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 assess 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:

<table>
<thead>
<tr>
<th>Specific objectives drawn up in terms of skills or know-how and attitudes</th>
<th>Contents or what is to be learnt</th>
<th>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)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Etc.</td>
<td>Etc.</td>
<td>-</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Topic</th>
<th>Time Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Living things</td>
<td>8 periods</td>
</tr>
<tr>
<td>Plants</td>
<td>12 periods</td>
</tr>
<tr>
<td>Animals</td>
<td>20 periods</td>
</tr>
<tr>
<td>The human body</td>
<td>22 periods</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>62 periods</strong></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Specific Objectives</th>
<th>Contents</th>
<th>Activities or experimentation of Teaching-Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Identify the characteristics of living things</td>
<td>Characteristics of living things</td>
<td>HAVE THE STUDENTS OBSERVE AND CONCLUDE:</td>
</tr>
<tr>
<td></td>
<td>Organisms:</td>
<td>- THAT LIVING ORGANISMS HAVE CHARACTERISTICS</td>
</tr>
<tr>
<td></td>
<td>- are composed of cells</td>
<td>WHICH ROCKS, CHALK AND WATER DO NOT HAVE;</td>
</tr>
<tr>
<td></td>
<td>- use energy</td>
<td>- HOW DO PLANTS MOVE.</td>
</tr>
<tr>
<td></td>
<td>- react to stimuli</td>
<td>EXPERIMENT: PLANT A BEAN SEED IN A POT IN THE</td>
</tr>
<tr>
<td></td>
<td>- reproduce</td>
<td>CLASS AND WATER IT REGULARLY; OBSERVE HOW IT</td>
</tr>
<tr>
<td></td>
<td>- adapt to the environment</td>
<td>GROWS TOWARD THE WINDOW THAT BRINGS LIGHT</td>
</tr>
<tr>
<td></td>
<td>- move</td>
<td>INTO THE CLASSROOM: THIS IS PHOTOTROPISM</td>
</tr>
<tr>
<td></td>
<td>- excrete</td>
<td>- ... THAT ORGANISMS NEED:</td>
</tr>
<tr>
<td></td>
<td>- grow and develop</td>
<td>• ENERGY</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• RAW MATERIAL</td>
</tr>
</tbody>
</table>
**Groups of organisms**

- Monera: bacteria
- Protista: amoeba, mould
- Fungi: ex.: edible mushrooms
- Plants: Ex.: beans, Eucalyptus
- Animals: sheep, man

**Micro-organisms**

- **Bacteria**: size 0.3-2.5 micrometers, visible only under a microscope; example: fermentation bacteria
- **Algae**: 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
- **Virus**: 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**

<table>
<thead>
<tr>
<th>Specific Objective</th>
<th>Content</th>
<th>Activities or experimentation (practical demonstration) of Teaching-Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Give examples of micro-</td>
<td><strong>Useful micro-organisms</strong></td>
<td>Make a yeast culture to illustrate the</td>
</tr>
</tbody>
</table>
organisms useful to man

- Fermentation of beer: fungus; *Saccharomyces cerevisiae*
- Recycling of organic waste: fungus and soil bacteria
- Enrichment of soil: Nitrifying bacteria; *Rhizobium*

**Harmful micro-organisms**

Sleeping sickness 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

Amoeboid dysentery

Transmitted by ingestion of *Entamoeba histolytica* cysts.

Symptoms:
- Blood-stained diarrhoea
- Abdominal cramps
- Fiver

Prevention:
- Drinking boiled water

Measles

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
<table>
<thead>
<tr>
<th>Disease</th>
<th>Description</th>
<th>Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIDS</td>
<td>Serious damage to the immune system.</td>
<td>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</td>
</tr>
<tr>
<td>Taenia</td>
<td>Disease caused by a microscopic fungus</td>
<td>Prevention: Bodily hygiene (especially of the head) Treatment Antifungal Treatment</td>
</tr>
<tr>
<td>Potato Mildew</td>
<td>Caused by a fungus; <em>Phytophthora infestans</em></td>
<td>Use available charts, photos, films, video projections Use available charts, photos, films, video projections</td>
</tr>
</tbody>
</table>

- Give examples of micro-organisms harmful to plants

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
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**

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

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

Leaves:
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

Flowers:
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

Fruits:
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

Seeds:
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)

<table>
<thead>
<tr>
<th>Specific objectives</th>
<th>Content</th>
<th>Activities or experimentation (practical demonstration) of Teaching-Learning</th>
</tr>
</thead>
</table>
| - 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

<table>
<thead>
<tr>
<th>Characteristics of Monocots and Dicots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monocots (Liliopsida): have parallel leaf veins, a single cotyledon, herbaceous stems, fibrous roots; (E.g.: maize)</td>
</tr>
<tr>
<td>Dicots (Magnoliopsida): have non-parallel leaf veins, two cotyledons, woody stems, well formed roots (Ex.: <em>Eucalyptus</em>)</td>
</tr>
</tbody>
</table>

Soak maize and bean seeds in water; dissect them and observe the cotyledon(s). Observe and 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**

<table>
<thead>
<tr>
<th>Specific objectives</th>
<th>Content</th>
<th>Activities or experimentation (practical demonstration) of Teaching-Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Define and describe the main characteristics of vertebrates</td>
<td><strong>Vertebrates</strong>&lt;br&gt;Vertebrates: animals that have a vertebral column&lt;br&gt;Characteristics: notochord, dorsal spinal cord, pharyngeal cavity, post anal tail, cartilaginous or bony endoskeleton</td>
<td>- Use the available charts diagrams and prepared specimens to illustrate the characteristics of each class</td>
</tr>
<tr>
<td>- Identify the characteristics of the different classes of vertebrates and give examples</td>
<td>Fish: Tilapia, cat-fish&lt;br&gt;Amphibians: frogs, toads&lt;br&gt;Reptiles: Chameleon, snakes&lt;br&gt;Birds: fouls, eagle&lt;br&gt;Mammals: man, gorilla, rabbit</td>
<td>- Observe the external characteristics of a tilapia and a toad to show the morphological characteristics&lt;br&gt;<em>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.</em>&lt;br&gt;Kill the animal with a single blow to the head</td>
</tr>
<tr>
<td>Give a general view of the external morphology of one representative from each group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Draw and interpret the external morphology of a fish, a frog or a lizard</td>
<td>Include the different body parts and skin appendages (scales, hairs,...) in each drawing</td>
<td>- Use models, charts or specimens</td>
</tr>
</tbody>
</table>
- 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
<table>
<thead>
<tr>
<th>Harmful invertebrates:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arthropods</td>
</tr>
</tbody>
</table>
| - 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 |
### General objective 6: Identify, localize and describe the organs of the various systems in the human body

<table>
<thead>
<tr>
<th>Specific objectives</th>
<th>Content</th>
<th>Activities or experimentation (practical demonstration) of Teaching-Learning</th>
</tr>
</thead>
</table>
| Identify the five parts of the human body | **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 | Show the various parts on a volunteer student; use charts, models, diagrams |
| - Identify the various internal and external organs associated with each body part | **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 students a long bone, a vertebra, and ribs  
Use charts and the skeleton models |
| - Describe the general structure of the human skeleton and identify the bones of the central and peripheral parts | | 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)
- carpal, metacarpal and phalanges support the hand (27 bones)

**Digestive system**

From the anatomical and functional point of view, the system is divided into 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 | **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, 6cm high and 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 |
| - Describe and localize the constituents of the male and female reproductive systems | scrotum
- the epididymus 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, bulbourethral gland and the penis
| - Identify the main constituents of the nervous system | Constituents of the female reproductive system:
- ovaries: are located on each side of the uterus and contain tiny eggs called ova or oocytes 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
**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 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 |
| | Use the charts to show the constituents of the human nervous system |

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- Distinguish between the central nervous system (CNS) peripheral nervous system (PNS)

<table>
<thead>
<tr>
<th>Distinguish between the CNS and the PNS</th>
<th>Draw and label the various parts of the brain</th>
</tr>
</thead>
<tbody>
<tr>
<td>- In the CNS the neurons are collectively known as nuclei; in the PNS neurons are collectively known as ganglia</td>
<td></td>
</tr>
<tr>
<td>- In the CNS, neurons are collectively known as tracts; In PNS, neurons are collectively known as nerves</td>
<td></td>
</tr>
</tbody>
</table>

5. ORDINARY LEVEL FORM II PROGRAM

5.1. Topics and their time allocation

<table>
<thead>
<tr>
<th>Topics</th>
<th>Time Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrition</td>
<td>16 periods</td>
</tr>
<tr>
<td>Circulation</td>
<td>8 periods</td>
</tr>
<tr>
<td>Respiration</td>
<td>6 periods</td>
</tr>
<tr>
<td>Excretion</td>
<td>4 periods</td>
</tr>
<tr>
<td>Non flowering plants</td>
<td>8 periods</td>
</tr>
<tr>
<td>The cell</td>
<td>8 periods</td>
</tr>
<tr>
<td>Protozoa</td>
<td>4 periods</td>
</tr>
<tr>
<td>Immunity</td>
<td>4 periods</td>
</tr>
<tr>
<td>Organisms and the environment</td>
<td>4 periods</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>62 periods</strong></td>
</tr>
</tbody>
</table>

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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**

