations
- Prepare a mixture of sorghum, wheat, maize, beans and rice.
- Count each type of seed in the mixture
- Demonstrate the difficulty in counting without earlier separation.
- Show the necessity of grouping elements in a periodic table

Specific objectives	**Contents**	**Teaching/Learning Activities**
At the end of this chapter the student should be able to : -Explain the relationship between the valency of an element and its position on the periodic table. -Classify the first 20 elements in groups and periods in the periodic table.	9.1. Organisation of elements in the periodic table (historical) 9.2. Atomic number and the periodic table 9.3. Valency electrons and position of elements in the periodic table. 9.4. Identification of an element (20first elements) using its group and period	-Construct a table of symbols and valencies of some elements. -Carry out exercises of finding the first 20 elements in the table using their atomic

Specific objectives	**Contents**	**Teaching/Learning Activities**
-Explain the variation of metallic and non-metallic characters in the periodic table. -Explain physical properties of metals and non-metals. -Show how reactivity varies in groups and periods. -Establish a relationship between configuration and chemical properties.	9.5 Electronic configuration and chemical properties 9.6 The difference between electropositive and electronegative elements. 9.7 Physical properties of metals and non-metals: (Electric and calorific conductivity, malleability, ductility…) 9.8 Reactivity in groups (downwards) and in periods (left to right) 9.9 Chemical properties and electronic configuration of elements **NB : Hydrogen is not an alkaline metal despite its position in the periodic table**	numbers, periods and valencies -Carry out exercises on identifying an element and its electronic structure through its period and group.. -Give a classification of metals and non-metals using observable properties (sparkle, colour, its conductivity, etc) -Carry out experiments to compare reactivity of elements in group I and II with air, water and diluted acids

CHAPTER 10: CHEMICAL BONDING *(12 periods)*

Teaching aids:
-Atomic models, plasticine, stalks, beakers, test-tubes, electric circuit with a lamp, microscope or magnifying glass, thermometer, deflagrating spoon,

-Big crystals of (: Sodium chloride, iron III chloride, copper sulphate), sodium, water, coloured indicators, hydrochloric acid, sugar, aluminium, alcohol,

Learning situations
-Study a case of a blind person and a paralysed person who was clear-sighted .They wanted to drink from a water -source but they could not get to it because of their disabilities. How will they reach the source?
-Explain the formation of a chemical bond.

Specific objectives	**Contents**	**Teaching/Learning Activities**
At the end of this chapter the student should be able to : -Explain what a chemical bond is. -Explain the reasons for chemical bond formation. -Show the use of valency electrons in chemical bond formation. -Describe and illustrate ionic bonding.	10.1Chemical bonding. - Electronic configuration of rare gases and their stability. -Definition of a chemical bond as a force that joins atoms - Chemical bond formation - Role of valency electrons in chemical bonding. 10.2 Ionic bonds : - Ion formation due to gain or loss of	**-Using atomic models** (from plasticine/other coloured balls and stalks), show molecular models. -Identify the different ways an atom can gain a stable structure of rare gases.

Specific objectives	Contents	Teaching/Learning Activities
	electrons. -Ionic compound formation (ex : Na Cl), by electrostatic attraction between ions with opposite charges creating a giant three-dimensional crystal structure	
-Show properties of ionic compounds. -Explain why ionic compounds have relatively high melting points.	-Crystal model (ex : Na Cl) -Proprieties of ionic compounds (physical states, mechanical and electrical properties)	-Carry out experiments to show properties of ionic and covalent compounds (electric conductivity or non-conductivity, brittle or non-brittle, melting point....
-Describe and explain covalent bond formation.	10.3 Covalent bond -Formation of a molecule by union of electrons (Cl_2, CH_4, NH_3, H_2O, HCl …)	
-Show some properties of covalent compounds. -Explain why covalent compounds have relatively low melting points. -Give some examples of crystal molecular compounds	-Properties of covalent compounds (physical states, mechanical and electrical properties) -Intermolecular interactions, boiling and melting points. -Examples of some crystal molecules like :Ice diiodine	-Represent the molecular structure of a covalent compound (The Lewis model) using its chemical formula. -Carry out exercises on showing ionic and covalent compounds using cross and point diagrams.
-Symbolically show ionic and covalent compounds. -Draw models of some simple molecules.	-Examples of some giant crystal molecules : diamond and graphite silicone SiO_2 -Strong covalent bonds in the giant crystal molecules give them very high melting points.	-Carry out exercises to determine the ionic and covalent properties of compounds.
-Describe a metallic bond	10.4 Metallic bond -Its the union of many valency	-Show the properties of heat conduction,

Specific objectives	Contents	Teaching/Learning Activities
-Establish the relation between a metallic bond and properties of a metal.	electrons between many atoms of the same element (cations in a sea of electrons (an example is sodium) -Properties (physical, mechanical, electrical.) and uses of metals.	electric conduction, ductility and malleability

CHAPTER 11: OXYGEN AND OXIDES *(10 periods)*

Teaching aids:
- Wick (matches), Bunsen burner, balloons, glass tubes, beakers, stand, cork, pierced cork, triangular file. Plastic tubes washing bottle,
- Concentrated sulphuric acid, calcium chloride, calcium oxide, potassium chlorate, manganese oxide, sulphur.,
  Calcium, magnesium, iron, copper, sulphur, hydrogen, solutions of their oxides

Learning situations
-Collect oxygen prepared from the decomposition of $KClO_3$
-Burn the sulphur or light the wick in the collected oxygen.
-Collect sulphur oxide in the balloon containing water and use an indicator to test.
-Conclude that oxygen is the active part of air responsible for combustion and oxide formation..

Specific objectives	Contents	Teaching/Learning Activities
At the end of this chapter the student should be able to :		

Specific objectives	**Contents**	**Teaching/Learning Activities**
-Indicate methods of oxygen preparation. -Prepare oxygen from oxides. - Show physical and chemical properties of oxygen. - Determine the percentage of oxygen in the air using a simple experiment. -Write a combustion reaction equation of a substance in air. -Show conditions for rusting by a simple experiment -Prevent rust formation -Classify oxides in acidic oxides, basic oxides neutrals and amphoteric oxides. -Identify the nature of an oxide using some tests -Give important uses of oxygen and oxides	11.1 Sources of oxygen -Air : Fractional distillation. -Water: electrolysis -Decomposition of oxides (H_2O_2, $KClO_3$, KNO_3) 11.2 Properties of oxygen: -Physical properties -Chemical properties 11.3Determination of oxygen percentage in air 11.4 Reaction of substances with oxygen in air: -quick combustion -slow combustion (example of rust, its composition and prevention) 11.5 Acidic, basic, amphoteric oxides and their properties 11.6 Uses of oxygen and its derivatives. -Combustion in presence of oxygen -CO_2 (photosynthesis, carbonated drinks, extinguishers) -CaO (cement)	-Carry out preparation and drying of oxygen from oxides (ordinary drying agents: H_2SO_4, $CaCl_2$, CaO) -Carry out an experiment on rusting iron in a calibrated cylinder inverted in water. -Show quick combustion of: Ca, Mg, Fe, Cu, S, H_2, -Exercise writing equations of combustion reaction. -Carry out acide-base tests on Magnesium, Sodium, Calcium, Aluminium, nitrogen sulphur carbon and zinc oxide solutions.

CHAPTER 12: ACIDIC AND BASIC SOLUTIONS *(5 periods)*

Teaching aids:
- Burette, pipette, stand, burette holder, washing bottle, dropper, beaker, balloons.
- Acidic solution (dilute HCl), basic solution (NaOH), Aluminium hydroxyde, magnesium oxide, water, magnesium hydroxide, acetic acid, ammoniac, universal indicator, phenolphthalein, barium chloride, lead salts(nitrate or acetate) potassium iodide.

Learning situations
-Show that Magnesium oxide, Magnesium hydroxide, aluminium hydroxide used to treat acid in the stomach are bases.
-Show (explain) that the stomach contains an acidic solution
-Conclude that treatment by the products mentioned above is an acido-basic neutralisation process.

