PHYSICS SYLLABUS S4-S6

FOR ASSOCIATE NURSING PROGRAM

KIGALI, 2022

FOREWORD

Rwanda Basic Education Board (REB) is honored to avail the physics syllabus as one of the subjects of the Associate Nursing Program. This document serves as an official guide to the teaching and learning of physics subject in Associate Nursing Program. The document ensures consistency and coherence in the delivery of quality education for the associate nurse that the country desires.

The Ministry of education through Rwanda Basic Education Board (REB) has undertaken the task to introduce the Associate Nursing Program in the second cycle of secondary education level. The underlying principles behind the introduction of this program is to ensure that the curriculum responds to the needs of the learners, the society, and the labor market.

Physics is one of the subjects of competence-based curriculum that emphasizes on equipping the learners with required knowledge, skills, and attitudes to produce well-trained learners for quality nursing care improvement. High Quality Health Care is an important component of Health and Well-being of the Rwanda Vision 2050, "The Rwanda We Want," that aims at transforming the country's socioeconomic status. It is only the healthy people who can significantly play a major role in this socioeconomic transformation journey. Physics subject introduces key medical concepts, such as laws of pressure and volume, which are incredibly important for cardiology; physics principles, methods and techniques in practice and research for the prevention, diagnosis and treatment of human diseases

I wish to sincerely appreciate all the people who contributed to the development of this syllabus, particularly the Human Resources for Health Secretariat (HRHS), in partnership with REB, who organized the whole process right from its inception. Any comments or contribution towards the improvement of this syllabus for the next edition are welcome.

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Director General, REB.

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1. GENERAL INTRODUCTION

1.1. Background to the introduction of the Associate Nursing Program in secondary schools

For a long time, nursing education around the world has taken different steps from the traditional apprenticeship, vocational, and hospital-based training model to a higher education academic model of teaching and learning (Gaberson & Oemann, 2010). This paradigm shift was driven by the increased demand of the professionalization of nursing, the changing illness patterns, and the expansion of the knowledge-based society requiring more improved and innovative education preparation of nursing professionals that is adapted to the context and specific health needs (Yam, 2004).

In Rwanda, the above-mentioned transformations in nursing education evolved overtime. Healthcare education in general started in 1933 with medical assistants "Assistants Médicaux" program, followed by the assistant midwives "Auxiliaires accoucheuses" in 1949 (Harelimana, et., 2015). From 1954 up to 1979, there was the program at secondary level "A2 and A3". From 1979 to 2004, the program of nursing education was exclusively "A2" secondary level (Kabgayi School of Nursing and Midwifery, 2013). Nurses were mostly prepared for hospitals and health centers, leaving out the community, which was later addressed by the introduction of the Community Health Workers (CHWs) in 1995 (MoH, 2012).

The Cabinet resolution of October 27th, 2004 phased out the A2 nursing program. A transition period was decided upon to move from nursing program A2 to Nursing Program A1 up to 2007. The purpose of this was to train more nursing professionals at a tertiary level in order to produce highly-qualified professionals, thus improving quality health care services delivery. However, gaps in providing basic nursing care at different levels were continually observed.

Fourteen years later after the closure of the A2 nursing program, the Government of Rwanda decided to introduce the Associate Nursing Program as provided by Article 58 of the Rwandan Law determining organisation of Education No 10/2021 of 16/02/2021 (MoE, 2021).

Therefore, Associate Nursing Program is being introduced to provide the support needed in basic nursing care provision, with the capacity to progress in different advanced health care professions. This decision aims at meeting the current and contextual health needs that present high demand at different levels of the healthcare system, particularly in the community. Therefore, nursing is based on science. The hard sciences like general chemistry, general biology (Biology, microbiology, human anatomy, physiology and nutrition), physics and mathematics are required by this Association Nursing Program as prerequisites for cornerstone preparing at earlier age of the future nurses.

1.2. Associate nurse leaver's profile

Upon completion of the Associate Nursing Program, the learner should have acquired knowledge, skills and attitudes to:

1. Provide support to individuals, families, and communities when faced with unwelcome news and life changing diagnoses;
2. Provide health education within her/his scope of practice;
3. Demonstrate understanding of the determinants of health that affect individuals, families, groups, and communities;
4. Demonstrate understanding of basic common health conditions affecting individuals of all age groups and their basic nursing care;
5. Assess individuals, families, groups and community needs and provide basic nursing care using evidence-based practice;
6. Collaborate effectively with multidisciplinary team members, clients and stakeholders in provision of basic nursing care;
7. Demonstrate values of responsibility, accountability, commitment and patriotism in serving the nation;
8. Ensure the privacy, dignity and safety of individuals is maintained at all times;
9. Provide support on basic care in reproductive, maternal, neonatal and child health;
10. Explain scientific phenomena using correct scientific terminologies;

11. Demonstrate knowledge and skills required to progress to higher learning education;
12. Express themselves fluently, and with confidence, in speaking and writing using correct vocabulary and grammar appropriately;
13. Perform experiments using a range of scientific and medical tools and equipment and draw appropriate conclusions;
14. Demonstrate ability to manage data (collect, recording, processing, analysis, synthesis, reporting) and take the appropriate decision.

2. TEACHING AND LEARNING PHYSICS

2.1. Rationale of teaching and learning physics

Physics generates fundamental knowledge needed for the future technological advances that will continue to drive the economic engine of the world. Most important, physics and other hard science train in the scientific method, which is foundation to modern medicine. Physics is a great help in the field of medicine, useful across many aspects both in treatment but especially in diagnostic medicine in medical imaging such as X-ray, CT scan, ultrasound etc. The physics subject is a competence-based like other subjects of the second cycle of secondary education level.

2.1.1. Physics and society

Physics is one of the natural science subjects and contributes significantly to global socioeconomic transformation through its discoveries. These have led to development of new technologies in all fields of production and are beneficial to mankind. Applications of Physics knowledge is evident in industries engineering, transport (automobiles, trains, flights, etc), medicine, Information and Communication Technology (ICT)

Physics significantly contributes to the advancement of new technologies that arise from theoretical breakthroughs. For example, advances and understanding of electromagnetism or nuclear physics has led to the development of new products which have dramatically transformed the modern society. Some of the discoveries based on Physics knowledge include televisions, computers, electrical appliances, and nuclear weapons advancements in thermodynamics and mechanics which led to industrialization.

Physics is key to the Rwandan education ambition of developing a knowledge-based society since it promotes science and technology which are necessary for learners to be competitive both at regional and global job markets.

2.1.2. Physics and learners

Physics is a worthwhile subject because it prepares students for the real world of work by providing career pathways in mechanical and construction engineering, information and communication technology and other related fields. Physics provides skills that guide the construction of theories and laws that help to explain natural phenomenon and enable management of environment.

It also provides answers to problems faced in our modern society by empowering students to be creative and innovative leading to independent approaches of solving daily life problems. Through physics students explore the laws and rules that govern all natural phenomena associated with the subject observed in the universe.

2.2. Competences

A competence is defined as the ability to use an appropriate combination of knowledge, skills, attitudes, values and behaviours to accomplish a particular task successfully. That is the ability to apply learning with confidence in a range of situations.

Basic competences are addressed in the stated broad subject competences and in the objectives highlighted in a year-on-year basis and in each of the units of learning. The generic competences and broad subject competences that must be emphasized and reflected in the learning process are briefly described below and teachers will ensure that learners are exposed to tasks that help the learners acquire the skills.