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

<table>
<thead>
<tr>
<th>Function</th>
<th>Composition</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium: regulation of fluid equilibrium in the body</td>
<td>Cereals, vegetables, legumes and fruits</td>
<td>It is advised for pregnant women to consume iron rich foods.</td>
</tr>
<tr>
<td>Potassium: body fluid balance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron: formation of red blood cells</td>
<td>Liver, beef, grapes, dates</td>
<td>Ask about the food in their daily meals</td>
</tr>
<tr>
<td>Iron: reinforcement of teeth and bones</td>
<td>Milk products, fish, meat</td>
<td>Assess the presence of food groups in those meals</td>
</tr>
<tr>
<td>Iron: normal growth, increases immunity</td>
<td>Rye bread, peanuts, almonds, melon seeds</td>
<td>Explain the importance of consuming the food groups in the proportions portrayed in the food pyramid (Appendix 1, Food Pyramid Model)</td>
</tr>
<tr>
<td>Zinc: excretion of uric acid and utilization of iron</td>
<td>Tomato</td>
<td></td>
</tr>
</tbody>
</table>

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
- Give guidelines for good feeding habits

**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*

<table>
<thead>
<tr>
<th>Specific objective</th>
<th>Content</th>
<th>Teaching and Learning Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Explain the various stages of food digestion</td>
<td><strong>Digestion</strong> mechanical digestion -chewing (mouth) -Swallowing (pharynx) -peristaltic movement (stomach and intestines)</td>
<td>Use charts to show the various parts of the digestive system where the stages take place</td>
</tr>
</tbody>
</table>

General objective 2: Describe the successive transformations of food during digestion
| - Define digestion and explain its importance | Chemical digestion:  
Carbohydrates  
- salivary amylase in saliva initiates the breakdown of carbohydrates  
- pancreatic amylase partially reduces digested carbohydrates into simple sugars  
Proteins  
- 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  
**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 cannot be assimilated  
- digestion breaks them down into simpler forms for assimilation  
**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  | 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  |
| - Name the practices that favour good functioning of the digestive system |  | With help from the elements above, have the students define and give the importance of digestion using questions and answers  |
|  |  | 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

<table>
<thead>
<tr>
<th>Specific objective</th>
<th>Content</th>
<th>Teaching and Learning activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Define photosynthesis and state its conditions</td>
<td>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: $6\text{CO}_2+6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_12\text{O}_6 + 6\text{O}_2$ in the presence of light and chlorophyll the primary products are therefore glucose and oxygen which diffuses into the atmosphere</td>
<td>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</td>
</tr>
<tr>
<td>- Identify the primary products of</td>
<td></td>
<td>Experiment: Put an aquatic plant in a beaker that is ¾ full of water, cover the beaker but...</td>
</tr>
<tr>
<td>photosynthesis</td>
<td>Other products formed from glucose: proteins, lipids, vitamins, carbohydrates</td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>--------------------------------------------------------------------------------</td>
<td></td>
</tr>
</tbody>
</table>
| - Identify other products formed from glucose | Importance:  
- nourishment for man and animals  
- Atmospheric oxygen balance by diffusing oxygen into air  
- Protection against atmospheric pollution by absorption of atmospheric carbon dioxide |
| - Explain the importance of green plants | 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 whereas a heterotrophic organism acquires the organic matter on which they feed |
| - Define and distinguish between autotrophic and heterotrophic organisms | 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  
*Explain to the students that these products are formed from glucose and that the mechanism of their synthesis will be explained in upper classes*  
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  
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

<table>
<thead>
<tr>
<th>Specific objective</th>
<th>Content</th>
<th>Teaching and Learning activities</th>
</tr>
</thead>
</table>
| - Describe the location and anatomy of the human heart | **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 | 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 |
| - Explain the difference between the main blood vessels types: arteries, veins and capillaries | **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 |
- **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

- **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

- **Blood groups**
  - Antigen: a living or non living substance recognised by the immune system as foreign body

- **Endothelium**: no muscles, no connective tissue

**Practice exercises**
- **Identify the direction blood flow through the heart and differentiate pulmonary circulation form systemic circulation**
- **Explain the concept of ABO blood groups**

**Use charts / diagrams to explain the composition of blood, and the structural difference between red blood cells and white blood cells.**

**Use charts / diagrams to show the direction of blood circulation.**

**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

<table>
<thead>
<tr>
<th>Specific objective</th>
<th>Content</th>
<th>Teaching and Learning activities</th>
</tr>
</thead>
</table>
| - 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

<table>
<thead>
<tr>
<th>Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>- avoid unprotected sex</td>
</tr>
<tr>
<td>HIV / AIDS: has neither cure nor vaccine</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Healthy practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>- physical exercise, games, jogging</td>
</tr>
<tr>
<td>- avoid oily, cholesterol rich diets</td>
</tr>
<tr>
<td>- avoid stress and anxiety</td>
</tr>
<tr>
<td>- avoid alcohol and tobacco</td>
</tr>
<tr>
<td>- avoid extremely tight clothing</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>Specific objective</th>
<th>Content</th>
<th>Teaching and Learning activities</th>
</tr>
</thead>
</table>
| - 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)

**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

- Identify the main function of respiration

Ask the students to make inspiration and expiration movements and observe the enlargement and shrinking of the chest

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

<table>
<thead>
<tr>
<th>Specific objective</th>
<th>Content</th>
<th>Teaching and Learning activities</th>
</tr>
</thead>
</table>
| 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

<table>
<thead>
<tr>
<th>Healthy practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Regular morning walk</td>
</tr>
<tr>
<td>- avoid smoking</td>
</tr>
<tr>
<td>- breathe through nose</td>
</tr>
</tbody>
</table>

- 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

Pneumonia: 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

Lung cancer: 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

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**

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

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

<table>
<thead>
<tr>
<th>Specific objective</th>
<th>Content</th>
<th>Teaching and Learning activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Identify the location of the kidneys, ureter,</td>
<td>Urinary system</td>
<td>Use charts and models to explain the</td>
</tr>
</tbody>
</table>
- 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)**

<table>
<thead>
<tr>
<th>Specific objective</th>
<th>Content</th>
<th>Teaching and Learning activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Identify the various groups of non-flowering plants</td>
<td>Various groups: Pteridophytes, Bryophytes, Algae, Lichens</td>
<td>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</td>
</tr>
</tbody>
</table>
| - describe the vegetative structures in the various groups | **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: | |
- 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

<table>
<thead>
<tr>
<th>Specific objective</th>
<th>Content</th>
<th>Teaching and Learning activities</th>
</tr>
</thead>
</table>
| - Define a cell                                                                   | **The cell:**  
- the structural and functional basic unit of living organisms  
**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  
**Main parts of a plant cell**  
Cell wall: composed of cellulose and proteins, | Use charts and diagrams to identify the main structures                                           |
| - Identify and describe the main parts of an animal cell in general and give their functions |                                                                                                   |                                                                                                  |
| - Identify and describe the main parts of a                                         |                                                                                                   |                                                                                                  |
### plant cell in general

- Distinguish between an animal cell and a plant cell
- Define: tissue, organ, system, organism
- Briefly describe the phases of mitosis and define cytoplasm division

<table>
<thead>
<tr>
<th><strong>Tissue, organ, system, organism</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tissue: group of cells with a common structure and function e.g.: epithelial tissue, sclerenchyma</td>
</tr>
<tr>
<td>Organ: is composed of a group tissues E.g.: root, stem</td>
</tr>
<tr>
<td>System: formed by a group of organs E.g.: a plant’s reproductive system consists of all the male and female organs</td>
</tr>
<tr>
<td>Organism: composed of all the systems</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Mitosis and cytoplasm division</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Prophase: chromosome is visible</td>
</tr>
<tr>
<td>Metaphase: chromosomes are arranged along the equatorial region</td>
</tr>
<tr>
<td>Anaphase: chromosomes separate toward opposite poles</td>
</tr>
</tbody>
</table>

- Use charts and diagram to identify the main structures of a plant cell
- Draw a table of comparison between an animal cell and a plant cell
- 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**

<table>
<thead>
<tr>
<th>Specific objective</th>
<th>Content</th>
<th>Teaching and Learning activities</th>
</tr>
</thead>
</table>
| - 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

<table>
<thead>
<tr>
<th>Specific objective</th>
<th>Content</th>
<th>Teaching and Learning activities</th>
</tr>
</thead>
</table>
| - Define natural immunity and acquired immunity | **Natural and acquired immunity**  
Natural immunity is inborn (for instance, the acidic gastric juice kills many microorganisms 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 microorganisms (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

<table>
<thead>
<tr>
<th>Specific objective</th>
<th>Content</th>
<th>Teaching and Learning activities</th>
</tr>
</thead>
</table>
| - 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 |
- Explain the food chain and give its importance

**Food chain**
- food link between the various organisms in a community
- transfer of energy and nutrients from one organism to another

- play a key role in the recycling of matter and the flow of energy

Explain why the use of polythene bags is not advisable

Give examples of a food chain in the school

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### General objective 15: Identify man’s effects on the environment

<table>
<thead>
<tr>
<th>Specific objectives</th>
<th>Content</th>
<th>Teaching/learning activities</th>
</tr>
</thead>
</table>
| - Explain man’s harmful effect on the environment | - poaching in game reserves  
- forest fires  
- soil erosion  
- soil, water and air pollution  
- deforestation  
- 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 | Use charts and audio-visual equipment  
Discuss various anti-erosive measures used in the school area  
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* |
| - Name man’s actions that favour the protection of the environment | | |
6. ORDINARY LEVEL FORM III PROGRAM

6.1. Topics and their time allocation

<table>
<thead>
<tr>
<th>Topic</th>
<th>Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>The nervous system and sensory organs</td>
<td>16</td>
</tr>
<tr>
<td>Endocrine glands</td>
<td>6</td>
</tr>
<tr>
<td>Reproduction</td>
<td>28</td>
</tr>
<tr>
<td>Sexually Transmitted Diseases and AIDS</td>
<td>6</td>
</tr>
<tr>
<td>Basics of genetics</td>
<td>6</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>62</strong></td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>Specific objective</th>
<th>Content</th>
<th>Activities</th>
</tr>
</thead>
</table>
| - 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)*
| - Draw and label the structure of a typical nerve cell (neurone) and describe its main elements | - 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  
**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  
Myelin 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  
Grey matter: composed of cell bodies  
White matter: composed of nerve fibres  
| - Give a brief view of the constituents of nervous tissue | Use charts and the available microscopic slides to draw the structure of a neurone  
*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*  
*A diagram showing the typical structure of a neurone is in appendix V*
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 intervertebral 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