Specific objectives	**Contents**	**Teaching/Learning Activities**
At the end of this chapter the student should be able to :		
- Explain the cause of acidity or alkalinity of aqueous solutions.	12.1Dissociation of acids and bases in an aqueous medium : -Release of H^+ ions in acidic solutions -presence of OH^- ions in basic solutions	
-Explain the difference between a strong acid/base and a weak acid/base.	-Strong and weak acids - Strong and weak bases	
- Determine the pH of a medium using a universal indicator.	12.2 The relation between the pH scale and the quantity of H^+ ions in solutions Ex : pH of medicines - The pH:scale shows pH as a unit of measuring acidity or alkalinity of a substance. It's measured from 0 to 14.	-Measure the pH of a strong acidic solution (ex : HCl aq) and a weak acidic solution (ex : CH_3COOH) of the same concentration -Measure the pH of a strong base (NaOH) and a weak base (NH_4OH) of the same

Specific objectives	Contents	Teaching/Learning Activities
	(avoid defining pH in terms of –log [H^+]) 12.3Acido-basic neutralisation and its products	concentration using a universal indicator. -Measure the pH of some medicines
-Explain a neutralisation reaction -Write some chemical equations of acid and base reactions	12.4 Reaction of acids and carbonates.	-Carry out dilutions of acid/base solutions and measure their pH using a universal indicator -Carry out neutralisation of dilute hydrochloric acid by an aqueous solution of sodium hydroxide. -Carry out exercises on writing equations of acid-base neutralisations.

CHAPTER 13: SALTS AND THEIR PREPARATION *(5 periods)*

Teaching aids :
- Bunsen burner, hotplate, Pyrex beakers, washing bottles.
- Aqueous sodium hydroxide solution (NaOH aq),aqueous hydrochloric acid solution (HCl aq),Solid sodium chloride (NaCl),zinc powder, silver nitrate, barium chloride, salts containing cations and (Cu^{2+}, Fe^{2+}, Fe^{3+}, CO_3^{2-}, SO_4^{2-} , Cl^- , Na^+, Ca^{2+}), magnesium oxide or a piece of nichrome and lime.

Learning situations
-Make an equimolar mixture of $NaOH_{aq}$ and HCl_{aq}
-Heat the solution until it is powder and observe.
-Dissolve the powder in water and observe.
-The powder formed is a salt.

Specific objectives	Contents	Teaching/Learning Activities
At the end of this chapter he student should be able to :		
-Show that a salt is formed from a metallic cation and an anion.	13.1Salt preparation -Nomenclature and chemical formulae of simple salts.	- Carry out exercises in writing chemical formulae of salts and naming them.
-Identify soluble and insoluble salts.	13.2 Properties of salts : -Physical states, -Colours,	-Using experiments identify soluble and insoluble salts. -Prepare saturated and non-saturated solutions.
-Explain salt dissolution in water.	- Solubilities of sulphates, chlorides, nitrates, carbonates -Electric conductivity.	-Carry out a crystalisation experiment.(ex : a saturated NaCl solution)
-Choose a suitable method for preparing soluble or insoluble salts. -Give properties of salt.	13.3 Preparation methods. : - Soluble salts by action of acids on metals, metallic hydroxides, metallic oxides and carbonates.	-Prepare soluble (ex : dilute hydrochloric acid + Zn in excess) and insoluble salts (ex : : precipitation of $BaSO_4$, PbI_2)
	- Insoluble salts by precipitation.	-Carry out identification of cations and anions (Cu^{2+}, Fe^{2+}, Fe^{3+}, CO_3^{2-},SO_4^{2-}, Cl^-, Na^+, Ca^{2+})
-Name some ions	13.4 Simple identification tests of cations and anions.	

CHAPTER 14: MOLE CONCEPT *(10 periods)*

Teaching aids:
- A collection of small objects (sugar, rice, sorghum, wheat…), weighing scale
-Magnesium ribbon, dilute HCl.

Learning situations.
- Count the small objects (sugar, rice, sorghum, wheat…)
- Explain the difficulty in counting small objects
- Explain the sale and purchase of these objects in packets.
- Introduce the idea of a chemist's packet (the mole) which contains a constant number of particles (Avogadro's number)

Specific objectives	**Contents**	**Teaching/Learning Activities**
At the end of this chapter the student should be able to : -Explain relative atomic mass and relative molecular mass (with C-12 as a reference) -Clearly explain what a mole is. -Explain the difference between the Empirical formula and molecular (brute)formula of a compound	14.1-Definition of relative atomic mass with C-12 as a reference -Definition and calculation of relative molecular mass. 14.2Avogadro's number and definition of a mole -Definition: -Molar mass -Avogadro's number and molar gas volume	-Determine molar gas volume (ex : by hydrogen production from reacting Mg with HClaq) -Carry out exercises on converting moles to mass units and vice versa

Specific objectives	Contents	Teaching/Learning Activities
-Deduce the Empirical formula using centesimal composition. -Interpret a chemical equation -Convert moles into mass units and vice versa. -Calculate stoichiometric quantities.	14.3 –Empirical and molecular formulae. -Molecular, molar, or mass reading of a chemical equation. - Calculations to : ▪ Convert moles to masses and vice versa. ▪ Determine Mass centesimal composition ▪ Determine Empirical and Molecular formulae ▪ Determine the stoichiometric quantities of reactants ▪ Determine limiting reactants ▪ Determine molar volumes	▪ Calculate mass centesimal composition. ▪ Write out Empirical and Molecular formulae, ▪ Calculate stoichiometric quantities of reactants, ▪ Determine limiting reactants. ▪ Calculate molar volumes

6. FORM III PROGRAM.

6.1 CHAPTERS

Chapter	Duration
15. Solutions and concentrations	12 periods
16. Electrolysis	10 periods
17 Study on some elements in the periodic table	20 periods
18. Introduction to organic chemistry	20 periods
Total	**62 periods**

6.2 GENERAL OBJECTIVES.

At the end of Form III the student should be able to:

-Interpret concentration of solutions and use it to determine quantity of matter.
-Explain electrolysis and its uses.
-Indicate properties of carbon, chlorine, sulphur, nitrogen, and their uses.
-Understand organic compounds and give some of their uses

6.3 DETAILED PROGRAM

CHAPTER 15: SOLUTIONS AND CONCENTRATIONS *(12 periods)*

Teaching aids :
- Weighing scale, burettes, pipettes, burette holders, gauge balloons, stands, beakers, spatulas, washing bottles.
- Sugar, kitchen salt, water, , NaOH, HCl, phenolphtalein;drinks, medicines, and labelled foods.

Learning situations
- Dissolve the same quantity of sugar (ex 1 spoon) in three different volumes of water.
- Explain why the three volumes of water have different tastes

Specific objectives	Contents	Teaching/Learning Activities

Specific objectives	Contents	Teaching/Learning Activities
At the end of this chapter the student should be able to :		
- Explain solutions and solvents giving examples. - Explain the concentration of a solution in terms of molarity and percentage. -Explain these terms: saturated solutions, non-saturated solutions, crystallisation and precipitation. -Undertake concentration calculations. -Prepare a solution of determined molarity. -Perform dilutions of different solutions - Perform a simple acido-basic titration -Make simple calculations on acid/base reactions.	15.1-Definition of a solute, solvent and solubility -Factors influencing solubility 15.2-Notion on concentration - Different explanations on concentration, molarity and percentage. 15.3-Saturated solutions, non saturated, Solutions , crystallisation and precipitation **(differentiate from solutes in excess)** 15.4-Preparation of solutions with different concentrations -Dilution of a solution 15.5-Strong monoacidic-monobasic titrations 15.6-Simple calculations on neutralisation reactions	-Carry out exercises on calculating solute quantities to use and prepare solutions of known concentrations. -Determine quantities of matter from labels (drinks, foods, medicines) -Prepare ORS (Oral Rehydration Salts) -Titrate HCl by NaOH or do the inverse -Determine unknown concentrations using determined volumes and concentrations.