2.2.1. Generic competences

Critical and problem-solving skills: The acquisition of such skills will help learners to think imaginatively, innovatively and broadly to evaluate and find solutions to problems encountered in our surrounding.

Creativity and innovation*:* The acquisition of such skills will help learners to take initiatives and use imagination beyond knowledge provided in classroom to generate new ideas and construct new concepts.

Research: This will help learners to find answers to questions based on existing information and concepts and use it explain

phenomena from gathered information.

Communication in official languages: Teachers, irrespective of being language teachers will ensure the proper use of the language of instruction by learners. The teachers should communicate clearly and confidently and convey ideas effectively through spoken and written by applying appropriate language and relevant vocabulary.

Cooperation, inter personal management and life skills: This will help the learner to cooperate as a team in whatever task assigned and to practice positive ethical moral values and while respecting rights, feelings and views of others. Perform practical activities related to environmental conservation and protection. Advocate for personal, family and community health, hygiene and nutrition and responding creatively to a variety of challenges encountered in life.

Lifelong learning: The acquisition of such skills will help learners to update knowledge and skills with minimum external support. The learners will be able to cope with evolution of knowledge advances for personal fulfillment in areas that are relevant to their improvement and development.

2.2.2 Broad physics competences

During and at the end of learning process, the learner can:

- Analyze and explain physics phenomena relating to life experience;
- Use and experiment with a range of scientific and technological tools and equipment and draw appropriate conclusions;
- Demonstrate curiosity, research skills and creativity;
- Apply scientific inquiry and methods to investigations;
- Apply the knowledge of Physics to technology and scientific investigation;
- Observe, analyse, evaluate, and interpret without prejudice and make reasonable decisions;
- Use principles of scientific methods and experimental techniques to solve specific problems in life;

- Develop attitudes in which scientific investigations depend on honesty, persistence, critical thinking and tolerance of uncertainty;
- Appreciate the scientific, social, economic, environmental and technological implications of physics;
- Identify the safe and appropriate techniques used in the preparation, storage, dispensing and supervision of materials used in science instructions;
- Identify the national legal requirements and standards for safe preparation, use, storage, and disposal of the materials

2.2.3. Physics and developing competences

The national policy documents based on national aspirations identify some 'basic Competences' alongside the 'Generic Competences" that will develop higher order thinking skills and help student learn subject content and promote application of acquired knowledge and skills.

Through observations, experimentation, and presentation of information during the learning process, the learner will not only develop deductive and inductive skills but also acquire cooperation and communication, critical thinking and problem-solving skills. This will be realized when learners make presentations leading to inferences and conclusions at the end of learning unit. This will be achieved through learner group work and cooperative learning of physics which in turn will promote interpersonal relations and teamwork.

The manipulation of apparatus and data during class experiments and undertaking of project work by learners will involve analytical and problem-solving skills directed towards innovation, creativity and research activities by learners.

The acquired knowledge in learning physics should develop a responsible citizen who adapts to scientific reasoning and attitudes and develops confidence in reasoning independently. The learner should show concern of individual attitudes, environmental protection and comply with the scientific method of reasoning. The scientific method should be applied with the necessary rigor, intellectual honesty to promote critical thinking while systematically pursuing the line of thought.

2.3. Pedagogical Approach

Learners enjoy learning when they are actively involved in the learning process with a high degree of participation, contribution and presentation. At the same time, each learner is an individual with his/her own needs, pace of learning, experiences and abilities. Teaching strategies must therefore be varied but flexible within well-structured sequences of lessons. Learner-centered education does not mean that the teacher is no longer responsible for learning.

2.3.1. Role of the learner

The activities to engage learner are indicated against each learning unit and reflect appropriate engagement of the learner in the learning process. The teaching/ learning process activities are tailored towards creating a learner friendly environment basing on the abilities, needs, experiences and interests of the learner.

The learning activities are organized in such a way that encourages learners to construct their own knowledge (minds-on and hands-on activities) either individually or in groups. The learners should suggest how to solve challenging problems exposed to them. Learners should work on one Competence outcome at a time in form of concrete unit with specific learning objectives which are broken into knowledge, skills, attitudes and values.

In practical lessons learners will work in groups depending on the availability of the apparatus however if apparatus permit then they work individually. However, working on simple project work individually will be encouraged and emphasized. Learners should use textbooks and other resources for complementing the knowledge acquired in classroom. Learners should strive to become thinkers, inquirers, problem solvers, and communicators, principled, open-minded, caring, risk takers, balanced in reflection.

2.3.2. Role of the teacher

The Competence-based curriculum is about transforming learning by ensuring that learning is deep, enjoyable and habit- forming.

The teachers ought to become facilitators in order to value and understand learners' individual needs and expectations.

The teacher must identify the needs of the learners, the nature of the learning to be undertaken, and the means to shape learning experiences accordingly.

The teacher's role is to organize the learners in the classroom or outside, engage them through participatory and interactive methods. Learning processes should target individual learners, pairs of learners or large of groups. This organization ensures that the learning is personalized, active, participatory and co-operative in nature. The teacher should design and introduce the tasks to the entire class to perform or for immediate discussion. The role of the teacher should be to guide the learners in constructing their own knowledge.

Learners should be taught on how to use the textbooks and other resource materials as supplementary ways of acquiring knowledge: During the research learners should take summary notes of what they are reading. The teacher must select and develop appropriate teaching materials like models, charts, and ICT facilities such as internet, videos, computers, simulations and so on.

During practical lessons, the teacher should first demonstrate the experiment procedure and manipulation of the apparatus. For dangerous tasks the teachers should give a demonstration of the experiment before exposing it to the learners.

The teacher must devise remedial strategies in and outside the classroom to cater for low achievers and those with learning difficulties in order to ensure they keep pace with the rest in acquiring the required competences.

The teacher have to ensure that the cross cutting issues are addressed in teaching and learning process.

2.4. Special needs education and inclusive approach

All Rwandans have the right to access education regardless of their different needs. The underpinnings of this provision would naturally hold that all citizens benefit from the same menu of educational programs. The possibility of this assumption is the focus of special needs education. The critical issue is that we have persons/ learners who are totally different in their ways of living and learning, as opposed to the majority. These differences can either be emotional, physical or sensory. Traditionally intellectual learning challenges were traditionally known as mental retardation.

These learners equally have the right to benefit from the free and compulsory basic education in nearby ordinary/main-stream schools. Therefore, the school's obligation is to enroll them and also set strategies to provide relevant education to them. The teacher therefore is requested to consider each learner's needs during teaching and learning process. Assessment strategies and conditions should also be standardised to the needs of these learners. Detailed information for each category of learners with special education needs is provided in the guidance for teacher's section.

2.5. Assessment Approach

Assessment is the process of evaluating the teaching and learning processes through collecting and interpreting evidence of individual learner's progress in learning and to make a judgment about a learner's achievements measured against defined standards. Assessment is an integral part of the teaching learning processes. In the competence-based curriculum assessment must also be competence-based, whereby a learner is given a complex situation related to his/her everyday life and asked to try to overcome the situation by applying what he/she learned.

Assessment will be organized at the following levels: School-based assessment, District based assessment, National assessment and National examinations.