<table>
<thead>
<tr>
<th>Specific objective</th>
<th>Content</th>
<th>Teaching and Learning Activities</th>
</tr>
</thead>
</table>
| - 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 |
- carry out 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

<table>
<thead>
<tr>
<th>Specific objective</th>
<th>Content</th>
<th>Teaching/Learning Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Name accessory secondary structures of the eye and their functions</td>
<td><strong>The eye</strong>&lt;br&gt;Eyebrows: protect eyes against sweat&lt;br&gt;Eye lids and eyelashes: cover the eyes during sleep, protect eyes from light and foreign bodies&lt;br&gt;Conjunctiva: fine protective membrane located anterior to the eye&lt;br&gt;Extrinsic muscles (6): movement of the eye ball in all directions&lt;br&gt;Lachrymal gland: produces tears which moisten the eye and protect it against microbes&lt;br&gt;Include: cornea, aqueous humor, iris, lens, vitreous humor, retina, optic nerve&lt;br&gt;<strong>Lens</strong>: refraction of light to the retina&lt;br&gt;<strong>Rod</strong>: vision in low light&lt;br&gt;<strong>Cone</strong>: vision of colour during the day&lt;br&gt;Optic nerve: fibre consisting of over one million axons from the ganglionic cells which transmits visual signals from the eye to the brain</td>
<td>Use models, charts, diagrams, sections of the eye showing the accessory structures of the eye</td>
</tr>
<tr>
<td>- Draw and label the parts of a human eye in longitudinal section</td>
<td><strong>Function</strong>: vision</td>
<td>Use a section of the eye to identify the various parts of the eye</td>
</tr>
<tr>
<td>- Give a general view of the lens,</td>
<td></td>
<td>Use a biconvex magnifying glass to illustrate refraction; the teacher emphasises how refraction follows the rules of refraction (see</td>
</tr>
</tbody>
</table>
| retinal photoreceptor and optic nerve functions | 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  
The outer ear:  
- Pinna: conducts sounds into the auditory canal  
- External auditory canal stretches from the pinna to the ear drum  
- Tympanic membrane (ear drum): receives sound  
The middle ear: contains three bones which conduct sound towards the inner ear  
The inner ear: 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 function of the eye |
<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Draw and label the parts of the ear in longitudinal section</td>
<td>Various parts of the ear, including ear, bones of the ear, semicircular canals, and cochlea.</td>
<td>Deafness:</td>
</tr>
<tr>
<td>- Identify the common diseases of the ear and propose healthy practices</td>
<td>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.</td>
<td>Use charts to draw the parts of the ear, have students identify diseases of the ear and propose methods to avoid them.</td>
</tr>
<tr>
<td>- Locate and describe the taste organ (tongue) and its receptors</td>
<td>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.</td>
<td>Sensitize the students on the importance of the hearing and consequences of the hearing loss</td>
</tr>
<tr>
<td>- Identify different taste types and their sites on the tongue</td>
<td></td>
<td>Use charts of a tongue to show the sites of different taste types.</td>
</tr>
<tr>
<td>- Suggest appropriate practices that keep the tongue healthy</td>
<td></td>
<td>Experiment: Put a quinine tablet at the tip of the tongue and explain its taste</td>
</tr>
<tr>
<td></td>
<td>- avoid drinks that are too hot or too cold, regularly clean the tongue using a metallic or plastic scraper.</td>
<td></td>
</tr>
</tbody>
</table>
- 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

**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
- **Section including the main layers, hairs, receptors and glands of the skin**
  - Sensory receptors:
    - tactile receptors (to touch)
    - pressure receptors
    - thermal receptors
    - pain receptors (free nerves ends)
- **Touch, pressure, temperature and pain**

- Locate and identify the different parts of the skin

- Draw and label a cross section of human skin

- Identify the various sensory receptors of the skin

- Name the sensory function of

Use charts to learn the parts of the smell organ

Discuss the various smells which the students can identify

Use charts and prepared sections to elaborate the parts of the skin

Test the various feelings by touching skin hairs, exerting pressure on skin, passing fire near the hand and pricking the skin

Discuss diseases of the skin and methods of
the skin
- Identify the common diseases of the skin
  - Burns: caused by thermal, radioactive or chemical agents (e.g., burns)
  - 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
- Propose practices that favour skin health

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

<table>
<thead>
<tr>
<th>Specific objective</th>
<th>Content</th>
<th>Teaching/Learning Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Define: endocrine gland,</td>
<td><strong>Endocrine gland</strong>: gland with no ducts, they secrete their</td>
<td></td>
</tr>
</tbody>
</table>

**Hormone**

- Name and locate the main endocrines glands in the human body
- Identify main hormones secreted by the mentioned endocrines and the main reactions of the organism
- Identify some endocrine disorders

**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

**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

**Endocrine dysfunction**
- Pituitary gland:
  - Deficiency causes the dwarfism
  - Excess causes gigantism
- Thyroid gland:
  - Thyroid dysfunction causes goitre

---

Introduce a chart showing the location of the various endocrines glands in a man and a woman

Ask the students what causes pubic hair and beards in boys and breasts in girls

Ask the students if they know goitre and explain its cause
### 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

<table>
<thead>
<tr>
<th>Specific objective</th>
<th>Content</th>
<th>Teaching/Learning Activities</th>
</tr>
</thead>
</table>
| - Identify the various modes of asexual reproduction in animals | **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 |
| - Identify modes of asexual reproduction in plants | | 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**

<table>
<thead>
<tr>
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<th>Content</th>
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</tr>
</thead>
</table>
| - 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 |
<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Draw and label the structures of the female reproductive system</td>
<td><strong>Female reproductive organs</strong>&lt;br&gt;Include: the ovary, fallopian tubes, uterus and vagina</td>
</tr>
<tr>
<td>- Locate and describe the main parts of the female reproductive system and give their function</td>
<td><strong>Ovary</strong>: solid and ovoid; produces ova and female hormones&lt;br&gt;<strong>Fallopian tubes</strong>: conduct the ova from the ovary to the uterus&lt;br&gt;<strong>Uterus</strong>: pear-shaped; normal site of blastocyst implantation; plays an active role in child birth&lt;br&gt;<strong>Vagina</strong>: receives spermatozoa from the penile urethra during the coitus&lt;br&gt;<strong>Vulva</strong>: female genital organs; main structure consists of the labia majora, the labia minora and the clitoris</td>
</tr>
<tr>
<td>- Define menstruation and briefly explain menstrual cycle</td>
<td><strong>Menstruation</strong>: periodical shedding of the internal layer of the uterine wall accompanied by loss of blood&lt;br&gt;Duration of the menstrual cycle: about 28 days&lt;br&gt;Stages of the menstrual cycle:&lt;br&gt;- follicular phase&lt;br&gt;- ovulation&lt;br&gt;- luteal phase</td>
</tr>
<tr>
<td>- Define spermatogenesis and ovogenesis</td>
<td><strong>Spermatogenesis and Ovogenesis</strong>&lt;br&gt;Spermatogenesis: mechanism of male gamete (spermatozoa) formation</td>
</tr>
</tbody>
</table>

Use charts and diagrams to draw and label the structures of the female reproductive system<br><br>Illustrate the stages of menstruation using charts<br><br>The teacher emphasises the variability of the menstrual cycle duration<br><br>Illustrate spermatogenesis and ovogenesis using charts
### General objective 7: Give a general view of fertilization, the formation and development of an embryo, including conception and contraception

<table>
<thead>
<tr>
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<th>Content</th>
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</tr>
</thead>
</table>
| - 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**

<table>
<thead>
<tr>
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</tr>
</thead>
</table>
| - Explain AIDS and its mode of transmission                                       | **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 | 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* |
| - Explain how the virus attacks the organism                                       |                                                                                                                                                                                                        |                                                                                                                                                                                                                             |
| - Propose methods of prevention against AIDS                                       | **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 |                                                                                                                                                                                                                             |
| - Name the other common sexually transmitted diseases and identify their main symptoms |                                                                                                                                                                                                        |                                                                                                                                                                                                                             |
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.

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

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

Collect a common flower (Hibiscus) and dissect it, then observe the various parts of the male and female reproductive systems.
<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
</tr>
</thead>
</table>
| Identify the female reproductive system of a flowering plant and    | Female reproductive organ (pistil): the carpel (ovary, style, stigmata)  
| their functions                                                       | - 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  
|                                                                      | Include the cells of the embryo sac  
| Draw and label the structure of a flowering plant ovule              | Use the available charts to identify the ovule structure and make a drawing  
|                                                                      | Ask the students why flowers with no colour and no nectar are not dispersed by insects  
| Define pollination, name the main types of pollination, agents of   | Pollination:  
| pollination and the flower's adaptation for 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  
| 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  
|                                           | **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  
|                                           | **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  
|                                           | different stages of fertilization in flowering plants  
|                                           | Use bean pods to show the fruit that originates from the ovary and the seeds that originate from the ovules  
|                                           | 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

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

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_
7. BIBLIOGRAPHY


15. WEBSITE consulted on November 2005: Medline Plus Medical Encyclopedia:
BIOLOGY APPENDIX

Appendix - I

Food Pyramid

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: Cl₂, O₂, CO₂). 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.
- Carry out 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

**At the end of this chapter the student should be able to:**

- Explain what chemistry is giving examples
- Show the importance of chemistry

- 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

- Differentiate the three states of matter giving examples
- Explain the process of changing from one state to another.