CHAPTER 16: ELECTROLYSIS *(10 periods)*

Teaching aids:
- Electrolyser (with an ammeter), test-tubes, direct current.
- NaCl, sugar, dilute sulphuric acid distilled water, phenolphthalein

Learning situations
- Electrolyse the acidulated water
- Identify products of electrolysis.
- Show the use of direct current in the process.

Specific objectives	**Contents**	**Teaching/Learning Activities**
At the end of this chapter the student should be able to :		
- Differentiate electrolytes from non-electrolytes - Indicate the difference between a metallic conductor and an electrolyte. - Give types of electrolytes.	16.1 Definition of an electrolyte and a non-electrolyte 16.2 Types of conductors (metallic, electrolytic solutions) 16.3 Types of electrolytes: -Strong and weak electrolytes -Electrolytic solutions and molten salts.	-Illustrate electric conduction in electrolytes and non electrolytes (ex: a salt or sugar solution…) -Illustrate the difference in conductivity for strong and weak electrolytes using electrolytes of the same concentration.
- Define electrolysis - Draw and label an electrolysis apparatus. - Mention some products of electrolysis.	16.4 Notion of electrolysis - Definition - Electrodes and reactions at electrodes Anode : electron loss (oxidation) Cathode : electron gain (reduction) **N.B Outside electrolysis, oxidation can**	-Carry out electrolysis : ▪ In water (acidulated) ▪ in NaCl in aqueuse solution -Carry out exercises in writing electrode reaction.

Specific objectives	Contents	Teaching/Learning Activities
- Give some applications of electrolysis.	**be defined as an oxygen gain and reduction as an oxygen loss.** 16.5 Application of electrolysis -Preparation of simple substances -Metal extraction and purification (ex : Cu, Al) - Metal protection (gold or silver coating of jewellery, metallic coating of utensils for protection.) **N.B Galvanisation and metallic painting do not constitute protection by electrolysis.**	

CHAPTER 17: STUDY OF SOME ELEMENTS IN THE PERIODIC TABLE *(20 periods)*

Teaching aids:

- Hotplate or Bunsen burner, Pyrex beakers, manual and magnetic stirring rods washing bottles, box of matches.
- Mineral water, bleach, sulphuric acid, NPK chemical fertilizer, calcium carbonate, lime, acid Hydrochloric acid, sodium hydrogen carbonate, soap, hard water, calcium hydroxide, ammonium chloride., Potassium nitrate, concentrated sulphuric acid, sulphur powder, acidified potassium permanganate solution, iron sulphide, iron fillings, sugar, piece of wood, piece of fabric, piece of paper, sodium dichloride, manganese dioxide.

Learning situations

- Present a number of articles in which we find carbon, sulphur, nitrogen and chlorine (mineral water, sulphuric acid, bleach, disinfection of water, NPK chemical fertiliser.....)

Specific objectives	Contents	Teaching/Learning Activities
At the end of this chapter the student should be able to : : - Identify the different forms of carbon and their properties.. - Explain the reaction of carbon and oxygen. - Describe the reaction of carbon and metallic oxides. -Describe the action of dilute acid on a carbonate and a hydrogencarbonate. - Describe the action of heat on a carbonate, or a hydrogencarbonate - Prepare carbondioxide, a carbonate, a hydrogencarbonate and describe their properties. - Explain the relation of hard water and carbonates - Use some methods to soften water.	**17. 1 CARBON** 17.1.1Forms of carbon (diamond, graphite and coal.) and their physical properties. 17.1.2 Carbon affinity for oxygen. : - Combustion reactions - Carbon reaction with metallic oxides (reducing agent) (ex : obtaining iron from reduction of Fe_2O_3 by carbon) 17.1.3Definition and sources of carbonates (ex : chalk) -Action of dilute acid on a carbonate, and a hydrogencarbonate -Action of heat on a carbonate and a hydrogencarbonate 17.1.4 Preparation of carbondioxide, a carbonate (Na_2CO_3, $CaCO_3$, $MgCO_3$), a hydrogencarbonte ($NaHCO_3$) and a description of their properties 17.1.5- Hard water and ways to soften it. (heating, precipitation) 17.6- Uses of carbon (graphite, diamond and coal) and its by- products (CO_2, CO,	-Carry out exercises on writing equations of dilute acids on carbonates and hydrogencarbonates - Heat decomposition of NaHCO . -Carry out a reaction of dilute HCl on $CaCO_3$ and identify the CO_2 by a lime test. -Show that soap does not foam well in hard water. -soften water that has been hardened (ex by lime and excess CO_2) by heating.

Specific objectives	**Contents**	**Teaching/Learning Activities**
- Mention the uses of carbon and its by-products. - Prevent dangers of CO_2 and CO - Describe the carbon cycle - Mention sources of nitrogen and its physical properties.. -Explain reactions of nitrogen and oxygen and of nitrogen and hydrogen. - Describe laboratory preparation of ammonia and give its properties. -Describe the reaction of ammonia and simple acids. - Describe nitric acid preparation.	Na_2CO_3, $NaHCO_3$, $CaCO_3$, $MgCO_3$) 17.7-Dangers of CO_2 and CO 17.8-Carbon cycle. **17..2. NITROGEN** 17.2.1-Principal sources (Air is a principal source) -Physical properties of nitrogen : Colour, density and solubility. 17.2.2-Chemical properties: reactivity (N_2 is inert) reaction with oxygen (Oxide formation with nitrogen NO_x) reaction with hydrogen 17.2.3-Laboratory preparation and properties of ammonia: solubility in water, reaction with HCl, action on coloured indicators and dilute acidic solutions. 17.2.4-Nitric acid preparation: in a laboratory in an industry	-Draw a simple carbon cycle -Prepare NH_3 using $Ca(OH)_2$ and NH_4Cl -Prepare HNO_3 by heating a mixture of KNO_3 and concentrated H_2SO_4 : $KNO_3(s) + H_2SO_4$ conc. $\xrightarrow{\Delta}$ $KHSO_4(s) + HNO_3(g)$ $HNO_3(g)$ must be passed in a condenser to liquidify the acid.(the experiment must be monitored by a teacher)

Specific objectives	**Contents**	**Teaching/Learning Activities**
- Mention some uses of nitrogen compounds. -Prevent pollution by nitrogenous substances. - Describe the nitrogen cycle - Describe extraction and properties of sulphur - Identify the allotropic forms of sulphur. - Explain how sulphur reacts with oxygen, metals and hydrogen.	17.2.5-Areas where nitrogen and its by-products are used. : ▪ agriculture (chemical fertilizers) ▪ Low temperature conservation. (liquid nitrogen) ▪ industries (manufacture of explosives, medicines) ▪ homes (removal of grease from clothes) - Dangers of and chemical manure. -The nitrogen cycle **17.3. SULPHUR** 17.3.1-Methods of extraction and sources of sulphur (FRASCH,natural gas and petroleum products) -Allotropic forms of sulphur (rhombic, monoclinic, plastic sulphur) and their properties **(avoid crystallographic details)** -Action of heat on allotropic forms of sulphur. 17.3.2-Reaction of sulphur and oxygen (SO_2) -metals (metallic sulphide) -directly with hydrogen or through metallic sulphides and diluted acids	-Draw the nitrogen cycle -Carry out sulphur combustion (formation de SO_2) -Carry out an identification test for SO_2 (by decoloration of an acidic solution of $KMnO_4$) -Prepare H_2S using a reaction of iron III sulphide and dilute hydrochloric acid. -Illustrate dehydration of sugar, pieces of fabric, paper, and wood....by concentrated sulphuric acid.