2.5.1. Types of assessment

a) Formative and continuous assessment (assessment for learning)

Continuous assessment involves formal and informal methods used by schools to check whether learning is taking place. When a teacher is planning his/her lesson, he/she should establish criteria for performance and behavior changes at the beginning of a unit. Then at the end of every unit, the teacher should ensure that all the learners have mastered the stated key unit competences basing on the criteria stated, before going to the next unit. The teacher will assess how well each learner masters both the subject and the generic competences described in the syllabus and from this, the teacher will gain a picture of the all-round progress of the learner. The teacher will use one or a combination of the following: (a) observation (b) pen and paper (c) oral questioning and d) experimentation. The change of behaviour (values, attitudes, beliefs and obey of norms) is the major indicator of ensuring that teaching and learning has taken place, therefore the set of mastery criterion should also reflect the change of behaviour of the learner.

b) Summative assessment (assessment of learning)

When assessment is used to record a judgment of a competence or performance of the learner, it serves a summative purpose. Summative assessment gives a picture of a learner's competence or progress at any specific moment. The main purpose of summative assessment is to evaluate whether learning objectives have been achieved and to use the results for the ranking or grading of learners, for deciding on progression, for selection into the next level of education and for certification. This assessment should have an

integrative aspect whereby a student must be able to show mastery of all competences.

It can be internal school-based assessment or external assessment in the form of national examinations. School based summative assessment should take place once at the end of each term and once at the end of the year.

External summative assessment will be done at the end of senior 6 and this will be for both theory and practical examinations.

2.5.2. Record Keeping

This is gathering facts and evidence from assessment instruments and using them to judge the student's performance by assigning an indicator against the set criteria or standard. Whatever assessment procedures used shall generate data in the form of scores which will be carefully be recorded and stored in a portfolio because they will contribute for remedial actions, for alternative instructional strategy and feed back to the learner and to the parents to check the learning progress and to advice accordingly or to the final assessment of the students.

This portfolio is a folder (or binder or even a digital collection) containing the student's work as well as the student's evaluation of the strengths and weaknesses of the work. Portfolios reflect not only work produced (such as papers and assignments), but also it is a record of the activities undertaken over time as part of student learning including the worksheets. The portfolio output (formative assessment) will be considered only as enough for three years of a level. Besides, it will serve as a verification tool for each learner that he/she attended the whole learning before he/she undergoes the summative assessment for the subject.

2.5.3. Item writing in summative assessment

Before developing a question paper, a plan or specification of what is to be tested or examined must be elaborated to show the units or topics to be tested on, the number of questions in each level of Bloom's taxonomy and the marks allocation for each question. In a Competence based curriculum, questions from higher levels of Bloom's taxonomy should be given more weight than those from knowledge and comprehension level.

Before developing a question paper, the item writer must ensure that the test or examination questions are tailored towards Competence based assessment by doing the following:

- Identify topic areas to be tested on from the subject syllabus.
- Outline subject-matter content to be considered as the basis for the test.
- Identify learning outcomes to be measured by the test.
- Prepare a table of specifications.
- Ensure that the verbs used in the formulation of questions do not require memorization or recall answers only but testing broad competences as stated in the syllabus.

2.5.4. Structure and format of the examination

There will be 3 papers in the Physics Subject to be examined. Time allocated for all papers will depend on their respective weight and in special case, it can depend on the needs of the learners. The papers will be structured as follows;

- Structured answer questions consist of a variable number of questions, of variable mark value. All questions will be based on the A` Level syllabus content. Candidates will answer all questions and on the question paper.
- Unstructured answer questions or extended paper in which all questions will be based on the A' level syllabus, but may require knowledge of material first encountered in the previous level of study.
- Practical paper will consist of experiments drawn from different areas of the syllabus that require candidates to carry out practical work in timed conditions. Candidates may not enter for single papers on the first occasion or for reset purposes. All components will be externally assessed.

Component Weighting

COMPONENT	WEIGHTING
Paper 1 measures knowledge and understanding (lower order thinking level) • Structured short answer questions. All questions will be based on the syllabus content.	Structured short answer questions will have 20% of the final marking of the assessment
Paper 2 consists of question with number of parts each with a variable mark value, which measures skills and advanced level of understanding (higher order thinking level) • Unstructured answer questions or extended essay questions. All questions will be based on the syllabus but may require knowledge of material first encountered in the previous syllabus of the same subject.	Unstructured answer questions will have 40 % of the final marking of the assessment
Paper 3 Advanced Practical Skills. This paper requires candidates to carry out practical work in timed conditions. This paper will consist of experiments drawn from different areas of the syllabus. Candidates will answer all questions. Candidates will answer on the question paper. [100 marks]	Practical exam will cover 40% of the final marking of the assessment

Assessment of Subject objectives (AO)

The assessment objectives listed below reflect those parts of the syllabus competences that will be assessed in the examination.

AO1 Knowledge with understanding

Candidates should be able to demonstrate knowledge and understanding of:

- Scientific phenomena, facts, laws, definitions, concepts and theories
- Scientific vocabulary, terminology and conventions (including symbols, quantities and units)
- Scientific instruments and apparatus used in physics, including techniques of operation and aspects of safety
- Scientific quantities and their determination
- Scientific and technological applications, with their social, economic and environmental implications. The subject content defines the factual knowledge that candidates may be required to recall and explain.

Questions testing these assessment objectives will often begin with one of the following words: define, state, name, describe, explain (using your knowledge and understanding) or outline.

AO2 Handling information and solving problems

Candidates should be able to handle information and solve problems, using, written, symbolic, graphical and numerical forms of presentation, to:

- locate, select, organise and present information from a variety of sources
- translate information from one form to another
- manipulate numerical and other data
- use information to identify patterns, report trends and draw conclusions
- give reasoned explanations for phenomena, patterns and relationships
- make predictions and hypotheses.
- apply knowledge, including principles, to new situations
- demonstrate an awareness of the limitations of physics theories and models.
- solve problems.

These assessment objectives cannot be precisely specified in the syllabus content because questions testing such skills may be based on information which is unfamiliar to the candidate. In answering such questions, candidates are required to use principles and concepts that are within the syllabus and apply them in a logical, reasoned or deductive manner to a new situation.

Questions testing these assessment objectives will often begin with one of the following words: discuss, predict, suggest, calculate, and explain (give reasoned explanations and explain the processes of using information and solving problems) or determine (see syllabus glossary of command words).

AO3 Experimental skills and investigations

Candidates should be able to:

- Observe, give feedback, plan experiments and investigations
- Collect, record and present observations, measurements and estimates
- Analyse and interpret data to reach conclusions.
- Evaluate methods and quality of data and suggest possible improvements.
- Use ICT in solving problems

2.6. Reporting to parents

The wider range of learning in the new curriculum means that it is necessary to think again about how to share a learners' progress with their parents. A single mark is not sufficient to convey the different expectations of learning that are outlined in the learning objectives. The most helpful reporting is to share what students are doing well and where they need to improve.

2.7. Resources

2.7.1. Material resources

Teaching and learning of Physics entails practical activities for better conceptualization of concepts and facts. The successful implementation of this curriculum requires Physics laboratories, textbooks, charts, ICT tools like computers and projectors.

However, there are some Physics concepts that cannot be easily explained and some experiments that cannot be done in our school laboratories due to safety reasons. Thus the use of ICT in teaching and learning is vital. With ICT these concepts can be concretized by use of animations and simulations. Similarly, both teachers and learners are encouraged to use internet for research as well as other ICT tools for teaching and learning purposes.