### Contents

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<tr>
<th>1.1. Introduction to chemistry</th>
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<tbody>
<tr>
<td>- Definition</td>
</tr>
<tr>
<td>- Chemistry objectives</td>
</tr>
<tr>
<td>- Importance of chemistry</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1.2. Materials and safety in the laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Rules of conduct and safety in a laboratory</td>
</tr>
<tr>
<td>- Simple material used in a chemistry laboratory (demonstration, diagram and handling)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1.3. States of matter</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Solid state</td>
</tr>
<tr>
<td>- Liquid state</td>
</tr>
<tr>
<td>- Gaseous state</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1.4. Change of state of matter: boiling condensation sublimation etc</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>1.5. Differentiate between solids</th>
</tr>
</thead>
</table>

### Teaching/learning activities

- 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.

- Using a case study encourage a student to respect safety rules in a laboratory

- 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.  
- 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,…

<table>
<thead>
<tr>
<th>Specific objectives</th>
<th>Contents</th>
<th>Teaching / learning activities.</th>
</tr>
</thead>
</table>
| **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
- Differentiate a pure substance from a mixture
- Identify different kinds of mixtures
- Give a separation method and explain it.

<table>
<thead>
<tr>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2.1 Type of mixtures homogenous (Solution) and heterogeneous.</td>
</tr>
<tr>
<td>2.2.2 Separation of mixtures</td>
</tr>
<tr>
<td>Sieving, Filtration, settling, Simple distillation, Fractional distillation Centrifugation (gucunda), Levigation, paper chromatography.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching / learning activities.</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Carry out a classification of mixtures Name homogenous or heterogeneous mixtures</td>
</tr>
<tr>
<td>- Carry out a separation of mixtures using the sieving method, filtration, settling, simple distillation fractional distillation and centrifugation (gucunda), levigation, Paper chromatography</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Specific Objectives</th>
<th>Contents</th>
<th>Teaching / learning activities</th>
</tr>
</thead>
</table>
| - Give causes of air pollution.  
- Show risks of air pollution.  
- Participate in avoiding air pollution. | 4.2. Air pollution. | |

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-Properties 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
<table>
<thead>
<tr>
<th>Specific objectives</th>
<th>Contents</th>
<th>Teaching / learning activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Show the existence of acids and bases in nature.</td>
<td>- Natural source of coloured indicators</td>
<td>flowers)</td>
</tr>
<tr>
<td></td>
<td>- Indicators</td>
<td>- Test acidity and alkalinity of various extracts.</td>
</tr>
<tr>
<td></td>
<td>(phenolphthalein, litmus,</td>
<td>- Give uses of the listed acids and bases in everyday life</td>
</tr>
<tr>
<td></td>
<td>methyl orange, bromothymol blue,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Universal indicator)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.3 Existence of acids and bases in plants and animals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.4 Some acids and bases and their uses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sulphuric acid</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydrochloric acid, Acetic acid (vinegar), Sodium hydroxide</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Caustic soda), Potassium hydroxide (potash), Ammonium hydroxide (ammoniac)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Acidity and fertility of soil Enrichment of soils: liming</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.5 Dangers of acids and bases. Dangers of excess acid in the stomach</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and its treatment.</td>
<td></td>
</tr>
</tbody>
</table>
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.
<table>
<thead>
<tr>
<th>Specific objectives</th>
<th>Contents</th>
<th>Teaching / learning activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>At the end of this chapter the student should be able to :</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Define an atom and an element.</td>
<td>5.1. Atom and element (group of atoms having the same atomic number)</td>
<td>-Draw a table showing atoms with different sizes</td>
</tr>
<tr>
<td>-Explain the difference between an atom and an element.</td>
<td>5.2. Atomic structure</td>
<td>-Draw the structure of an atom.</td>
</tr>
<tr>
<td>-Describe a simple structure of an atom.</td>
<td></td>
<td>-Carry out exercises on writing electronic configurations of the first 20 elements.</td>
</tr>
<tr>
<td>-Identify parts of an atom : electrons, neutrons et protons</td>
<td><strong>N. B. the parts of an atom are identical for all atoms</strong></td>
<td></td>
</tr>
<tr>
<td>-Explain the nature of these particles</td>
<td>5.3. Characteristics (mass and charge) of neutrons, protons, electrons</td>
<td></td>
</tr>
<tr>
<td>-Explain isotopes</td>
<td>5.4. Definition of an atomic number (number of charges) and mass numbers</td>
<td>-Carry out exercises on symbols and names of elements</td>
</tr>
<tr>
<td>-Write symbols of elements</td>
<td>5.5. Symbolic representation of parts of an atom and isotopes.</td>
<td></td>
</tr>
<tr>
<td>-Write the formulae of common elements and compounds.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Write and explain the arrangement of electrons (configuration) in terms of energy</td>
<td>5.6. Energy levels and shells (n=1, 2, 3… or K, L, M….)</td>
<td></td>
</tr>
<tr>
<td>levels and shells (n=1, 2, 3, or KLM….)</td>
<td>The electronic configuration of the first 20 elements (avoid orbital models)</td>
<td></td>
</tr>
</tbody>
</table>
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.

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

7.1 Valency (number of free electrons)
<table>
<thead>
<tr>
<th>Specific objectives</th>
<th>Contents</th>
<th>Teaching / learning activities.</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Draw a table of the valency of atoms or group of atoms</td>
<td>formulae of some oxides, chlorides, bromides, iodides, acids, carbonate nitrates and phosphates.</td>
<td>- Carry out exercises in naming some oxides, chlorides, bromides, iodides, acids, bases (hydroxydes), carbonates, nitrates and phosphates</td>
</tr>
<tr>
<td>- Construct formulae of simple compounds using the table of valencies</td>
<td></td>
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</table>
5. FORM II PROGRAM

5.1 CHAPTERS

<table>
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<tr>
<th>Chapter</th>
<th>Duration</th>
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<tr>
<td>8. Reactions and chemical equations</td>
<td>10 periods</td>
</tr>
<tr>
<td>9. Periodic table of chemical elements</td>
<td>7 periods</td>
</tr>
<tr>
<td>10. Chemical bonding</td>
<td>12 periods</td>
</tr>
<tr>
<td>11. Oxygen and oxides</td>
<td>10 periods</td>
</tr>
<tr>
<td>12. Acidic and alkaline solutions</td>
<td>6 periods</td>
</tr>
<tr>
<td>13. Salts and their formation</td>
<td>6 periods</td>
</tr>
<tr>
<td>14. Mole concept</td>
<td>11 periods</td>
</tr>
</tbody>
</table>

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

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<thead>
<tr>
<th>At the end of this chapter, the student should be able to:</th>
<th>Contents</th>
<th>Teaching/Learning Activities</th>
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<tbody>
<tr>
<td>- Explain a chemical reaction</td>
<td>8.1. Chemical reaction(combination and rearrangement of atoms)</td>
<td>- Give the difference between a physical and chemical change.</td>
</tr>
<tr>
<td>- Write simple balanced chemical equations in sentences and symbols</td>
<td>8.2 Chemical equations: presentation of chemical reactions through balanced equations in sentences and in symbols</td>
<td>- Carry out certain experiments: combination (Fe + S); combustion, action of acid on bases or oxides, displacement reaction, Precipitation reaction.</td>
</tr>
<tr>
<td>Specific objectives</td>
<td>Contents</td>
<td>Teaching/Learning Activities</td>
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<tr>
<td>----------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>-Explain the law of conservation of matter</td>
<td>(indicate the physical states of the reactants and products)</td>
<td>-Carry out exercises on balancing chemical equation</td>
</tr>
<tr>
<td>-Explain the action of heat to certain substances.</td>
<td>8.3 The law of conservation of matter</td>
<td>-Carry out simple experiments to illustrate the law of conservation of matter (example: Fe + S =FeS)</td>
</tr>
<tr>
<td>-Identify certain chemical reactions</td>
<td>-Action of heat on certain substances</td>
<td>-Carry out experiments to study change in mass of a substance following heating of a substance (example : dehydration of CuSO₄.5H₂O by heat.)</td>
</tr>
<tr>
<td></td>
<td>-Types of chemical reactions combination, decomposition and displacement</td>
<td></td>
</tr>
</tbody>
</table>
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.

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<th>Teaching/Learning Activities</th>
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</table>
| At the end of this chapter the student should be able to: | 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 (20 first 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 |
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<tr>
<td>- Explain the variation of metallic and non-metallic characters in the periodic table.</td>
<td>9.5 Electronic configuration and chemical properties</td>
<td>numbers, periods and valencies</td>
</tr>
<tr>
<td>- Explain physical properties of metals and non-metals.</td>
<td>9.6 The difference between electropositive and electronegative elements.</td>
<td>- Carry out exercises on identifying an element and its electronic structure through its period and group.</td>
</tr>
<tr>
<td>- Show how reactivity varies in groups and periods.</td>
<td>9.7 Physical properties of metals and non-metals: (Electric and calorific conductivity, malleability, ductility…)</td>
<td>- Give a classification of metals and non-metals using observable properties (sparkle, colour, its conductivity, etc)</td>
</tr>
<tr>
<td>- Establish a relationship between configuration and chemical properties.</td>
<td>9.8 Reactivity in groups (downwards) and in periods (left to right)</td>
<td>- Carry out experiments to compare reactivity of elements in group I and II with air, water and diluted acids</td>
</tr>
<tr>
<td></td>
<td>9.9 Chemical properties and electronic configuration of elements</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>NB : Hydrogen is not an alkaline metal despite its position in the periodic table</strong></td>
<td></td>
</tr>
</tbody>
</table>
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.