Specific objectives	Contents	Teaching/Learning Activities
	(H_2S formation)	
-Describe preparation of sulphuric acid (contact process) -Carefully carry out dilution of concentrated sulphuric acid.	17.3.3-Preparation of sulphuric acid by the contact process -Dilution of concentrated H_2SO_4 (battery acid) -Reactions of dilute sulphuric acid with : ▪ Copper (only in the presence of heat) ▪ Mg, Fe, Zn	-Prepare HCl using NaCl and concentrated H_2SO_4 : $NaCl(s) + H_2SO_4$ conc. $\xrightarrow{\Delta}$ $NaHSO_4(s) + HCl(g)$ HCl(g) gives white fumes formed by drops of concentrated hydrochloric acid reacting with water vapour in air..
- Mention uses of sulphur and its derivatives	17.3.4-Uses of sulphur and its derivatives : ▪ medical (skin diseases), ▪ Industrial (manufacture of matches, battery acid, food preservation, chemical fertilizers, cleaning metals.)	
	17. CHLORINE	
- Describe and illustrate preparation of chlorine and its properties.	17.4.1-Preparation and properties of chlorine using concentrated HCl and $KMnO_4/MnO_2$ 17.4.2-Reaction with: ▪ hydrogen, ▪ metals (Na, Mg and Fe)	-Carry out the preparation of sodium chloride in the laboratory by heating

Specific objectives	Contents	Teaching/Learning Activities
- Describe and explain preparation and properties of HCl -Describe laboratory preparation of sodium chloride. -Give the uses of chlorine and its derivatives.	▪ non-metals (S, I_2 and P), Bleaching and bactericidal action 17.4.3 Preparation and properties of HCl : - Preparation using NaCl and concentrated H_2SO_4 -Properties : state odour, colour -Reaction withNH_3 and water. -Reaction of an aqueous solution of HCl : with metals, carbonates and hydrogen carbonates 17.4.4-Laboratory preparation of NaCl 17.4.5-Uses of chlorine and its derivatives : disinfectant (water), bleaching, preservative, condiment, caustic (textile industry)	sodium in chlorine.

CHAPTER 18: INTRODUCTION TO ORGANIC CHEMISTRY *(20 periods))*

Teaching aids:
-Atomic models (coloured balls, plasticine, stalks),hotplate or Bunsen burner, balloons, beakers, corks, pierced corks, plastic tubes, glass tubes, washing bottles.,

- Sugar or fruit juice, yeast, acetic acid, water, ethanol, concentrated sulphuric acid, palm oil, sodium hydroxide and sodium chloride.

Learning situations:
- Carry out pyrolysis of organic compounds (sugar, sawdust, soaps) and table salt.
- Note the presence of carbon in all organic products and its absence in salt and other minerals in general.
-Start with these observations and define organic chemistry.

Specific objectives	**Contents**	**Teaching/Learning Activities**
At the end of this chapter the student should be able to : -Explain the difference between an organic and an inorganic substance -Write and name semi-developed and developed formulae of alkanes up to C_5 -Mention common products in distillation of petroleum. - Describe properties of methane and its uses. -Interpret alkane combustion reactions. -Name and class organic compounds until	18.1 Origin of organic chemistry 18.2-Writing semi developed and developed formulae and nomenclature of alkanes up to C_5 18.3-Petroleum and products of its distillation 18.4-Methane : Physical properties Applications :-Fuel -fertilizer production chemicals -production of derivatives (chlorinated derivatives : CH_3Cl : weak anaesthesia CH_2Cl_2 : solvent $CHCl_3$: solvent	-Make displays of hydrocarbon chains in molecular models. -Carry out exercises of writing formulae of some alkanes and name them. -Carry out combustion of a gas in a laboratory by heating it. -Carry out exercises in writing alkane combustion reactions.

Specific objectives	**Contents**	**Teaching/Learning Activities**
c.5 -Describe preparation and properties of ethylene -Prepare alcohol -Prepare ethanol. -Explain the addition reaction of ethylene and compare with substitution reactions in alkanes -Explain an esterification reaction of acetic acid by ethanol. - Mention some areas where organic chemistry can be used.	CCl_4 : solvent 18.5-Alkane combustion reactions 18.6-Classification and nomenclature of other organic compounds up to C_5 (alkenes, alkynes, cynes, alcohols, aldehydes, ketones, carboxylic acid, esters, amines) 18.7-Preparation and properties of ethylene 18.8-Preparation of an alcohol 18.9-Addition reactions of ethylene (with chlorine, bromine, hydrogen and gaseous hydrogen chloride.) 18.10-Esterification reaction of acetic acid by ethanol. 18.11-Use of petroleum products. (Energy source) in transport, industry and in homes - Making soap, plastic, nylon and organic pigments in paint.	-Carry out exercises in classifying organic compounds and naming them up to C_5 -Prepare alcohol by fermentation -Prepare ethyl ethanolate using acetic acid and ethanol in the presence of concentrated sulphuric acid -Prepare soap using palm oil and sodium hydroxide.

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PART THREE: ORDINARY LEVEL PHYSICS PROGRAM

1. GENERAL ORIENTATIONS

In its definite aspect, by the precision of its processes and reasoning, Physics allows a development of the mind and makes up an important component of culture essential to man. The reviewed ordinary level physics program should allow complete training of the student creating an understanding of different phenomena in physics occurring in the environment and to exploit them for better participation in the development of society.

At this level the ordinary level student must move from knowledge of direct experience to a level of scientific ideas governed by laws and theories. In addition to that physics lessons must arouse scientific curiosity of the student and motivate a spirit of research. Teaching methods are to be student–centred and primarily active, inductive and practical as opposed to the old approach that was mainly theoretical and deductive. The teacher will create Learning situations that need observation of facts and phenomena in everyday life or use technological and professional techniques to develop a spirit of curiosity, interest and critical thinking in students. Students will have to be given practical work since physics is an experimental science. Students will be put in a situation that requires action and research; this will allow better acquisition of knowledge and a spirit of observation, cogitation and synthesis of ideas. The approach will be of inductive nature by encouraging observation and experimentation. The ordinary level physic program was developed in this context

For each chapter, a list (not exhaustive) of teaching aids and examples of teaching and learning activities are suggested. The teacher should cover these activities as a minimum.

However, the teacher is also encouraged to find or create other Learning situations according to available means . The study duration is also suggested. Although it’s an estimation, it helps the teacher assign appropriate time to material to be taught. A three column table has been availed with specific objectives, contents, and teaching/learning activities. Teaching/learning activities will include practical work and exercises. These constitute the minimum activities to be carried out. The teacher may give additional exercises to help the students.

To encourage students to work regularly, homework will have to be given frequent. The teaching and learning of Physics at ordinary level will be oriented towards attaining the general and specific objectives of this program. Evaluations of various types and forms will be given to confirm that the objectives have been attained at different levels

2. GENERAL OBJECTIVES

At the end of the ordinary level, the student should be able to::

- Explore his/her physical environment
- Explain the importance of physic in everyday life
- Show knowledge in quantities in physics
- Explain certain natural phenomena occurring in his/her physical environment
- Understand the applications of physical phenomena in technology and in everyday life.
- Solve common problems that require knowledge in Physics
- Use a systematic approach to solve problems in Physics

3. EVALUATION APPROACH

To confirm that the objectives have been attained, Formative and accumulative evaluations will be given. A formative evaluation will be given for each lesson to confirm that specific objectives have been attained. An accumulative evaluation in the form of general, end-of-term, annual or national exams will be given for general objectives. During the setting of these evaluations, taxonomic levels in the educational objectives such as knowledge, understanding, application, analysis, synthesis and evaluation of the cognitive field should be taken into account. (refer: taxonomy of Bloom’s cognitive field)...

4. FORM I PROGRAM

4.1 TOPICS AND CHAPTERS

Topics and Chapters	**Duration**
TOPIC 1: Introduction to Physics	
Chapter 1: Measurement in physics	12 periods
Chapter 2: Properties of Matter	6 periods
TOPIC 2: Liquids in equilibrium	
Chapter 1: Force and pressure	10 periods
Chapter 2: Pressure in fluids in equilibrium	34 periods
Total:	**62 periods**

4.2 GENERAL OBJECTIVES

At the end of Form I the student should be able to:

- Differentiate physics from other sciences
- Choose an appropriate measuring instrument
- Measure physical quantities in appropriate SI units.
- Explain physical properties of solids, liquids and gases.
- Illustrate static and kinetic effect of a force
- State Pascal's principle and give some of its applications in every day life.
- State Archimedes' principle and give some of its applications every day life.