2.7.2. Human resource

The effective implementation of this curriculum needs a joint collaboration of educators at all levels. Given the material requirements, teachers are expected to accomplish their noble role as stated above. On the other hand, school head teachers and directors of studies are required to make a follow-up and assess the teaching and learning of this subject due to their profiles in the schools. These combined efforts will ensure bright future careers and lives for learners as well as the contemporary development of the country.

The following are some of the skills required for the Physics teacher:

- Engage students in variety of learning activities
- Use multiple teaching and assessment methods
- Effective discipline skills
- Guide and counselor
- Adjust instructions to the level of the learner
- Should have high level of knowledge of the content

- Good classroom management skills
- Makes connections/relations with other subjects
- Good communicator
- Creativity and innovation
- Passion for children teaching and learning

3. SYLLABUS UNITS

3.1. Presentation of the Structure of the syllabus units

PHYSICS subject is taught and learned in lower secondary education as a core subject, i.e. in S1, S2 and S3 respectively. At every grade, the syllabus is structured in Topic Areas, sub-topic Areas where applicable and then further broken down into Units. The units have the following elements:

1. Unit is aligned with the Number of Lessons.
2. Each Unit has a Key Unit Competence whose achievement is pursued by all teaching and learning activities undertaken by both the teacher and the learners.
3. Each Unit Key Competence is broken into three types of Learning Objectives as follows:
   a) Type I: Learning Objectives relating to Knowledge and Understanding (*Type I* Learning Objectives are also known as Lower Order Thinking Skills or LOTS)
   b) *Type II* and *Type III*: These Learning Objectives relate to acquisition of skills, Attitudes and Values (*Type II* and *Type III* Learning Objectives are also known as Higher Order Thinking Skills or HOTS) – These Learning Objectives are actually considered to be the ones targeted by the present reviewed curriculum.
4. Each Unit has a Content which indicates the scope of coverage of what a teacher should teach, and learner should learn in line with stated learning objectives
5. Each Unit suggests Learning Activities that are expected to engage learners in an interactive learning process as much as possible (learner-centered and participatory approach).
6. Finally, each Unit is linked to Other Subjects, its Assessment Criteria and the Materials (or Resources) that are expected to be used in teaching and learning process.

3.2. Physics subject for senior Four

3.2.1. Key competences at the end of senior four

- Explain the properties of lenses and image formation by lenses.
- Describe and use optical instruments.
- Analyze the principle of moments and equilibrium of bodies.
- Evaluate the relation between Work, Energy and Power.
- Analyse complex electric circuits using Kirchhoff's laws.
- Evaluate energy sources in the world.
- Analyse and solve problems related to projectile and circular motion.
- Explain the gravitational field, gravitational potential and their applications in planetary motion.
- Analyse the electric field and electric potential.
- Evaluate the applications of first and second laws of thermodynamics in real life.

3.2.2. Senior Four Units

TOPIC AREA: LIGHT				
S4 Physics	**Unit 1: Thin Lenses**			**Number of periods: 24**
Key unit Competence: Explain the properties of lenses and image formation by lenses.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Explain physical features of thin lenses. – State types of lenses. – Explain properties of lenses. – Differentiate between lenses and curved mirrors. – Explain phenomena of refraction of light by lenses. – Explain the image construction principle of lenses – Explain and illustrate rays applied in locating images formed by lenses. – Explain defects of lenses and their corrections	– Apply knowledge of the lens equation and sign conventions to locate images. – State characteristics of images formed for different objects positions. – Carry out experiments to locate position of image formed by lens for given object position. – Differentiate focal length of convex and concave lenses. – Derive lens equation from first principle.	– Appreciate the applications of lenses. – Recognize the focusing power of converging lenses and its applications. – Enjoy using lenses equipment during experiments. – Show the understanding of the terms real and virtual images.	– Characteristics of lenses. – Types of lenses: converging (double convex, plan convex, convex meniscus) and diverging (double concave, plano-concave, concave meniscus). – Refraction of light through lenses. – Ray drawing and properties of images formed by lenses for an object located at different positions. – Graphical determination of focal length of lenses. – Thin lens equation, power of lens, magnification and sign convention. – Lens combination and effective focal length. – Derivation of lenses formula – Defects and correction of Lenses.	– Working in groups, differentiate lenses and report. – Carry out experiment to determine characteristics of images formed by lenses, given object positions. – Establish experimentally the laws of refraction. – Determine experimentally the critical angle of a glass block and prism – Devise and perform experiment to determine the focal length of a lens.

– Explain situations in which light is refracted	– Determine the refractive index of a medium. – Observe and describe the shape of a prism. – Determine the refractive index of a prism. – Analyse the behaviour of light using a prism. – Locate experimentally image positions, given object distance from lens		– Applications of combined lenses. – Refraction through prisms. – Terms associated with refraction of light passing through a prism. – Deviation of light rays by a glass prism. – Angle of minimum deviation and the determination of refractive index of a prism. – Dispersion of light by a prism. – Applications of total internal reflection of light by prism. – Problem solving related to combined thin lenses and refraction of light.	– Solve problems involving image position and linear magnification using lens formulae. – Search using internet for details on properties of lenses, image formation and lens combinations.
Links to other subjects: *Medicine- Biology (Microscope), Astronomy, Photography (camera)*				
Assessment criteria: *Learner can clearly explain the properties of lenses and the image characteristics for objects located at different positions and can analyse situations in which light is refracted.*				
Materials: *Concave and Convex lenses, prism, glass block, lasers, candles, optical bench, screen microscope.*				

TOPIC AREA: LIGHT		SUB-TOPIC AREA: OPTICS		
S4 Physics		**Unit 2: Optical instruments.**		**Number of periods: 20**
Key unit Competence: Describe and use optical instruments.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Identify the physical features of simple and compound microscope. – Explain the applications of simple and compound microscope. – Differentiate between simple microscope and compound microscope. – Explain operation of other optical instruments.	– Describe image formation in optical instruments. – Construct diagrams of simple and compound microscope. – Carry out an investigation on how optical instruments form images. – Design compound microscope.	– Appreciate applications of simple and compound microscope. – Appreciate the importance of simple and compound optical instruments in everyday life – Appreciate the magnifying power of simple and compound microscopes. – Recognize the functions of simple and compound microscope. – Appreciate the focusing power of optical instruments. – Appreciate the working mechanism of optical instruments (microscope, telescope and camera). – Enjoy using optical instruments.	– Definition of an optical instrument. – Image formation by a camera, simple and compound microscope. – Magnifying power of optical instruments. – Determination of magnifying power of optical instruments. – Astronomical telescope. – Human eye as single lens system, – Defects of vision and their correction.	– Discuss in groups physical features of optical instruments. – Determine the magnifying power of optical instruments. – Make a group presentation on the functioning of simple and compound microscope and other optical instruments and write a report. – Devise a project to design a compound microscope. – Search on internet for details on combinations of lenses.
Links to other subjects: *In Astronomy (Telescopes observe distant), Biology and Medicine (microscope used observe tinny organism).*				
Assessment criteria: *Learner can clearly explain the properties and image formation of commonly used optical instruments.*				
Materials: *Converging lens, diverging lens, Microscope, Camera, simple telescopes, and binoculars.*				