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<tr>
<td>At the end of this chapter the student should be able to:</td>
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</tr>
<tr>
<td>- Explain what a chemical bond is.</td>
<td>10.1 Chemical bonding.</td>
<td>- Using atomic models (from plasticine/other coloured balls and stalks), show molecular models.</td>
</tr>
<tr>
<td>- Explain the reasons for chemical bond formation.</td>
<td>- Electronic configuration of rare gases and their stability.</td>
<td>- Identify the different ways an atom can gain a stable structure of rare gases.</td>
</tr>
<tr>
<td>- Show the use of valency electrons in chemical bond formation.</td>
<td>- Definition of a chemical bond as a force that joins atoms</td>
<td></td>
</tr>
<tr>
<td>- Describe and illustrate ionic bonding.</td>
<td>- Chemical bond formation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Role of valency electrons in chemical bonding.</td>
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<tr>
<td></td>
<td>10.2 Ionic bonds:</td>
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<td>- Ion formation due to gain or loss of</td>
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</tr>
<tr>
<td>Specific objectives</td>
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<td>Teaching/Learning Activities</td>
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<tr>
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</tbody>
</table>
| -Show properties of ionic compounds. | electrons.  
-Ionic compound formation (ex : Na Cl), by electrostatic attraction between ions with opposite charges creating a giant three-dimensional crystal structure  
-Crystal model (ex : Na Cl)  
-Properties 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.... |
| -Explain why ionic compounds have relatively high melting points. | 10.3 Covalent bond  
-Formation of a molecule by union of electrons (Cl₂, CH₄, NH₃, H₂O, HCl …)  
-Properties of covalent compounds (physical states, mechanical and electrical properties)  
-Intermolecular interactions, boiling and melting points.  
-Examples of some crystal molecules like :Ice diiodine  
-Examples of some giant crystal molecules : diamond and graphite silicone SiO₂  
-Strong covalent bonds in the giant crystal molecules give them very high melting points. | -Represent the molecular structure of a covalent compound (The Lewis model) using its chemical formula. |
| -Describe and explain covalent bond formation. | 10.4 Metallic bond  
-Its the union of many valency | -Carry out exercises on showing ionic and covalent compounds using cross and point diagrams. |
| -Show some properties of covalent compounds.  
-Explain why covalent compounds have relatively low melting points.  
-Give some examples of crystal molecular compounds. | | -Carry out exercises to determine the ionic and covalent properties of compounds. |
| -Symbolically show ionic and covalent compounds. | | |
| -Draw models of some simple molecules. | | |
| -Describe a metallic bond | | |

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### Specific Objectives

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<tr>
<td>Establish the relation between a metallic bond and properties of a metal.</td>
<td>Electric conduction, ductility and malleability</td>
</tr>
<tr>
<td>Electrons between many atoms of the same element (cations in a sea of electrons (an example is sodium)</td>
<td></td>
</tr>
<tr>
<td>Properties (physical, mechanical, electrical) and uses of metals.</td>
<td></td>
</tr>
</tbody>
</table>

### 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 $\text{KClO}_3$
- 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..

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<th>Contents</th>
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<tbody>
<tr>
<td>Indicate methods of oxygen preparation.</td>
<td><strong>11.1 Sources of oxygen</strong></td>
<td>-Carry out preparation and drying of oxygen from oxides (ordinary drying agents: H₂SO₄, CaCl₂, CaO)</td>
</tr>
<tr>
<td>Prepare oxygen from oxides.</td>
<td>-Air : Fractional distillation.</td>
<td></td>
</tr>
<tr>
<td>Show physical and chemical properties of oxygen.</td>
<td>-Water: electrolysis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Decomposition of oxides (H₂O₂, KClO₃, KNO₃)</td>
<td></td>
</tr>
<tr>
<td>Determine the percentage of oxygen in the air using a simple experiment.</td>
<td><strong>11.2 Properties of oxygen:</strong></td>
<td>-Carry out an experiment on rusting iron in a calibrated cylinder inverted in water.</td>
</tr>
<tr>
<td></td>
<td>-Physical properties</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Chemical properties</td>
<td></td>
</tr>
<tr>
<td>Write a combustion reaction equation of a substance in air.</td>
<td><strong>11.3 Determination of oxygen percentage in air</strong></td>
<td></td>
</tr>
<tr>
<td>Show conditions for rusting by a simple experiment.</td>
<td><strong>11.4 Reaction of substances with oxygen in air:</strong></td>
<td>-Show quick combustion of: Ca, Mg, Fe, Cu, S, H₂</td>
</tr>
<tr>
<td>Prevent rust formation</td>
<td>-quick combustion</td>
<td>-Exercise writing equations of combustion reaction.</td>
</tr>
<tr>
<td>Classify oxides in acidic oxides, basic oxides, neutrals and amphoteric oxides.</td>
<td><strong>11.5 Acidic, basic, amphoteric oxides and their properties</strong></td>
<td>-Carry out acide-base tests on Magnesium, Sodium, Calcium, Aluminium, nitrogen sulphur carbon and zinc oxide solutions.</td>
</tr>
<tr>
<td>Identify the nature of an oxide using some tests.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Give important uses of oxygen and oxides.</td>
<td><strong>11.6 Uses of oxygen and its derivatives.</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Combustion in presence of oxygen</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-CO₂ (photosynthesis, carbonated drinks, extinguishers)</td>
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<td></td>
<td>-CaO (cement)</td>
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</tr>
</tbody>
</table>
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.

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<tr>
<th>Specific objectives</th>
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<th>Teaching/Learning Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>At the end of this chapter the student should be able to:</td>
<td>12.1 Dissociation of acids and bases in an aqueous medium:</td>
<td>- Measure the pH of a strong acidic solution (ex: HCl aq) and a weak acidic solution (ex: CH₃COOH) of the same concentration</td>
</tr>
<tr>
<td>- Explain the cause of acidity or alkalinity of aqueous solutions.</td>
<td>- Release of H⁺ ions in acidic solutions</td>
<td>- Strong and weak acids</td>
</tr>
<tr>
<td>- Explain the difference between a strong acid/base and a weak acid/base.</td>
<td>- Presence of OH⁻ ions in basic solutions</td>
<td>- Strong and weak bases</td>
</tr>
<tr>
<td>- Determine the pH of a medium using a universal indicator.</td>
<td>12.2 The relation between the pH scale and the quantity of H⁺ ions in solutions Ex: pH of medicines</td>
<td>- The pH scale shows pH as a unit of measuring acidity or alkalinity of a substance. It’s measured from 0 to 14.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Measure the pH of a strong base (NaOH) and a weak base (NH₄OH) of the same concentration</td>
</tr>
</tbody>
</table>
Specific objectives | Contents | Teaching/Learning Activities
--- | --- | ---
-Explain a neutralisation reaction | **(avoid defining pH in terms of \(-\log [H^+]\))** | concentration using a universal indicator.
-Write some chemical equations of acid and base reactions | 12.3 Acido-basic neutralisation and its products | -Measure the pH of some medicines

---

### 12.3 Acido-basic neutralisation and its products

- Carrying out dilutions of acid/base solutions and measure their pH using a universal indicator.
- Carrying out neutralisation of dilute hydrochloric acid by an aqueous solution of sodium hydroxide.
- Carrying out exercises on writing equations of acid-base neutralisations.

### 12.4 Reaction of acids and carbonates.

**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 anions (Cu²⁺, Fe²⁺, Fe³⁺, CO₃²⁻, SO₄²⁻, Cl⁻, Na⁺, Ca²⁺), 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.
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<tbody>
<tr>
<td>At the end of this chapter he student should be able to :</td>
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</tbody>
</table>
| -Show that a salt is formed from a metallic cation and an anion. | 13.1 Salt 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,  
- Solubilities of sulphates, chlorides, nitrates, carbonates  
- Electric conductivity. | - Using experiments identify soluble and insoluble salts.  
- Prepare saturated and non-saturated solutions.  
- Carry out a crystallisation experiment.(ex: a saturated NaCl solution) |
| -Explain salt dissolution in water. | | |
| -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.  
- Insoluble salts by precipitation. | - Prepare soluble (ex: dilute hydrochloric acid + Zn in excess) and insoluble salts (ex: precipitation of BaSO₄, PbI₂) |
| -Name some ions | 13.4 Simple identification tests of cations and anions. | - Carry out identification of cations and anions (Cu²⁺, Fe³⁺, Fe²⁺, CO₃²⁻, SO₄²⁻, Cl⁻, Na⁺, Ca²⁺) |
## 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)

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

- Deduce the Empirical formula using centesimal composition.
- Interpret a chemical equation
- Convert moles into mass units and vice versa.
- Calculate stoichiometric quantities.

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<tr>
<td>- Interpret a chemical equation</td>
<td>- Molecular, molar, or mass reading of a chemical equation.</td>
<td>- Write out Empirical and Molecular formulae,</td>
</tr>
<tr>
<td>- Convert moles into mass units and vice versa.</td>
<td>- Calculations to:</td>
<td>- Calculate stoichiometric quantities of reactants,</td>
</tr>
<tr>
<td>- Calculate stoichiometric quantities.</td>
<td>▪ Convert moles to masses and vice versa.</td>
<td>- Determine limiting reactants.</td>
</tr>
<tr>
<td></td>
<td>▪ Determine Mass centesimal composition</td>
<td>- Calculate molar volumes</td>
</tr>
<tr>
<td></td>
<td>▪ Determine Empirical and Molecular formulae</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Determine the stoichiometric quantities of reactants</td>
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</tr>
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<td></td>
<td>▪ Determine limiting reactants</td>
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<td>▪ Determine molar volumes</td>
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### 6. FORM III PROGRAM.

#### 6.1 CHAPTERS

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<td>12 periods</td>
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<tr>
<td>16. Electrolysis</td>
<td>10 periods</td>
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<tr>
<td>17. Study on some elements in the periodic table</td>
<td>20 periods</td>
</tr>
<tr>
<td>18. Introduction to organic chemistry</td>
<td>20 periods</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>62 periods</strong></td>
</tr>
</tbody>
</table>
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, phenolphthalein; 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

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## Specific objectives

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.