4.3 DETAILED PROGRAM

TOPIC I: INTRODUCTION TO PHYSICS

Chapter 1: Measurement of physical quantities (12 periods)

Teaching aids:

Vernier callipers, micrometer screw gauge, marbles, metallic thread, stop watch, scales, Eureka can, calibrated cylinder, various objects whose volumes are to be measured

Learning situations

- Examples of physical and non physical phenomena (chemical and biological)
- Students observe the environment and describe what they see (certain bodies are solid, others are liquid and others are gaseous; some people moving and others at rest, some people are big, others are small, the class is lit by electric current, etc)
- Give examples of physical quantities and measuring instruments.
- Explain the meaning of the international system of units of measurement.

Specific objectives	Contents	Teaching and learning activities
• Distinguish between physics and other sciences • Choose an appropriate measurement instrument • Measure whole or portions of common objects • Give measurements in appropriate units • Explain the concept of physical quantities such as volume, mass, density, weight, force • Calculate area, volume, density. • Differentiate fundamental quantities from derived quantities	Definition of physics Objective of physics Physical quantities: 1. Concept of physical quantities 2. Measurement of a physical quantity 3. Measurements and units of certain fundamental quantities such as: length, mass, time. 4. Derived quantities: area, volume, weight, mass, density, force. 5. International System of Units (SI)	- Use various instruments for measuring sizes of various objects Use a vernier callipers and micrometer screw gauge to measure the length and diameter of various objects To use and draw the available tools to measure physical quantities such as the time, the mass, the length, density force... Determine the volume of a solid body of any form by using a Eureka can or a calibrated cylinder Do exercises on converting units into SI system - .

Chapter 2: Properties of Matter (6 periods)

Teaching aids:
Containers of various forms, articles of various forms, different liquids, plastic packet (to wrap salt, sugar), bicycle pump …

Learning situations

- Observe the articles (water, oil, pebbles, nail, piece of wood, piece of chalk) and help students use their physical properties to differentiate them..
- Illustrate that unlike solids, liquids have a clear volume but no permanent form.
- Illustrate that air (gases) is compressible and expansible (by using a plastic packet or a tube).

Specific objectives	**Contents**	**Teaching and learning activities**
- Arrange substances in solids liquids or gases Describe physical properties of solids, liquids and gases.	States of matter: solids, liquids and gases Physical properties of solids Physical properties of liquids Physical properties of gases	Give examples of solids ,liquids and gases Illustrate some properties of solids, liquids and gases giving examples.

TOPIC II. LIQUIDS IN EQUILIBRIUM

Chapter 1: Force and pressure (10 periods)

Teaching aids:
Dynamometer, two identical bricks, nail, sponge blocks, fine sand, fine soil …

Learning situations
- Illustrate static and kinetic effects of a force
- Observe deformation on a sponge block under a brick on its different sides..
- Place a brick on the sponge block and observe the deformation ,stack another brick and compare the deformations, (in the absence of a sponge block use a heap of sand or fine soil)

Specific objectives	Contents	Teaching and learning activities
-Define force -Give the effects of force -Identify different types of forces -Differentiate between scalar and vector quantities -Use instruments to measure force - Define pressure - Identify factors influencing pressure.	Force: Introduction Define force by its effects Types of forces Particular case: weight (difference between mass and weight) Vector character of force Vector variation Vector and scalar quantities. Tools to measure force Force composition in the same direction Pressure: Force exerted by solids Definition (formula) Units of pressure	- Use a dynamometer to measure forces -Use the formula p=F /S to answer questions.

Chapter 2: Pressure in liquids in equilibrium (34 periods)

Teaching aids:
Plastic bottle with holes at different heights, pressure gauge, packets, plastic pipes, syringe, paper, glass, water, rubber ball , dynamometer, Eureka can, funnel, beaker, straw, barometer, basin

Learning situations

- Research on historical personalities like Archimedes, Torricelli or Pascal to discover that their scientific' activities went hand in hand with other interests (army ,politics, writing …)
- Show variation of pressure with depth using a water container with holes at different heights
- Carry out an experiment showing the equilibrium of a liquid in communicating containers
- Illustrate Pascal's principle by pressing a packet full of holes at different places
- Prove the existence of atmospheric pressure by inverting a glass of water covered by a sheet of paper.
- Interpret Torricelli's experiment.
- Show the existence of upthrust using a dynamometer by comparing weight of a body in air and in a fluid.
- Carry out experiments illustrating Archimedes' principle.
- Determine the level of flotation of a body
- Read about aerostats and sounding balloons and make a report in class

Specific objectives	**Contents**	**Teaching and learning activities**
Differentiate a liquid from a solid. Identify factors influencing pressure at a point in a liquid in equilibrium. Use a manometer to measure pressure in a liquid Give and illustrate Pascal's principle	Define a liquid. Pressure in liquids: forces existing in liquids Factors influencing pressure at a point in a liquid in equilibrium ($p = \rho g h$) Applications: Pascal's burst barrel, Dikes Pressure difference between two points in a liquid at rest. Equilibrium of a liquid in communicating	Create a hydraulic press using a plastic pipe with two syringes in different sections Create manometer using a flexible and transparent plastic pipe, funnel and a rubber ball

Give and explain some applications of Pascal's principle in everyday. Identify factor's influencing pressure in gases. Experimentally show the existence of atmospheric pressure. Use barometers to measure atmospheric pressure Solve problems requiring the conversion of common units of atmospheric pressure. Give and explain certain applications of atmospheric pressure in everyday life. Illustrate the existence of upthrust in liquids. - Show Archimedes' principle in a liquid. Explain conditions of floatation and give examples of applications in everyday life..	containers Equilibrium of several non- miscible liquids in a container in two communicating containers Measure of pressures by a manometer Free surface of a liquid at rest Pascal's principle and its applications: hydraulic press, hydraulic lift pump and hydraulic brakes Pressure of gases in equilibrium: .1.Existence of force in air 2 .Atmospheric pressure. Torricelli's experiment. 3. Atmospheric pressure units Uses of pressure in gases: operating a bicycle pump, suction pump, syringe, siphon, straw. Archimedes' principle: Archimedes' principle in liquids. 1 Upthrust 2 Factors affecting upthrust. 3.State principle and formula Applications: Floating, ships, submarines	Measure atmospheric pressure using barometers Do exercises about pressure of a liquid in equilibrium Use a Eureka can and a solid object to compare the difference between weight of this solid and the weight of displaced liquid Illustrate conditions of floatation. Using articles that float and others that sink.

Explain the existence of upthrust in gases. State the Archimedes principle in general.	densimeter Archimedes principle in gases 1 Upthrust. 2 State the principle and formula of Archimedes in fluids. in general	

5. FORM II PROGRAM

5.1 TOPICS AND CHAPTERS

Topics and Chapters Length

TOPIC I: MECHANICS	
Chapter 1: Kinetics of rectilinear motion	14 periods
Chapter 2: Dynamics of rectilinear motion	14 periods
Chapter 3: Work and energy	12 periods
TOPIC II: HEAT	
Chapter 1: Thermometry	4 periods
Chapter 2: Transmission of heat	2 periods
Chapter 3: Expansion of bodies	2 periods
Chapter 4: Principles of heat exchange	6 periods
Chapter 5: Change of physical states	8 periods
Total:	**62 periods**

5.2 GENERAL OBJECTIVES

At the end of the Form II the student should be able to:

- Make a quantitative study on rectilinear motion
- State Newton's laws of motion and their uses
- Give advantages and disadvantages of friction
- Illustrate different types of equilibrium
- Differentiate potential energy from kinetic energy

- Explain the law of conservation of mechanical energy
- Give examples of simple machines and explain their principles of functioning
- Give the difference between the temperature and heat
- Use a thermometer to measure temperature of bodies.
- Illustrate heat transmission methods.
- Explain expansion of bodies.
- Illustrate the principle of heat exchange.
- Name and explain the different changes of state of matter.

5.3 DETAILED PROGRAM

TOPIC I: MECHANICS

Chapter 1: Kinetics of rectilinear motion. **(14 periods)**

Teaching aids:
Chronometer (or watch), inclined plane, marbles, different objects available in class and outside.