TOPIC AREA: MECHANICS				
S4 Physics		**Unit 3: Moments and Equilibrium of bodies.**		**Number of periods: 22**
Key unit Competence: Analyze the principle of moments and equilibrium of bodies.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Recall forces, vectors and stability. – State the principle of moments about a point. – Explain forces in equilibrium. – Explain couples and torques – Explain equilibrium of connected systems. – State Stevinus proof.	– Distinguish a vector and a scalar quantity. – Analyze the forces that keep a body in equilibrium. – Manipulate the resultant force as a vector sum. – Analyse free body diagrams. – Analyse diagrams of coplanar forces. – Locating the centre of gravity of a flat object. – Solve problems involving vectors and scalars. – Solving problems involving moments and equilibrium of bodies.	– Appreciate the importance of vectors and scalars in life. – Recognize the importance of moments life. – Appreciate balancing of forces in life.	– Difference between vector and scalar quantities. – Force as vector. – Moment of a force about a point. – Principles of moment. – Types of equilibrium: stable, unstable and neutral. – Conditions for equilibrium of a body about an axis. – Stevinus proof. – Forces in equilibrium. – Free –body diagrams. – Couples and Torques. – Equilibrium of Coplanar forces. – Archimedes and the principle of the lever. – Equilibrium of moments of force. – Centre of gravity and the total weight – Centre of gravity of a flat object – Equilibrium of a system of objects (balancing on a seesaw).	– Discuss the difference between vector and scalar quantities. – Devise an experiment to determine the centre of gravity of a lamina. – Carry out an experiment to demonstrate equilibrium of a system of objects. – Search on internet to learn about moments of force and equilibrium of a system of bodies.
Links to other subjects: *Mathematics (resolution of vectors)*				
Assessment criteria: *learner can explain the principle of moment and apply it the equilibrium of a body.*				
Materials: *Meter ruler, knife edges, and standard masses, see saw*				

TOPIC AREA: MECHANICS				
S4 Physics		**Unit 4: Work, Energy and Power.**		**Number of periods: 20**
Key unit Competence: Evaluate the relation between work, energy and power and the resulting phenomena.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Recall the concept of mass and energy. – Recall the difference between energy and power. – State the formulae of work, Energy and Power. – Explain how power depends on energy. – Explain gravitational potential energy. – Identify the difference between Potential energy and Kinetic energy. – State conservation of mechanical energy.	– Evaluate quantitatively work, energy and power. – Derive the formulae of work, energy, and power. – Derive the equations of potential and kinetic energy. – Carry out an investigation on how power is measured. – Observe the effect caused by force on a body at rest. – Describe strain energy and work done in deforming materials. – Describe elastic and inelastic collisions and their types. – Identify conservation of linear momentum.	– Appreciate the conservation of energy in the universe. – Recognize the importance of energy in terms of magnitude of power developed. – Realize the danger of fast moving bodies.	– Concepts of Work, Energy and Power. – Mathematical expression of potential energy, kinetic energy, work, and power. – Conservation of mechanical energy. – Work energy theorem. – Gravitational potential energy. – Work done in deforming materials. – Strain energy. – Collision and impulse. – Conservation of linear momentum. – Solve problems related to energy conservation.	– Discuss in group the relationship between work, energy and power. – Observe the impact of collision between two moving bodies then report. – Solve problems involving work, energy, power and conservation of mechanical energy. – Solve problems on collisions. – Make a group presentation on mechanical energy and report.
Links to other subjects: *Chemistry, Astronomy, Civil engineering and Military science.*				
Assessment criteria: *learner can evaluate the relation between work, energy and power.*				
Materials: *Simple pendulum, Two blocks one on a fixed spring, two trolleys or (two round objects).*				

TOPIC AREA: ELECTRICITY	SUB-TOPIC AREA: CURRENT ELECTRICITY	
S4 Physics	**Unit 5: Kirchhoff's laws and Electric Circuits**	**Number of periods: 22**

Key unit Competence: Analyse the complex electric circuits using Kirchhoff's laws

Learning Objectives			Content	Learning Activities
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Recall sources of electric current, emf electric and receptors/ appliances. – Describe components of simple electric circuit. – State Kirchhoff's laws.	– Explain the difference between potential difference and electromotive force. – Apply Kirchhoff's laws to problems in electric circuits. – Acquire practical skills such as how to manipulate apparatus and equipment, carry out given procedures, and present data, draw conclusions and evaluate experimental procedures. – Differentiate between resistance and resistor. – Evaluate advantages and disadvantages of series and parallel arrangement of current source(battery) and resistors. – Solve problem using Kirchhoff's Laws.	– Value correct connection of electric components in a circuit when measuring current. – Develop positive values and attitudes such as curiosity, honesty, and respect for evidence, perseverance and tolerance of uncertainty through the study of electric current. – Enjoy connecting resistors in series and parallel and determining the effective resistance. – Enjoy resolving simple circuits using Kirchhoff's laws.	– Review elements of simple electric circuit and state their applications. – Definition of electromotive force. – Voltage or terminal potential and electromotive force. – Sources of electric current and electric receptors/appliances. – Internal and external resistance and potential difference across a cell. – Connection of electrical current source and resistors either in series or parallel or mix-up. – Kirchhoff's laws (loop rule and junction rule) – Application of Kirchhoff's laws to simple circuits.	– Use a voltmeter to measure terminal potential difference and compare it with electromotive force. – Construct a simple electric circuit consisting of current source (battery), electric receptors (resistors) and use it to verify Kirchhoff laws. – Observe electrical components at home and school and explain their use. – Search on internet to learn about sources of electric current, electric receptors (resistors) and Kirchhoff 'laws.

Links to other subjects: *Electrochemistry (electrolysis) in Chemistry.*

Assessment criteria: *Learner can easily apply Kirchhoff' laws to analyse complex electrical circuits.*

Materials: *Ammeter, voltmeter, ohmmeter, Rheostat, conductors and resistors, batteries, multimeter, connecting wires.*

TOPIC AREA: ENERGY, POWER AND CLIMATE CHANGE	SUB-TOPIC AREA: SOURCES OF WORLD ENERGY	
S4 Physics	**Unit 6: Sources of Energy in the world**	**Number of periods: 18**

Key unit Competence: Evaluate the energy sources in the world

Learning Objectives			Content	Learning Activities
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Recall application of energy. – Outline the basic features of renewable and non-renewable energy sources – State relative proportions of world energy sources available for use. – Explain the relative advantages and disadvantages of various energy sources.	– Identify sources of energy in Rwanda. – Explain extraction and creation of energy (Renewable and non-renewable energy). – Evaluate energy uses and availability in the world. – Analyse the relative advantages and disadvantages of various energy sources. – Acquire knowledge in analysing and modelling physical processes related to energy consumption.	– Recognize and avoid energy sources associated with higher carbon dioxide emission. – Appreciate that the sun is the prime energy source of world energy. – Appreciate the relationship between industrial development and higher energy consumption. – Be aware of the moral and ethical issues associated with nuclear energy. – Recognize the value of adapting scientific method in reporting uses of world energy sources.	– World energy sources (fossil fuel, nuclear fuel and renewable sources). – Extraction and creation of renewable and non- renewable energy sources (Fossil and non-fossil fuels, power production). – Solar energy (photovoltaic cells and solar heating panels). – Hydroelectric power, wind power and wave power.	– Discuss in groups and present on extraction and creation of renewable and non-renewable energy sources. – Visit power generation plants and report. – Search on internet for details on world energy resources, extraction and conservation clean energy resources and level of emission of harmful gases