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<th>Definition of a solute, solvent and solubility</th>
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<td>Notion on concentration</td>
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<td>Factors influencing solubility</td>
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<tr>
<td>15.3</td>
<td>Saturated solutions, non saturated, Solutions, crystallisation and precipitation (differentiate from solutes in excess)</td>
</tr>
<tr>
<td>15.4</td>
<td>Preparation of solutions with different concentrations</td>
</tr>
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<td>Dilution of a solution</td>
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<tr>
<td>15.5</td>
<td>Strong monoacidic-monobasic titrations</td>
</tr>
<tr>
<td>15.6</td>
<td>Simple calculations on neutralisation reactions</td>
</tr>
</tbody>
</table>

## Teaching/Learning Activities

- 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.

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<th>Teaching/Learning Activities</th>
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</table>
| At the end of this chapter the student should be able to : | 16.1 Definition of an electrolyte and a non-electrolyte | - Illustrate electric conduction in electrolytes and non electrolytes (ex: a salt or sugar solution…)
| - Differentiate electrolytes from non-electrolytes | 16.2 Types of conductors (metallic, electrolytic solutions) | - Illustrate the difference in conductivity for strong and weak electrolytes using electrolytes of the same concentration.
| - Indicate the difference between a metallic conductor and an electrolyte. | 16.3 Types of electrolytes: Strong and weak electrolytes, Electrolytic solutions and molten salts. | - Carry out electrolysis:
| - Give types of electrolytes. | 16.4 Notion of electrolysis | - In water (acidulated) in NaCl in aqueous solution
| - Define electrolysis | - Definition | - Carry out exercises in writing electrode reaction.
| - Draw and label an electrolysis apparatus. | - Electrodes and reactions at electrodes |}

N.B Outside electrolysis, oxidation can...
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</table>
| - 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.....)
<table>
<thead>
<tr>
<th>Specific objectives</th>
<th>Contents</th>
<th>Teaching/Learning Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>At the end of this chapter the student should be able to : :</td>
<td>17. 1 CARBON</td>
<td>- Carry out exercises on writing equations of dilute acids on carbonates and hydrogencarbonates</td>
</tr>
<tr>
<td>- Identify the different forms of carbon and their properties.</td>
<td>17.1.1 Forms of carbon (diamond, graphite and coal.) and their physical properties.</td>
<td>- Heat decomposition of NaHCO .</td>
</tr>
<tr>
<td>- Explain the reaction of carbon and oxygen.</td>
<td>17.1.2 Carbon affinity for oxygen.</td>
<td>- Carry out a reaction of dilute HCl on CaCO₃ and identify the CO₂ by a lime test.</td>
</tr>
<tr>
<td>- Describe the reaction of carbon and metallic oxides.</td>
<td></td>
<td>- Show that soap does not foam well in hard water.</td>
</tr>
<tr>
<td>- Describe the action of dilute acid on a carbonate and a hydrogencarbonate.</td>
<td>17.1.3 Definition and sources of carbonates (ex : chalk)</td>
<td>- soften water that has been hardened (ex by lime and excess CO₂) by heating.</td>
</tr>
<tr>
<td>- Describe the action of heat on a carbonate, or a hydrogencarbonate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Prepare carbon dioxide, a carbonate, a hydrogencarbonate and describe their properties.</td>
<td>17.1.4 Preparation of carbon dioxide, a carbonate (Na₂CO₃, CaCO₃, MgCO₃), a hydrogencarbonate (NaHCO₃) and a description of their properties</td>
<td></td>
</tr>
<tr>
<td>- Explain the relation of hard water and carbonates</td>
<td>17.1.5- Hard water and ways to soften it. (heating, precipitation)</td>
<td></td>
</tr>
<tr>
<td>- Use some methods to soften water.</td>
<td>17.6- Uses of carbon (graphite, diamond and coal) and its by-products (CO₂, CO,</td>
<td></td>
</tr>
<tr>
<td>Specific objectives</td>
<td>Contents</td>
<td>Teaching/Learning Activities</td>
</tr>
<tr>
<td>---------------------</td>
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</tr>
<tr>
<td>- Mention the uses of carbon and its by-products.</td>
<td>Na$_2$CO$_3$, NaHCO$_3$, CaCO$_3$, MgCO$_3$</td>
<td>- Draw a simple carbon cycle</td>
</tr>
<tr>
<td>- Prevent dangers of CO$_2$ and CO</td>
<td>17.7-Dangers of CO$_2$ and CO</td>
<td></td>
</tr>
<tr>
<td>- Describe the carbon cycle</td>
<td>17.8-Carbon cycle.</td>
<td></td>
</tr>
<tr>
<td>- Mention sources of nitrogen and its physical properties.</td>
<td>17.2. NITROGEN</td>
<td></td>
</tr>
<tr>
<td>- Explain reactions of nitrogen and oxygen and of nitrogen and hydrogen.</td>
<td>17.2.1-Principal sources (Air is a principal source)</td>
<td>- Prepare NH$_3$ using Ca(OH)$_2$ and NH$_4$Cl</td>
</tr>
<tr>
<td></td>
<td>- Physical properties of nitrogen: Colour, density and solubility.</td>
<td></td>
</tr>
<tr>
<td>- Describe laboratory preparation of ammonia and give its properties.</td>
<td>17.2.2-Chemical properties: reactivity (N$_2$ is inert) reaction with oxygen (Oxide formation with nitrogen NO$_x$) reaction with hydrogen</td>
<td></td>
</tr>
<tr>
<td>- Describe the reaction of ammonia and simple acids.</td>
<td>17.2.3-Laboratory preparation and properties of ammonia: solubility in water, reaction with HCl, action on coloured indicators and dilute acidic solutions.</td>
<td>- Prepare HNO$_3$ by heating a mixture of KNO$_3$ and concentrated H$_2$SO$_4$ : KNO$_3$(s) + H$_2$SO$_4$ 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)</td>
</tr>
<tr>
<td>- Describe nitric acid preparation.</td>
<td>17.2.4-Nitric acid preparation: in a laboratory in an industry</td>
<td></td>
</tr>
<tr>
<td>Specific objectives</td>
<td>Contents</td>
<td>Teaching/Learning Activities</td>
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</tr>
<tr>
<td>- Mention some uses of nitrogen compounds.</td>
<td>17.2.5-Areas where nitrogen and its by-products are used.</td>
<td>- Draw the nitrogen cycle</td>
</tr>
<tr>
<td>- Prevent pollution by nitrogenous substances.</td>
<td>- agriculture (chemical fertilizers)</td>
<td></td>
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<tr>
<td>- Describe the nitrogen cycle</td>
<td>- Low temperature conservation. (liquid nitrogen)</td>
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</tr>
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<td></td>
<td>- industries (manufacture of explosives, medicines)</td>
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<td></td>
<td>- homes (removal of grease from clothes)</td>
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<tr>
<td></td>
<td>- Dangers of and chemical manure.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- The nitrogen cycle</td>
<td></td>
</tr>
<tr>
<td>17.3. SULPHUR</td>
<td>17.3.1-Methods of extraction and sources of sulphur (FRASCH, natural gas and petroleum products)</td>
<td>- Carry out sulphur combustion (formation de SO₂)</td>
</tr>
<tr>
<td></td>
<td>- Allotropic forms of sulphur (rhombic, monoclinic, plastic sulphur) and their properties (avoid crystallographic details)</td>
<td>- Carry out an identification test for SO₂ (by decoloration of an acidic solution of KMnO₄)</td>
</tr>
<tr>
<td></td>
<td>- Action of heat on allotropic forms of sulphur.</td>
<td>- Prepare H₂S using a reaction of iron III sulphide and dilute hydrochloric acid.</td>
</tr>
<tr>
<td></td>
<td>17.3.2-Reaction of sulphur and oxygen (SO₂)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- metals (metallic sulphide)</td>
<td>- Illustrate dehydration of sugar, pieces of fabric, paper, and wood.... by concentrated sulphuric acid.</td>
</tr>
<tr>
<td></td>
<td>- directly with hydrogen or through metallic sulphides and diluted acids</td>
<td></td>
</tr>
<tr>
<td>Specific objectives</td>
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<td>Teaching/Learning Activities</td>
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<td>---------------------</td>
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<td>-----------------------------</td>
</tr>
<tr>
<td></td>
<td>(H₂S formation)</td>
<td>- Prepare HCl using NaCl and concentrated H₂SO₄: NaCl(s) + H₂SO₄ conc. → NaHSO₄(s) + HCl(g) HCl(g) gives white fumes formed by drops of concentrated hydrochloric acid reacting with water vapour in air.</td>
</tr>
<tr>
<td>- Describe preparation of sulphuric acid (contact process)</td>
<td>17.3.3-Preparation of sulphuric acid by the contact process - Dilution of concentrated H₂SO₄ (battery acid) - Reactions of dilute sulphuric acid with: ▪ Copper (only in the presence of heat) ▪ Mg, Fe, Zn</td>
<td></td>
</tr>
<tr>
<td>- Carefully carry out dilution of concentrated sulphuric acid.</td>
<td>17.3.4-Uses of sulphur and its derivatives: ▪ medical (skin diseases), ▪ Industrial (manufacture of matches, battery acid, food preservation, chemical fertilizers, cleaning metals.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17. CHLORINE</td>
<td></td>
</tr>
<tr>
<td>- Mention uses of sulphur and its derivatives</td>
<td>17.4.1-Preparation and properties of chlorine using concentrated HCl and KMnO₄/MnO₂</td>
<td></td>
</tr>
<tr>
<td>- Describe and illustrate preparation of chlorine and its properties.</td>
<td>17.4.2-Reaction with: ▪ hydrogen, ▪ metals (Na, Mg and Fe)</td>
<td>- Carry out the preparation of sodium chloride in the laboratory by heating</td>
</tr>
</tbody>
</table>
### 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.