Learning situations
- Observe objects in the school environment and show those at rest and those in motion.
- Carry out illustrations showing different trajectories and classify the different kinds of motion according to their course.
- Record times of two students running the same distance outside class and calculate their distances per second.
- Observe the motion of a marble on an inclined plane (UARM)

Specific objectives	**Contents**	**Teaching and learning activities**
Define rest, motion, trajectory, velocity and acceleration	Introduction Rest and motion Trajectory, distance and	Plot a graph and interpret the relation between distance and time in URM.

Make a quantitative study of uniform rectilinear motion Plot a graph of distance with time for URM. Differentiate uniform rectilinear motion from uniformly accelerated rectilinear motion Plot a graph for velocity and time in rectilinear motion with uniform acceleration. Describe Uniform Circular Motion Define and calculate the period, frequency, linear velocity, angular velocity	movement Uniform rectilinear motion: Definition of URM velocity (definition, formula, units) : velocity-time and distance-time graphs Rectilinear motion with uniform change: . Acceleration: formula, units Definition (uniformly accelerated or decelerated motion) UARM: Equations Graphs Example: free-fall UDRM: Equation Graphs Uniform Circular Motion. (UCM) Definition Period, frequency Linear and angular ordinates Linear velocity Angular velocity -	- Relation of velocity with time in rectilinear motion with uniform acceleration Do exercises on URM and UARM/UDRM Do exercises on UCM ▪

Chapter 2: The dynamics of rectilinear motion (14 periods)

Teaching aids:
Dynamometers, articles with smooth surfaces and others with rough surfaces, weighing scales, different objects of the same mass and others of different masses, flat surfaces, concave surfaces, rounded surface and a precision balance.

Learning situations

- Show that a body in a state of rest requires an external force to put it into motion and it needs an external force to bring it to rest or change its motion.
- Observe motion of two bodies of different masses subjected to the same force
- Observe motion of two bodies of same mass subjected to different forces.
- Couple two dynamometers, one is fixed and the other stretches it. Take readings from each dynamometer.
- Illustrate friction force in a body in motion using a dynamometer on different surfaces (smooth or rough surfaces)
- Illustrate static and kinetic friction using a dynamometer attached to a body that is being slowly pulled.
- Illustrate different types of equilibrium (stable, unstable and neutral) using bodies of different forms on a flat surface
- Observe the equilibrium position of a marble or a cylinder on a flat, concave or convex surface.

Specific objectives	**Contents**	**Teaching and learning activities**
State and use Newton's laws of motion Differentiate dynamics from kinetics Define friction force Give the effects of friction Explain how friction can be overcome Differentiate static friction from kinetic friction. Give factors affecting friction Give advantages and disadvantages of friction	Newton's laws of motion: 1. Principle of inertia: Newton; s 1st law. 2. Newton's second law 3. Newton's third law: Action-reaction Friction force : 1. Definition of friction 2. Effects of friction 3. Static and kinetic friction 4. Factors affecting friction and ways	▪ Do exercises on Newton's second law of motion.

Give the equilibrium state of a body Identify types of equilibrium and give the conditions for an equilibrium Determine the centre of gravity of different objects Name and explain the factors influencing stability of equilibrium -	to reduce it 5. Advantages and disadvantages of friction Equilibrium of a solid : 1. State of equilibrium 2. Centre of gravity and types of equilibrium	▪ Experimentally determine the centre of gravity of a body of any form using a precision balance.

Chapter 3: Work, Power and Energy (12 periods)

Teaching aids:
- Dynamometer, spring, a non-stretch thread and a small marble (to make a pendulum), levers of different kinds, an inclined plane

Learning situations
- Illustrate work in moving an object using a dynamometer
- Illustrate potential energy and its transformation into kinetic energy and vice versa using: a catapult, simple pendulum mouse trap, compressed spring, etc to illustrate potential energy and its transformation into kinetic energy and vice versa
- Use different types of simple machines to do simple work

Specific objectives	Contents	Teaching and learning activities
Define work, power and energy. Differentiate potential energy from kinetic energy Give the law of conservation of energy. Give examples of simple machines Explain the working principle of lever, a pulley and an inclined plane Define machine work and resistance work Determine output of a simple machine Answer questions on simple machines Explain the transformation of potential energy into kinetic energy and vice versa Define output of simple machines Answer questions on simple machines.	Work 1. Definition 2. Formula 3. Units Power : 1. Definition 2. Formula 3. Units Energy: 1. introduction 2. Kinetic energy 3. Potential energy 4. Conversion of potential energy to kinetic energy and vice versa. 5. Conservation of mechanical energy Simple machines: 1. Definition 2. Types of simple machines	- Answer questions on energy, power and work - - - - - - - l - Solve problems on simple machines

Specific objectives	Contents	Teaching and learning activities
	3. Machine work and resistance work 4. Mechanical advantage and Velocity ratio. 5. Output.	-Construct some simple machines and use them

TOPIC II. HEAT

Chapter 1: Thermometry. (4 periods)

Teaching aids:
Thermometers, heat source, 2 containers of water

Learning situations

- Put a thermometer into a container of water at room temperature and take readings from the thermometer, then put it into a container with hot water and take the readings. Note that everything in any state has a temperature.
- Increase water temperature by heating it and again take the reading on the thermometer. Note that the increase of temperature is an effect of increased heat.

Specific objectives	Contents	Teaching and learning activities
- Give the difference between temperature and heat. - Use a thermometer to measure temperature. - Explain the principle of calibrating a thermometer - Compare different temperature scales.	Introduction : heat Introduction. :temperature Difference between heat and temperature. Measure temperature and thermometer temperature scales	▪ Use a thermometer to take the temperatures of different bodies.

Chapter 2: Transmission of heat (2 periods)

Teaching aids:
Thermometers, heat sources, containers water, paper in spiral form, candles, wooden stick, metallic rod

Learning situations
- Heat the ends of a metallic rod and a wooden stick and touch the other ends to determine what takes place**..**
- Illustrate transmission of heat by conduction using a metal rod marked by balls of candle wax.
- Illustrate transmission of heat in liquids and gases by convection using a paper in spiral form above a hotplate and heating water in a container.
- Illustrate transmission of heat by radiation by feeling the heat of an person under the sun and then under a shade.

Specific objectives	**Contents**	**Teaching and learning activities**
- Explain transmission of heat. - Give examples of heat transmission in everyday life.	Transmission of heat. : ▪ Conduction ▪ Convection ▪ Radiation	▪ Illustrate transmission of heat by radiation from a light bulb.

Chapter 3: Expansion of bodies (2 periods)

Teaching aids:
Metallic rod with a frame of the same length, a rectangular frame, a thermometer, transparent container, capillary tube, heat source

Learning situations
- Using a rectangular frame and a metallic rod of the same length in its centre, illustrate expansion of a body.
- Carry out an experiment illustrating expansion of liquids. (Use a plastic bottle with a capillary tube .Place it in a hot water basin.)

Specific objectives	Contents	Teaching and learning activities
- Explain expansion of bodies. - Give examples of expansion of bodies	Quantitative study on expansion of bodies.	▪ Create a simple bimetallic strip using a piece of foil paper.) ▪ Give uses of bimetallic strips ▪ Illustrate the anomaly of water between 0 and 4°C

Chapter 4: Principle of transmission of heat **(6 periods)**

Teaching aids:

Calorimeter, thermometer, heat source, water container, a metallic body,

Learning situations

- Illustrate heat transmission from a hotter body by putting a heated metallic rod into a container of water.
- Illustrate the principle of heat transmission by mixing some hot water with cold water, measure their temperatures before and after mixing. (Equilibrium temperature).
- Explain how a thermos flask works.

Specific objectives	Contents	Teaching and learning activities
- Explain how a calorimeter works. - Define internal energy and specific heat capacity.	Calorimeter Heat gain Heat loss. Internal energy and specific heat capacity.	-Do exercises on determination of internal energy and specific heat capacity.

Chapter 5: Change of physical states **(8 periods)**

Teaching aids:
Ice, funnel, heat source, transparent container, thermometers

Learning situations

- Heat ice and observe what happens while taking temperature up to the boiling point.
- Explain cloud formation and rainfall.