Links to other subjects: *Graphical representation in mathematics, photographic interpretation in Geography , compound formation in chemistry, Environment and Agriculture.*

Assessment criteria: *Learner can effectively evaluate the extraction and creation of renewable and non-renewable energy in the world.*

Materials: *Environment, Simulation on energy sources, Scientific reports.*

TOPIC AREA: MECHANICS		SUB-TOPIC AREA: DYNAMICS		
S4 Physics		**Unit 7: Projectile and Uniform Circular motion**		**Number of periods: 22**
Key unit Competence: Analyse and solve problems related to projectile and circular motion.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Define and explain terms used in projectile and circular motion. – Give examples of projectile motion and circular motion. – Discuss different applications of projectile and circular motion.	– Relate projectile motion to linear. – Illustrate examples of projectile motion. – Resolve projectile motion in horizontally and vertically components. – Derive equations of projectile motion. – Determine the maximum height and horizontal range in projectile motion. – Relate linear and angular motion. – Derive equations of circular motion. – Apply concepts of projectile, circular motion to different real life.	– Appreciate applications of projectile and circular motion. – Appreciate the effect of the angle of projection in projectile motion. – Appreciate centripetal force acts to towards the centre of circular motion. – Show concern of the effects of gravity on body projected at an angle to the horizontal.	– Definition of projectile motion and related terms. – Applications of projectile motion. – Graphs of projectile motion. – Expressions of projectile motion (horizontal range and maximum height) – Definition of key terms in circular motion: angular displacement, linear and angular velocity, period, frequency, angular and linear acceleration. – Relationship between angular and linear parameters. – Uniform circular motion. – Constant acceleration in circular motion, tangential acceleration.	– Observe, discuss and report on parameters in projectile motion. – Use the equations of linear motion to determine the horizontal and vertical velocities of a projectile – Working in groups, observe circular motion and distinguish between linear and angular quantities. – Discuss in groups and make presentation on relationship between angular and linear motion – Work in groups to solve problems in circular motion. – Search on internet the information on projectile or circular motion and their applications.

	– Solve problems involving projectile and circular motion.		– Distance time graph of circular motion. – Centripetal force. – Applications of circular motion. (Vertical and horizontal circles, conical pendulum, spinning drier and road banking)	
Links to other subjects: *Physical sports (basketball, football, netball, golf, darts), Military missiles and cannon balls,*				
Assessment criteria: *Learner can effectively relate, analyse and solve problems related to linear, projectile and circular motion.*				
Materials: *ball, Conical pendulum (bob, thread and fixed point), road banking, whirling water in bucket,*				

TOPIC AREA: MECHANICS		SUB-TOPIC AREA: DYNAMICS		
S4 Physics		**Unit 8: Universal gravitational field and potential**		**Number of periods: 20**
Key unit Competence: Explain the gravitational field, gravitational potential and their applications in planetary motion				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Explain universal gravitation field. – State the universal gravitational law. – Describe the factors affecting force of gravity. – Differentiate between universal gravitational constant and force of gravity. – State and explain Kepler's laws of planetary motion	– Discuss universal gravitational law. – Derive Kepler's laws of planetary motion. – Investigate planetary motion using computer simulation. – Observe and identify problems that require hypothesis formulation and lead investigation of the universe. – Apply Kepler's laws to natural and artificial satellites.	– Appreciate application of universal gravitation laws and Kepler's laws to planetary motion – Develop positive attitude of curiosity, honest, respect for evidence, perseverance and tolerance of uncertainty throughout the study of gravitational field potential. – Recognize the force acting between two bodies. – Enjoy solving problems on satellite motion around earth.	– Newton's law of universal gravitation. – Gravitational field – Universal gravitational field potential. – Gravitational potential energy. – Relation between universal gravitational constant and force of gravity – Kepler's laws. – Problems on gravitational potential. – Problems on natural and artificial satellites.	– Solve problems involving the Law of universal gravitation. – Solve problems – involving Kepler's laws. – Use internet search for history of scientists who contributed to model the universe and make report. – Use internet to get information about Kepler's law
Links to other subjects: *Geography and Astronomy (landslides, motion of planets and satellites) Chemistry (electrons orbiting the nucleus)*				
Assessment criteria: *Learner can clearly explain the effects of gravitational field potential on the stability of the universe*				
Materials: *Telescope, solid object, Earth globe.*				

TOPIC AREA: MOTION IN FIELDS		SUB-TOPIC AREA: ELECTRIC FIELD AND ELECTRIC POTENTIAL		
S4 Physics		**Unit 9: Electric field and electric potential**		**Number of periods: 24**
Key unit Competence: Analyse the electric field and electric potential				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Recall electric circuit and potential. – Describe the characteristics of electric field. – State the principle of superposition. – Define electric field and electric potential. – Explain the relationship between the electric potential and the electric field.	– Apply the flux of an electric field on a surface and deduce Gauss's theorem. – Describe the strength of electric field. – Establish relation between electrostatic field and potential difference. – Observe and inquire, about effects of electric problems formulate hypothesis to it. – Describe functioning of lightening arrestors. – Solve and analyse electric field and electric potential for uniform field.	– Appreciate the importance of lightning conductor in life. – Be aware of the dangers which can be caused by lightning and measures to avoid them.	– Electric charge and Coulomb's law. – Charge and electric fields. – Properties of electric field. – Electric field patterns and field lines. – Electric field due to a single electric charge. – Electric field pattern due to more than one charge (resultant electric field). – Electric potential. – The potential of a point charge. – Electric Potential Energy. – Relation between electric potential and electric field E= –V/d. – Motion of electric charge in uniform electric field. – Lightening and lightening arrestor. – Problems on uniform electric field and electric potential.	– Devise and perform an experiment to illustrate electric fields between two parallel plates. – Solve problems involving electric field strength and electric potential. – Investigate the patterns of electric field lines and present them in diagrams. – Search on internet for electric field patterns and their combination.
Links to other subjects: *Chemistry (electrolysis, dye cells), Geography (formation of clouds and lightening)*				
Assessment criteria: *Learner can correctly describe the combination of electric fields and solve problems related to fields.*				
Materials: *plastic rods, glass rode, electroscope, metal plate and battery.*				