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<tr>
<td>At the end of this chapter the student should be able to:</td>
<td>18.1 Origin of organic chemistry</td>
<td>- Make displays of hydrocarbon chains in molecular models.</td>
</tr>
<tr>
<td>- Explain the difference between an organic and an inorganic substance</td>
<td>18.2-Writing semi developed and developed formulae and nomenclature of alkanes up to C₅</td>
<td>- Carry out exercises of writing formulae of some alkanes and name them.</td>
</tr>
<tr>
<td>- Write and name semi-developed and developed formulae of alkanes up to C₅</td>
<td>18.3-Petroleum and products of its distillation</td>
<td>- Carry out combustion of a gas in a laboratory by heating it.</td>
</tr>
<tr>
<td>- Mention common products in distillation of petroleum.</td>
<td>18.4-Methane: Physical properties</td>
<td>- Carry out exercises in writing alkane combustion reactions.</td>
</tr>
<tr>
<td>- Describe properties of methane and its uses.</td>
<td>Applications: -Fuel</td>
<td></td>
</tr>
<tr>
<td>- Interpret alkane combustion reactions.</td>
<td>-fertilizer production chemicals</td>
<td></td>
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<tr>
<td>- Name and class organic compounds until</td>
<td>-production of derivatives (chlorinated derivatives: CH₃Cl: weak anaesthesia</td>
<td></td>
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<tr>
<td></td>
<td>CH₂Cl₂: solvent</td>
<td></td>
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<tr>
<td></td>
<td>CHCl₃: solvent</td>
<td></td>
</tr>
<tr>
<td>Specific objectives</td>
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<td>Teaching/Learning Activities</td>
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<tr>
<td>c.5</td>
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</tr>
<tr>
<td>-Describe preparation and properties of ethylene</td>
<td>CCl₄: solvent</td>
<td>-Carry out exercises in classifying organic compounds and naming them up to C₅</td>
</tr>
<tr>
<td>-Prepare alcohol</td>
<td>18.5-Alkane combustion reactions</td>
<td></td>
</tr>
<tr>
<td>-Prepare ethanol</td>
<td>18.6-Classification and nomenclature of other organic compounds up to C₅ (alkenes, alkynes, cyanes, alcohols, aldehydes, ketones, carboxylic acid, esters, amines)</td>
<td>-Prepare alcohol by fermentation</td>
</tr>
<tr>
<td>-Explain the addition reaction of ethylene and compare with substitution reactions in alkanes</td>
<td>18.7-Preparation and properties of ethylene</td>
<td>-Prepare ethyl ethanolate using acetic acid and ethanol in the presence of concentrated sulphuric acid</td>
</tr>
<tr>
<td>-Explain an esterification reaction of acetic acid by ethanol.</td>
<td>18.8-Preparation of an alcohol</td>
<td>-Prepare soap using palm oil and sodium hydroxide.</td>
</tr>
<tr>
<td>- Mention some areas where organic chemistry can be used.</td>
<td>18.9-Addition reactions of ethylene (with chlorine, bromine, hydrogen and gaseous hydrogen chloride.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18.10-Esterification reaction of acetic acid by ethanol.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18.11-Use of petroleum products. (Energy source) in transport, industry and in homes - Making soap, plastic, nylon and organic pigments in paint.</td>
<td></td>
</tr>
</tbody>
</table>
7. BIBLIOGRAPHY

4. DURANDEAU, J.P ; BRAMAND, P ; CAILLET, D ; COMTE, M.J ; DOERMAN, F ; FAYE, P ; THOMASSIER, G. (1993)
12. STAUVEN, C. (1996). Construire une formation, Définition des objectifs pédagogique et exercices d’application, 2ème édition,
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 physics 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

<table>
<thead>
<tr>
<th>Topics and Chapters</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TOPIC 1: Introduction to Physics</strong></td>
<td></td>
</tr>
<tr>
<td>Chapter 1: Measurement in physics</td>
<td>12 periods</td>
</tr>
<tr>
<td>Chapter 2: Properties of Matter</td>
<td>6 periods</td>
</tr>
<tr>
<td><strong>TOPIC 2: Liquids in equilibrium</strong></td>
<td></td>
</tr>
<tr>
<td>Chapter 1: Force and pressure</td>
<td>10 periods</td>
</tr>
<tr>
<td>Chapter 2: Pressure in fluids in equilibrium</td>
<td>34 periods</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>62 periods</strong></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Specific objectives</th>
<th>Contents</th>
<th>Teaching and learning activities</th>
</tr>
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</table>
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)

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

<table>
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<tr>
<th>Specific objectives</th>
<th>Contents</th>
<th>Teaching and learning activities</th>
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<td>Differentiate a liquid from a solid.</td>
<td>Define a liquid.</td>
<td>Create a hydraulic press using a plastic pipe with two syringes in different sections</td>
</tr>
<tr>
<td>Identify factors influencing pressure at a</td>
<td>Pressure in liquids:</td>
<td>Create manometer using a flexible and transparent plastic pipe, funnel and a rubber ball</td>
</tr>
<tr>
<td>point in a liquid in equilibrium.</td>
<td>forces existing in liquids</td>
<td></td>
</tr>
<tr>
<td>Use a manometer to measure pressure in a</td>
<td>Factors influencing pressure at a point in a liquid in equilibrium (p = ρ g h)</td>
<td></td>
</tr>
<tr>
<td>liquid</td>
<td>Applications: Pascal’s burst barrel, Dikes</td>
<td></td>
</tr>
<tr>
<td>Give and illustrate Pascal’s principle</td>
<td>Pressure difference between two points in a liquid at rest.</td>
<td></td>
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<td></td>
<td>Equilibrium of a liquid in communicating</td>
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<tr>
<td>Application</td>
<td>Illustration</td>
<td>Measure</td>
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</tr>
<tr>
<td>Give and explain some applications of Pascal’s principle in everyday.</td>
<td>Equilibrium of several non-miscible liquids in a container</td>
<td>Measure atmospheric pressure using barometers</td>
</tr>
<tr>
<td>Identify factor’s influencing pressure in gases.</td>
<td>Equilibrium in two communicating containers</td>
<td>Do exercises about pressure of a liquid in equilibrium</td>
</tr>
<tr>
<td>Experimentally show the existence of atmospheric pressure.</td>
<td>Measure of pressures by a manometer</td>
<td></td>
</tr>
<tr>
<td>Use barometers to measure atmospheric pressure</td>
<td>Free surface of a liquid at rest</td>
<td></td>
</tr>
<tr>
<td>Solve problems requiring the conversion of common units of atmospheric pressure.</td>
<td>Pascal’s principle and its applications: hydraulic press, hydraulic lift pump and hydraulic brakes</td>
<td></td>
</tr>
<tr>
<td>Give and explain certain applications of atmospheric pressure in everyday life.</td>
<td>Pressure of gases in equilibrium:</td>
<td></td>
</tr>
<tr>
<td>Illustrate the existence of upthrust in liquids.</td>
<td>1. Existence of force in air</td>
<td></td>
</tr>
<tr>
<td>Show Archimedes’ principle in a liquid.</td>
<td>2. Atmospheric pressure. Torricelli’s experiment.</td>
<td></td>
</tr>
<tr>
<td>Explain conditions of floatation and give examples of applications in everyday life.</td>
<td>3. Atmospheric pressure units Uses of pressure in gases: operating a bicycle pump, suction pump, syringe, siphon, straw.</td>
<td>Use a Eureka can and a solid object to compare the difference between weight of this solid and the weight of displaced liquid</td>
</tr>
<tr>
<td></td>
<td>Archimedes’ principle:</td>
<td>Illustrate conditions of floatation. Using articles that float and others that sink.</td>
</tr>
<tr>
<td></td>
<td>Archimedes’ principle in liquids.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Upthrust</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Factors affecting upthrust.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. State principle and formula</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Applications: Floating, ships, submarines</td>
<td></td>
</tr>
<tr>
<td>Explain the existence of upthrust in gases. State the Archimedes principle in general.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>densimeter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Archimedes principle in gases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Upthrust.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 State the principle and formula of Archimedes in fluids. in general</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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)

<table>
<thead>
<tr>
<th>Specific objectives</th>
<th>Contents</th>
<th>Teaching and learning activities</th>
</tr>
</thead>
</table>
| 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. |
<table>
<thead>
<tr>
<th>Make a quantitative study of uniform rectilinear motion</th>
<th>movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plot a graph of distance with time for URM.</td>
<td>Uniform rectilinear motion:</td>
</tr>
<tr>
<td>Differentiate uniform rectilinear motion from uniformly accelerated rectilinear motion</td>
<td>Definition of URM</td>
</tr>
<tr>
<td>Plot a graph for velocity and time in rectilinear motion with uniform acceleration.</td>
<td>velocity (definition, formula, units)</td>
</tr>
<tr>
<td></td>
<td>: velocity-time and distance-time graphs</td>
</tr>
<tr>
<td></td>
<td>Rectilinear motion with uniform change:</td>
</tr>
<tr>
<td></td>
<td>Acceleration: formula, units</td>
</tr>
<tr>
<td></td>
<td>Definition (uniformly accelerated or decelerated motion)</td>
</tr>
<tr>
<td></td>
<td>UARM:</td>
</tr>
<tr>
<td></td>
<td>Equations</td>
</tr>
<tr>
<td></td>
<td>Graphs</td>
</tr>
<tr>
<td></td>
<td>Example: free-fall</td>
</tr>
<tr>
<td></td>
<td>UDRM:</td>
</tr>
<tr>
<td></td>
<td>Equation</td>
</tr>
<tr>
<td></td>
<td>Graphs</td>
</tr>
<tr>
<td>Describe Uniform Circular Motion</td>
<td>Uniform Circular Motion. (UCM)</td>
</tr>
<tr>
<td>Define and calculate the period, frequency, linear velocity, angular velocity</td>
<td>Definition</td>
</tr>
<tr>
<td></td>
<td>Period, frequency</td>
</tr>
<tr>
<td></td>
<td>Linear and angular ordinates</td>
</tr>
<tr>
<td></td>
<td>Linear velocity</td>
</tr>
<tr>
<td></td>
<td>Angular velocity</td>
</tr>
</tbody>
</table>

- 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.