Specific objectives	**Contents**	**Teaching and learning activities**
- Differentiate change of states in matter :melting, sublimation, solidification, evaporation, boiling, condensation - Differentiate boiling from evaporation - Define melting and boiling points. - Explain latent heat.	-Melting -Sublimation -Solidification: from a liquid to a solid, from a gas to a solid. -Vaporisation : Evaporation Boiling -Condensation -Temperature of change of state -Latent heat	- Experimentally determine latent heat of fusion in ice. - Carry out exercises.

6. FORM III PROGRAM

6.1 TOPICS AND CHAPTERS

TOPIC I. ELECTRICITY AND MAGNETISM

Chapter 1: Magnetism 6 periods
Chapter 2: Electrostatics 4 periods
Chapter 3: Electric current 14 periods
Chapter 4: Generators and receptors 10 periods

TOPIC II: OPTICS

Chapter 1: Light propagation 6 periods
Chapter 2: Light reflection 10 periods
Chapter 3: Light refraction. 8 periods

TOPIC III: FORMS OF ENERGY 4 periods

Total 62 periods

6.2 GENERAL OBJECTIVES

At the end of Form III a student should be able to:

- Illustrate attraction and repulsion between magnetic poles.
- Show methods of magnetization and induced magnets
- Give uses of magnets in everyday life.
- Illustrate the phenomenon of static electricity.
- Create a simple electric circuit.
- Use an electric device.
- State Ohm's law and use it to answer questions
- Explain the principle of domestic installation and protection methods
- Illustrate light propagation
- Illustrate reflection and refraction of light.
- Give uses of reflection and refraction of light.
- Name the different forms of energy
- Identify energy sources.
- Give solutions to the energy problem in Rwanda

6.3 DETAILED PROGRAM

TOPIC I: ELECTRICITY AND MAGNETISM

Chapter 1: Magnetism (6 periods)

Teaching aids:
Magnets of different forms, copper, silver, a piece of wood, plastic, iron filings, nails (or other iron objects), compass, etc.

Learning situations

- Illustrate attraction and repulsion between two poles of magnets
- Show a magnetic field using iron filings
- Create an induced magnet using a permanent magnet and an iron object (example: nail)

Specific objective	Contents	Teaching and learning activities
At the end of this chapter, the pupil will be able of: - Define a magnet - State magnetic properties. - Define a magnetic field - Show the magnetic flux. - Determine earth poles using a compass. - Show the poles of a magnet - Describe methods of magnetization	- Magnets - Magnetic poles. - Magnetic field: • definition • field lines • magnetic flux - Earth's magnetic field. - Magnetization methods: Magnetization by contact, by induction, by electric current - Types of magnets: Permanent and induced magnets, artificial and natural magnets..	▪ Determine the poles of a magnet using a magnetized needle; ▪ Determine the geographical North Pole using a compass.

Chapter 2: Introduction to static electricity (4 periods)

Teaching aids:
Electroscope, electrical pendulum, silk, a glass rod, an ebonite rod, pieces of paper,
Sawdust
Learning situations:

- Illustrate electrification by rubbing, contact or induction
- Give details on atomic structure.
- Visit and/or read on the functioning and usefulness of lightning conductors and make a report

Specific objective	Contents	Teaching and learning activities
- **Name two kinds of electric charges** - **Describe methods of electrification.** - **Show a relation between the two charges.** - **Differentiate insulators from conductors** - **Explain the functioning of a lightning conductor**	**Atomic structure** **Electric charges** **Units of electric charges** **Methods of electrification** **Conductors and insulators**	- **Create an electric pendulum.** - **Create an electroscope**

Chapter 3: Electrokinetics (14 periods)

Teaching aids:
Voltmeter, ammeter, ohmmeter, conductor wires, light bulbs, generators, flatiron, electric iron

Learning situations

- **Create an electric circuit with an ammeter and a voltmeter**
- **Illustrate heat due to electric current when using household appliances (electric iron, immersion heater, hotplate…**).

Specific objectives	Contents	Teaching and learning activities
- Draw a simple electric circuit and label each component. - Define electric intensity and its units. - Define potential difference and its units - Use a voltmeter and an ammeter. - Using a diagram show an electric circuit and the direction of current. - Give the effects of electric current. - Define resistance. - Describe resistance in different conductors. - Use Ohm's law to calculate equivalent resistances in resistors.	Electric current. Electric circuit. Nature of electric current Potential difference (Unit, measuring instrument) Current (Unit, measuring apparatus) Conventional direction of current Effects of electric current ,heat, chemical, magnetic Resistance**:** - introduction - Units of resistivity - Resistivity and Pouillet's law - Units of resistance - Resistance of a conductor - Ohm's law - Connection of resistors in series, parallel and mixed	- Experimentally show Ohm's law giving the resistance of a conductor. - Use a voltmeter, ammeter and an ohmmeter to measure current, potential difference and resistance of a conductor. - Draw and label an electric circuit. -Carry out exercises using Ohm's law.

Chapter 4: Generators and receptors **(10 periods)**

Teaching aids:
Primary cells and secondary cells, voltmeter, ammeters, passive receptors (bulbs, electric iron, immersion heater …)
Active receptors (secondary cells, electrical clippers, electrical motors …)

Learning situations

- Show different types of generators and receptors
- Measure the e.m.f. of an electric cell and internal resistance in its terminals as its producing electric current.

- Observe different electric components at home and at school and write the use of each component.

Specific objectives	**Contents**	**Teaching and learning activities**
- Give examples of generators - Differentiate between e.m.f. and internal resistance at terminals of a generator - Give examples of receptors - Differentiate between e.m.f. and internal resistance at terminals of a receptor - Show the different connections of generators and receptors.	Generators **:** Definition Types of generators : primary and secondary cells , direct current generators, solar cell Electromotive force(e.m.f.) internal resistance at terminals Association in series and in parallel Receptor : Definition Types of receptors : 1. Passive : definition Examples: bulbs, electric iron hotplates..... 2. Active : Definition Examples : secondary cells, electric motors … Back electromotive force (b e.m.f.), internal resistance and tension at terminals Association in series and in parallel Electrical energy and power: Electrical energy. Joule effect, Joule's law,, applications (bulbs, fuses, immersion heaters, electric iron	- Create an electric circuit supplied by batteries in series and in parallel. - Classify receptors as passive or active - Carry out an experiment showing the Joule effect. - Carry out different exercises on this chapter

Specific objectives	Contents	Teaching and learning activities
- Explain the Joule effect and its applications - Explain the principle of a domestic installation and protection methods	Electrical power waste by the Joule effect Electricity in homes : o Domestic installation : protection of equipment, fuses, automatic circuit breakers, safety instructions and the role of humidity o Electrical energy transport , electrical energy and kilowatt rates	

TOPIC II: OPTICS

Chapter 1: Light propagation (6 periods)

Teaching aids:
Source of light from a point and an extended source, opaque, transparent and translucent objects, cardboard screens with holes in their centres strings and a screen

Learning situations

- Illustrate that light travels in straight lines using cardboard screens with holes in their centres.
- Illustrate formation of an umbra and a penumbra by lighting an opaque object with a light source that is pointed and extended.
- Read about eclipses and write a report.

Specific objectives	Contents	Teaching and learning activities
- Identify light sources and bodies	Introduction	

Specific objectives	Contents	Teaching and learning activities
with light - Identify transparent, translucent and opaque bodies. - Illustrate light propagation in straight lines. - Explain formation of umbra, penumbra and eclipses Explain image formation in a dark room..	Sources of light Opaque, translucent and transparent bodies Light propagation in a straight line. Rays and beams of light Umbra and penumbra Eclipses Dark room : 1. Image formation in a dark room 2. Characteristics of an image	- Observe the image of an object in a dark room and give its characteristics.