TOPIC AREA: HEAT AND THERMODYNAMICS		SUB-TOPIC AREA: THERMAL EFFECTS		
S4 Physics		**Unit10: Applications of thermodynamics Laws**		**Number of periods: 24**
Key unit Competence: Evaluate the applications of first and second laws of thermodynamics in real life				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Differentiate internal energy and total energy of a system. – Explain the work done by expanding gas. – State the first law of thermodynamics. – State the second law of thermodynamics. – Explain thermodynamic processes in heat engines.	– Apply laws of thermodynamics to isothermal, isochoric and isobaric and adiabatic processes. – Apply law of thermodynamics to explain the principle of a Carnot engine, diesel engine and refrigerator. – Determine and evaluate the efficiency of heat engines. – Solve problems related to Carnot cycle, Carnot and diesel engine, refrigerators. – Analyse efficiency of heat engines. – Discuss impact of heat engine on climate.	– Appreciate applications of heat engines in human development. – Acquire knowledge of analysing and optimizing efficiency of heat engine. – Acquire capacity to work with heat engines and reduce their effect on climate change.	– Internal energy and total energy. – Work done by an expanding gas. – First law of thermodynamics. – Applications of first law: Isothermal, Isochoric and isobaric processes etc. – Second law of thermodynamics: Adiabatic process, Carnot cycle. – Applications of second law of thermodynamics: Carnot engine, diesel engine and refrigerator. – Efficiency of heat engine. – Heat engine and climate change.	– Work in groups to differentiate first and second laws of thermodynamics. – Work in groups to investigate changes in energy and work done for a thermodynamic process and present findings. – Work in groups to evaluate the change in energy and work done during the Carnot cycle and report. – Solve problems related to the efficiency of a refrigerators. – Work in groups to solve problems related to the heat engine and its efficiency. – Search on internet for the new applications of laws of thermodynamics and present.
Links to other subjects: *chemistry (reactions).*				
Assessment criteria: *Learner can correctly explain applications of laws of thermodynamics and estimate the efficiency of heat engines.*				
Materials: *fridge, motorcycle, or water pump.*				

3.3. Senior Five

3.3.1. Key Competences for senior five

- Evaluate the wave and particle nature of light.
- Analyze energy changes in Simple harmonic motion.
- Analyze the effect of forced oscillations and resonance on systems.
- Evaluate the propagation of mechanical waves.
- Analyze the interference of light waves.
- Construct and analyze Complex electrical circuits.
- Analyze electric field potential and gravitational potential.
- Evaluate Newton's law of gravitation and apply Kepler's laws of planetary motion.
- Evaluate atomic model and photoelectric effect.
- Differentiate analog from digital signals.
- Distinguish mobile phone and Radio system of communication.
- Analyze the relativity concepts and postulates of special relativity.

3.3.2. Senior Five Units

<table>
<tr><th colspan="4">TOPIC AREA: LIGHT</th></tr>
<tr><th colspan="2">S5 Physics</th><th>Unit 1: Wave and Particle nature of light</th><th>Number of periods: 21</th></tr>
<tr><td colspan="4">Key unit Competence: Evaluate the wave and particle nature of light</td></tr>
<tr><th colspan="3">Learning Objectives</th><th rowspan="2">Content</th><th rowspan="2">Learning Activities</th></tr>
<tr><th>Knowledge and understanding</th><th>Skills</th><th>Attitudes and values</th></tr>
<tr><td>– State Planck's quantum theory.
– Explain the photon theory of light and photoelectric effect.
– Explain the relationship between energy, mass and momentum of photon.</td><td>– Explain the wave theory of light and state its limitations.
– Describe phenomena of black-body radiation.
– Evaluate properties of light as a wave.
– Describe photon interactions and the wave nature of matter.
– Investigate the theory of wave-particle duality.
– Differentiate electron microscope and Compton Effect as applied in medicine.</td><td>– Appreciate the importance of light waves in life.
– Realize applications of photoelectric effects in science domains.
– Recognize the value of analyzing light energy.</td><td>– Planck's quantum theory.
– Photon theory of light and the photoelectric effect.
– Wave theory of (monochromatic light).
– Properties of a light wave.
– Black-body radiation.
– Measurement of Plank's constant.
– Application of photoelectric effect.
– Energy, mass and momentum of a photon
– Compton effect (X-rays).
– Photon interactions.
– Wave-particle duality.
– The principle of complementarity.
– The wave nature of matter.
– Electron microscope.</td><td>– Make group presentation on
– Planck's quantum Theory (hypothesis).
– Discuss in groups and make presentations about black and white body radiation.
– Solving problems on light energy and photon theory.
– Perform an experiment on photoelectric effect and report.</td></tr>
<tr><td colspan="5">Links to other subjects: Radiography and physiotherapy in Medicine, electrons and photons in Chemistry, Astronomy in geography.</td></tr>
<tr><td colspan="5">Assessment criteria: Learner can describe nature of light as photons or wave.</td></tr>
<tr><td colspan="5">Materials: Light source, Evacuated glass tube, small metal plate (photocell), Battery, Ammeter, Black and white bodies and electronic microscope.</td></tr>
</table>

TOPIC AREA: OSCILLATIONS AND WAVES	SUB-TOPIC AREA: ENERGY CHANGES IN SIMPLE HARMONIC MOTION	
S5 Physics	**Unit 2: Simple harmonic motion.**	**Number of periods: 20**

Key unit Competence: Analyze the energy changes in simple harmonic motion.

Learning Objectives			Content	Learning Activities
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Explain kinematics of simple harmonic motion – Describe examples of simple harmonic oscillators. – Explain the equations of simple harmonic motion. – Explain energy change and conservation in oscillating systems. – Explain superposition of harmonic motions of same frequency.	– Describe kinematics of simple harmonic motion – Analyse examples of simple harmonic motion oscillators. – Derive equations of simple harmonic motion. – Analyse energy changes and conservation in oscillating systems. – Analyse superposition of harmonic motions of frequency.	– Appreciate the importance of simple harmonic motion in life. – Acquire scientific reasoning and attitude for interpreting simple harmonic motion. – Acquire aptitude to pursue simple harmonic motion situations logically and systematically – Adapt scientific method of thinking applicable in all areas of life. – Acquire knowledge for analysing and modelling physical processes. – Enjoy observing bodies undergoing simple harmonic motion	– Kinematics of simple harmonic motion – Simple harmonic oscillators. – Equations of simple harmonic motion. – Energy changes and conservation in oscillating systems. – Superposition of harmonic motion with same frequency.	– Discuss in groups kinematics and simple harmonic motion and report. – Discuss examples of simple harmonic oscillators. – Working in groups solve simple harmonic motion problems. – Derive expressions of energy exchanges and conservation in oscillating systems. – Devise experiment to illustrate superposition of harmonic motions of same frequency.

Links to other subjects: *Physical sports*

Assessment criteria: *Learner can describe and analyse simple harmonic oscillators apply simple harmonic motion equations.*

Materials: *String, bob, fixed point, springs and masses etc.*

TOPIC AREA: OSCILLATIONS AND WAVES		SUB-TOPIC AREA: FORCED OSCILLATIONS AND RESONANCE		
S5 Physics		**Unit 3: Forced oscillations and resonance of a system.**		**Number of periods: 17**
Key unit Competence: Analyze the effects of forced oscillations and resonance on systems.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Define damped oscillation. – Outline types of damped oscillations. – Explain examples of damped oscillators. – Explain natural vibration and forced oscillation. – Describe resonance and give examples.	– Perform experiments to demonstrate damping of oscillating systems. – Analyse damped oscillators. – Analyse natural vibration and forced oscillation – Analyse – graphically forced oscillations. – Describe graphically the variation of forced oscillations. – Describe resonance and give examples. – Describe applications of resonance.	– Appreciate applications of damped oscillators in life. – Acquire scientific attitudes for interpreting the resonance. – Acquire ability to systematically analysis cases of simple harmonic motion. – Acquire knowledge for analysing and modelling physical processes.	– Damped oscillations. – Types of damped oscillations. – Natural frequency of a vibration and forced oscillation. – Variation of forced frequency on graph at amplitude close to natural frequency of vibration. – Examples of resonance. – Effect of resonance on a system.	– Perform an experiment to demonstrate damping of oscillating systems. – Suggest examples of damped oscillators. – Working in groups to discuss natural vibration and forced oscillations – Graphically illustrate forced oscillations. – Perform an experiment on resonance and suggest more examples on it. – Use computer simulation to analyse forced oscillations and resonance in systems.
Links to other subjects: *Beats in music, electrons.*				
Assessment criteria: *Learner can graphically illustrate natural and forced oscillations and solve related to simple harmonic motion.*				
Materials: *Simple pendulum (string and bob) masses and springs.*				

TOPIC AREA: OSCILLATIONS AND WAVES	SUB-TOPIC AREA: WAVES	
S5 Physics	**Unit 4: Propagation of mechanical waves.**	**Number of periods: 20**

Key unit Competence: Evaluate the propagation of mechanical waves.