<table>
<thead>
<tr>
<th>Specific objectives</th>
<th>Contents</th>
<th>Teaching and learning activities</th>
</tr>
</thead>
</table>
| State and use Newton’s laws of motion | Newton’s laws of motion:  
1. Principle of inertia: Newton; s 1st law.  
2. Newton’s second law  
| Differentiate dynamics from kinetics | Friction force :  
1. Definition of friction  
2. Effects of friction  
3. Static and kinetic friction  
4. Factors affecting friction and ways | |
| 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 | | |
| Give the equilibrium state of a body | to reduce it |
| Identify types of equilibrium and give the conditions for an equilibrium | 5. Advantages and disadvantages of friction |
| Determine the centre of gravity of different objects | Equilibrium of a solid: |
| Name and explain the factors influencing stability of equilibrium | 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

<table>
<thead>
<tr>
<th>Specific objectives</th>
<th>Contents</th>
<th>Teaching and learning activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define work, power and energy.</td>
<td>Work 1. Definition 2. Formula 3. Units</td>
<td>- Answer questions on energy, power and work</td>
</tr>
<tr>
<td>Differentiate potential energy from kinetic energy</td>
<td>Power: 1. Definition 2. Formula 3. Units</td>
<td>-</td>
</tr>
<tr>
<td>Give examples of simple machines</td>
<td>Simple machines: 1. Definition 2. Types of simple machines</td>
<td>-</td>
</tr>
<tr>
<td>Explain the working principle of lever, a pulley and an inclined plane</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Define machine work and resistance work</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Determine output of a simple machine</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Answer questions on simple machines</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Explain the transformation of potential energy into kinetic energy and vice versa</td>
<td></td>
<td>- 1</td>
</tr>
<tr>
<td>Define output of simple machines</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Answer questions on simple machines.</td>
<td></td>
<td>- Solve problems on simple machines</td>
</tr>
</tbody>
</table>
### 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.

<table>
<thead>
<tr>
<th>Specific objectives</th>
<th>Contents</th>
<th>Teaching and learning activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Give the difference between temperature and heat.</td>
<td>Introduction : heat</td>
<td>- Use a thermometer to take the temperatures of different bodies.</td>
</tr>
<tr>
<td>- Use a thermometer to measure temperature.</td>
<td>Introduction : temperature</td>
<td></td>
</tr>
<tr>
<td>- Explain the principle of calibrating a thermometer</td>
<td>Difference between heat and temperature.</td>
<td></td>
</tr>
<tr>
<td>- Compare different temperature scales.</td>
<td>Measure temperature and thermometer temperature scales</td>
<td></td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Specific objectives</th>
<th>Contents</th>
<th>Teaching and learning activities</th>
</tr>
</thead>
</table>
| - Explain transmission of heat. | Transmission of heat:  
  - Conduction  
  - Convection  
  - Radiation | Illustrate transmission of heat by radiation from a light bulb. |
| - Give examples of heat transmission in everyday life. | | |

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.

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

<table>
<thead>
<tr>
<th>Specific objective</th>
<th>Contents</th>
<th>Teaching and learning activities</th>
</tr>
</thead>
</table>
| At the end of this chapter, the pupil will be able of: | - 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

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

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

**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.

<table>
<thead>
<tr>
<th>Specific objectives</th>
<th>Contents</th>
<th>Teaching and learning activities</th>
</tr>
</thead>
</table>
| - Give examples of generators | 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 | - Create an electric circuit supplied by batteries in series and in parallel. |
| - Differentiate between e.m.f. and internal resistance at terminals of a generator | 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 ....) | - Classify receptors as passive or active |
| - Give examples of receptors | | - Carry out an experiment showing the Joule effect. |
| - Differentiate between e.m.f. and internal resistance at terminals of a receptor | | - Carry out different exercises on this chapter |
| - Show the different connections of generators and receptors. | | |
### Specific objectives

<table>
<thead>
<tr>
<th>Contents</th>
<th>Teaching and learning activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Explain the Joule effect and its applications</td>
<td></td>
</tr>
<tr>
<td>- Explain the principle of a domestic installation and protection methods</td>
<td></td>
</tr>
<tr>
<td>Electrical power waste by the Joule effect</td>
<td></td>
</tr>
<tr>
<td>Electricity in homes:</td>
<td></td>
</tr>
<tr>
<td>- Domestic installation:</td>
<td></td>
</tr>
<tr>
<td>protection of equipment, fuses, automatic circuit breakers, safety</td>
<td></td>
</tr>
<tr>
<td>instructions and the role of humidity</td>
<td></td>
</tr>
<tr>
<td>- Electrical energy transport,</td>
<td></td>
</tr>
<tr>
<td>electrical energy and kilowatt rates</td>
<td></td>
</tr>
</tbody>
</table>

### 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

<table>
<thead>
<tr>
<th>Contents</th>
<th>Teaching and learning activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Identify light sources and bodies</td>
<td></td>
</tr>
<tr>
<td>Introduction</td>
<td></td>
</tr>
<tr>
<td>Specific objectives</td>
<td>Contents</td>
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<tr>
<td>----------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>with light</td>
<td>Sources of light</td>
</tr>
<tr>
<td>- Identify transparent, translucent and opaque bodies.</td>
<td>Opaque, translucent and transparent bodies</td>
</tr>
<tr>
<td>- Illustrate light propagation in straight lines.</td>
<td>Light propagation in a straight line.</td>
</tr>
<tr>
<td>- Explain formation of umbra, penumbra and eclipses</td>
<td>Rays and beams of light</td>
</tr>
<tr>
<td>Explain image formation in a dark room.</td>
<td>Umbra and penumbra</td>
</tr>
<tr>
<td></td>
<td>Eclipses</td>
</tr>
<tr>
<td></td>
<td>Dark room :</td>
</tr>
<tr>
<td></td>
<td>1. Image formation in a dark room</td>
</tr>
<tr>
<td></td>
<td>2. Characteristics of an image</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Specific objectives</th>
<th>Contents</th>
<th>Teaching and learning activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify reflection surfaces</td>
<td></td>
<td>Build a periscope to observe objects behind obstacles.</td>
</tr>
<tr>
<td>Distinguish between regular and diffuse reflection.</td>
<td></td>
<td>Verify the laws of reflection with the appropriate apparatus.</td>
</tr>
<tr>
<td>State the laws of reflection</td>
<td></td>
<td>Create an image of an object in a plane mirror and give its properties.</td>
</tr>
<tr>
<td>Identify a plane mirror</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Form an image of an object in a plane mirror</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain how a periscope works.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Specific objectives

- Identify spherical mirrors
- Form an image of an object using a spherical mirror.
- Explain the importance of spherical mirrors.

### Contents

- Geometrical elements of a spherical mirror:
  - Centre of curvature, radius of curvature, principle axis, caustic and apex.
- 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
- 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.
- Uses of spherical mirrors in everyday life

### Teaching and learning activities

### 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 a magnifying glass.
- Read about the rainbow and make a report in class.
- Illustrate light refraction when light crosses through a light prism.

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

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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, …)

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

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

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

<table>
<thead>
<tr>
<th></th>
<th>FORM 1</th>
<th>FORM 2</th>
<th>FORM 3</th>
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<tbody>
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<td>37</td>
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### ORDINARY LEVEL SCIENCE PROGRAM: ADDENDUM

## BIOLOGY

<table>
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<td>38</td>
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<td>50</td>
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<tr>
<td>59</td>
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<tr>
<td>68 &amp; 69</td>
</tr>
<tr>
<td>76</td>
</tr>
</tbody>
</table>

### Form one
- Insert the protozoa in the micro organisms.
- Insert the malaria under the title “harmful micro-organisms”.
- Insert worms among the harmful invertebrates.
- Insert the muscular system.
- Add the bladder and the urinary passages as components of the urinary system.
- Add the external genital organs as components of the female reproductive system.

### Form two
- Add the trypanosomes, malaria (paludisme) and filaria among the illnesses transported by blood.
- 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)
- The general objective 7 becomes “To give the composition and the role of the human reproductive system” (see content page 76).
- 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).
- 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

<table>
<thead>
<tr>
<th>PAGE</th>
<th>CHANGES TO MAKE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cover</td>
<td>To put the year of edition 2006</td>
</tr>
<tr>
<td>P.142.</td>
<td>In the column “contents” it is necessary to replace” types of forces” by &quot;Example of forces&quot; and to add units of forces directly below</td>
</tr>
<tr>
<td>P.146.</td>
<td>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 &quot;make a quantitative study of the uniform circular Motion&quot;</td>
</tr>
<tr>
<td>P.147.</td>
<td>For the title of the chapter 1, it is necessary to read “Kinematics of the rectilinear motion and the uniform circular motion”</td>
</tr>
<tr>
<td>P.150.</td>
<td>In the column &quot;contents&quot; 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”</td>
</tr>
<tr>
<td>P.151.</td>
<td>For the second learning situation, it is necessary to delete what comes after &quot;etc.&quot;</td>
</tr>
<tr>
<td>P.152.</td>
<td>In the column “specific objectives” it is necessary to read the third objective as follows: To &quot;explain the principle of calibrating a liquid thermometer&quot;</td>
</tr>
</tbody>
</table>