Chapter 2: Reflection of light **(10 periods)**

Teaching aids:
Sources of light, plane mirrors, convex mirrors, concave mirrors, candles, box of matches, tattlers, boards,
Operation to prove the laws of reflection

Learning situations

- Illustrate light reflection by diverting a beam of light using a plane mirror.
- Observe the image of an object in a plane mirror.
- Illustrate the symmetry of an image and an object in a plane mirror using two lit candles on both sides of a mirror.
- Observe images formed in concave and convex mirrors and give their characteristics.
- Give the uses of spherical mirrors in everyday life.

Specific objectives	**Contents**	**Teaching and learning activities**
- Explain the concept of reflection. - Identify reflection surfaces - Distinguish between regular and diffuse reflection. - State the laws of reflection - Identify a plane mirror - Form an image of an object in a plane mirror - Explain how a periscope works.	Introduction Reflection surfaces, types of reflections and laws of reflection Plane mirror: o Image formation in a plane mirror o Properties of images. ,Real and virtual images, … o Geometric formation of images. o Uses of plan mirrors in everyday life, periscopes, bathroom mirrors., Spherical mirrors: o Definition, types of spherical mirrors o	- Form an image of an object by a plane mirror. - Build a periscope to observe objects behind obstacles. - Verify the laws of reflection with the appropriate apparatus. - Create an image of an object in a plane mirror and give its properties.

Specific objectives	Contents	Teaching and learning activities
- Identify spherical mirrors - Form an image of an object using a spherical mirror. - - Explain the importance of spherical mirrors.	o Geometrical elements of a spherical mirror: Centre of curvature, radius of curvature, principle axis, caustic and apex. o Concave mirrors : ▪ Reflection of a light ray on a concave mirror. ▪ Principal focus, focal distance ▪ Three rays for the construction of an image in a spherical mirror. ▪ Properties of the image o Convex mirrors : ▪ Reflection of a light ray on a convex mirror. ▪ Virtual focus, focal distance, centre and radius of curvature, principal axis. ▪ Formation of an image in a convex mirror. ▪ Properties of the image. o Uses of spherical mirrors in everyday life	

Chapter 3: Refraction of light **(8 periods)**

Teaching aids:

- Transparent container, water, glass block, straight stick, bright beam, a light prism, lens (magnifying glass), camera, slide with parallel faces

Learning situations

- Show refraction by dipping a rod into a container with water and another rod into an empty container..
- Observe transmission of light through a glass block

- Illustrate refraction of light rays across a glass slide with parallel surfaces.
- Observe different objects with n magnifying glass.
- Read about the rainbow and make a report in class
- Illustrate light refraction when light crosses through a light prism.

Specific objectives	**Contents**	**Teaching and learning activities**
- Describe an experiment showing refraction - State the laws of refraction - Explain the effects of a glass slide and a prism on a beam of light - Recognise a convergent and divergent lens. - Form an image of an object by a lens. - Describe the human eye - Explain eye defects and give the methods of their correction - Explain the use of a magnifying glass - Explain image formation in a camera	Refraction and its characters Laws of refraction Movement of light rays across a glass slide with parallel sides Movement of light rays through a glass prism : deviation and dispersion(rainbow) Thin lenses : o Definition and types o Geometrical components of a spherical lens o Formation of an image by a lens The eye : o Description o Eye defects and correction spectacles Magnifying glass Camera	- Draw a lens labelling its geometrical components - - Show the different kinds of lens - Form an image of an object by a lens. - Experimentally determine the focus of a convergent lens. - - Graphically construct an image of an object with a lens -

TOPIC III: FORMS AND SOURCE SOF ENERGY. *(4 periods)*

Teaching aids:
Cells ,a torch, bicycle dynamo 12V bulbs, conducting wire, magnifying glass

Learning situations

- Prepare a presentation on the energy problems in Rwanda and suggest solutions
- Visit an energy transformation area(hydroelectric power station, biogas, solar energy, …)

Specific objectives	**Contents**	**Teaching and learning activities**
-Distinguish the different forms of energy -Identify different sources of energy in Rwanda. -Explain some types of energy transformations -Explain some energy storage methods.. -Explain benefits of energy conservation.	Energy forms : 1. Electric 2. Chemical 3. Solar 4. Light 5. Heat 6. Aeolian (wind) 7. Biogas 8. Geothermic 9. Methane gas. Energy sources and resources. Energy transformation and its conservation Energy storage Energy conservation	- Illustrate the transformation of mechanical energy into electrical energy using a bicycle dynamo and a 12V bulb. - Illustrate the transformation of chemical energy into electrical energy using a torch with cells.

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APPENDICES.

1. ORDINARY LEVEL LEAVER'S PROFILE

At the end of Ordinary Level Secondary Education, the student should have acquired the basic knowledge, skills and attitudes to enable him to:

- Reason scientifically and logically ;
- Reason objectively and not depend too much on the thinking of others;
- Understand and use proficiently the official languages : English, French and Kinyarwanda;
- Possess basic knowledge of Mathematics, Science and Technology ;
- Acquire appropriate civic, religious and moral values and physical fitness ;
- Develop a sense of curiosity and creativity ;
- Acquire ability to fit into an international environment;
- Develop aesthetic values and artistic skills;
- Acquire good habits that protect health, especially those against the spread of HIV/AIDS.
- Acquire basic knowledge of commerce, accounting and agriculture

2. WEEKLY TIMETABLE ALLOCATION FOR ORDINARY LEVEL

SUBJECT	FORM 1	FORM 2	FORM 3
1. Religion or Ethics	1	1	1
2. Kinyarwanda	2	2	2
3. French	6	6	6
4. English	6	6	6
5. Mathematics	6	6	6
6. Physics	2	2	2
7. Chemistry	2	2	2
8. Biology	2	2	2
9. Geography	2	2	2
10. History	2	2	2
11. Initiation to Arts	1	1	1
- Music			
- Drawing			
12. Initiation to Economics	2	2	2
- Commerce and Accounting			
- Domestic Science			
- Agriculture and Livestock			
13. Political Education	2	2	2
14. P E..	1	1	1
TOTAL : 14 SUBJECTS	**37**	**37**	**37**

ORDINARY LEVEL SCIENCE PROGRAM: ADDENDUM

BIOLOGY

PAGES	
	Form one
23	Insert the protozoa in the micro organisms.
24	Insert the malaria under the title "harmful micro-organisms".
34	Insert worms among the harmful invertebrates.
36	Insert the muscular system.
37	Add the bladder and the urinary passages as components of the urinary system.
38	Add the external genital organs as components of the female reproductive system.
50	
59	
	Form two
68&69	Add the trypanosomes, malaria (paludisme) and filaria among the illnesses transported by blood.
76	Insert the notion of meiosis.
	Form three
	Adjust (Arrange) the objectives in front of their respective contents.
	The general objective 6 becomes "Describe the reproduction organs of a flowering plant, non flowering plant and fungus and specify their functions" (see content page 81)
78	The general objective 7 becomes "To give the composition and the role of the human reproductive system" (see content page 76).
78	The general objective 8 becomes "To give a general view of fertilization, the formation and development of an embryo, including the conception and contraception" (see content page 78).
80	The general objective 8 "Identify the sexually transmitted diseases including HIV /AIDS and suggest the ways and means of their prevention" becomes the general objective 9.

PHYSICS

PAGE	CHANGES TO MAKE
Cover	To put the year of edition 2006
P.142.	In the column “contents” it is necessary to replace" types of forces" by "**Example of forces**" and to add units of forces directly below
P.146.	It is necessary to read “chapter: **Kinematics of rectilinear motion and the uniform circular motion**" In the general objectives, it is necessary to add, as second objective, To "**make a quantitative study of the uniform circular Motion**"
P.147.	For the title of the chapter 1, it is necessary to read **“Kinematics of the rectilinear motion and the uniform circular motion”**
P.150.	In the column "contents" it is necessary to read “**equilibrium of a solid submitted to the gravitation force” instead of “equilibrium of a solid”** and “**1.state of static equilibrium**” instead of “1. State of equilibrium”
P.151.	For the second learning situation, it is necessary to **delete** what comes after "**etc.**"
P.152.	In the column “specific objectives” it is necessary to read the third objective as follows: To "**explain the principle of calibrating a liquid thermometer**"