Learning Objectives			Content	Learning Activities
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Explain the wave concept. – Explain the terms amplitude, frequency, displacement, wavelength and wave phase. – Explain the terms transverse and longitudinal waves. – Explain the terms progressive and stationary waves. – Explain phase of vibration. – Explain reflection, refraction, diffraction and interference of waves.	– Describe wave properties and their characteristics. – Classify waves as longitudinal and transverse, mechanical and electromagnetic waves. – Observe and describe nodes and antinodes in stationary waves. – Explain conditions necessary for interference to occur. – Apply the equation of two superimposed progressive waves.	– Appreciate applications of wave interference in life – Recognize importance of resonance in designing musical instruments – Appreciate the sound systems on the studio – Appreciate application of acoustic in a radio studio – Develop positive attitude of curiosity, honest, respect for evidence, perseverance and tolerance while solving wave related problems.	– Wave concept. – Types of waves. – Waves Terms. – Characteristics of waves. – Relationship between wavelength, frequency (Period) and velocity. – Properties of waves (Reflection, refraction, interference, diffraction). – Progressive and stationary waves. – Equation of a progressive wave. – Example of progressive. – Wave on a vibrating string.	– Practical demonstration of wave concept. – Demonstrate longitudinal and transverse waves using rope and slinky spring. – Use ripple tank to demonstrate wave fronts, frequency, crest/trough. – Use a vibrating rope to demonstrate nodes and antinodes. – Use guided discovery on interference of sound wave coherent source and microphone connected to a cathode ray oscilloscope. – Use internet to access information on applications of waves.

Links to other subjects: *Telecommunication and Music.*

Assessment criteria: *Learners can correctly evaluate propagation of waves and their applications.*

Materials: *Ripple tank, microphone, loudspeaker, cathode ray oscilloscope, rope.*

TOPIC AREA: ELECTROMAGNETIC WAVES	SUB-TOPIC AREA: E M WAVES AND INTERFERENCE OF LIGHT WAVES	
S5 Physics	**Unit 5: Interference of light waves.**	**Number of periods: 19**
Key unit Competence: Analyze the interference of light waves.		

Learning Objectives			Content	Learning Activities
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Explain the nature of electromagnetic waves. – Explain regions of the electromagnetic spectrum. – Explain dispersion of EM waves. – Explain dispersion of EM waves in relation to refractive index and wavelength. – Distinguish between transmission, absorption and scattering of radiation. – Identify examples of transmission, absorption and scattering of EM radiation.	– Analyse conditions for interference to occur given two sources. – Explain and describe the principle of superposition – Analyse interference pattern produced by two coherent point sources. – Carry out an investigation on double-slit experiment. – Derive Young's equation for double slit interference. – Draw intensity distribution for fringe pattern.	– Appreciate the importance of light waves in life. – Acquire scientific techniques, reasoning and attitudes in analyzing electromagnetic waves. – Acquire scientific reasoning and attitudes in interpreting the concepts of interference. – Acquire ability to pursue a particular liner of thought logically and systematically. – Acquire knowledge for analysing and modelling physical processes.	– Nature of electromagnetic waves. – Conditions for interference to occur given two sources of light. – Principle of superposition, – Interference patterns of two coherent point sources of light. – Double-slit experiment. – Intensity distribution of fringe pattern. – Problems on double-slit experiment.	– Discuss in groups conditions necessary for interference. – Discuss in groups the principle of superposition and production of interference patterns from two coherent point sources. – Devise and perform double-slit experiment and estimate the wavelength of light. – Solve problems double slit experiment. – Search on internet for information on light interference.

	– Solve problems involving two interfering sources of light.			
Links to other subjects: *Electrons (chemistry).*				
Assessment criteria: *Learner can perform double-slit experiment for light interference, draw the intensity distribution of observed fringe pattern and solve problems double slit experiment.*				
Materials: *Diffracting or Slits, slit holder, screen, source of light and white screen*				

TOPIC AREA: ELECTRICITY		SUB-TOPIC AREA: CURRENT ELECTRICITY		
S5 Physics		**Unit 6: Complex electrical circuit**		**Number of periods: 18**
Key unit Competence: Construct and analyze a complex electrical circuit.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– State and explain Kirchhoff' laws. – Distinguish between simple and complex circuits. – Identify mixture of parallel and series connections in complex circuit. – Explain applications of Kirchhoff 's laws to complex circuits. – Outline measuring instruments for voltage and electrical current. – Explain advantages and disadvantages of potentiometer.	– Carry out investigation on measurement of voltage and electrical current. – Evaluate complex circuits using Kirchhoff's laws. – Analyze the electrical current flowing in a complex circuit. – Design complex electrical circuit. – Perform an experiment using simple potentiometer circuits. – Solve problems involving complex circuit and potentiometer.	– Appreciate application of Kirchhoff 's laws in designing complex circuits. – Enjoy applying Kirchhoff's laws in complex electrical circuits. – Adapt scientific skills in analyzing complex circuits to avoid overloads.	– Kirchhoff 's laws (junction rule and loop rule). – Resistors and electromotive forces in series and parallel complex circuits. – Design of complex electrical circuits. – Simple potentiometer circuits. – Advantages and disadvantages of potentiometer. – Potentiometer and other devices (Ammeter and voltmeter.). – Problems involving complex circuit.	– Perform complex circuit analysis using Kirchhoff's laws. – Discuss in groups applications of Kirchhoff 's laws. – Work in groups and present on steps for analyzing a complex electric circuit. – Experimentally design circuit to illustrate application of simple potentiometer. – Discuss in groups advantages and disadvantages of potentiometer over voltmeter and report. – Solve complex problems on the potentiometer.
Links to other subjects: *Electrons and conductor (chemistry). Radio Volume adjustment Circuits.*				
Assessment criteria: *Learner can accurately design, solve and analysis complex electrical circuits using Kirchhoff's laws.*				
Materials: *Source of voltage, wires, constantan wire, nichrome wire, Ammeter and voltmeter.*				

TOPIC AREA: MOTION IN FIELDS		SUB-TOPIC AREA: ELECTRIC POTENTIAL AND ENERGY		
S5 Physics		**Unit 7: Electric potential and gravitational potential.**		**Number of periods: 17**
Key unit Competence: Analyze electric potential and gravitational potential.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Explain electric potential and electric potential energy. – State the relation between equipotential surface and electric field lines. – Define gravitational potential and gravitational potential energy.	– Derive an expression for electric potential for one or more-point charges. – Describe and sketch field patterns of equipotential surfaces due to one- or two-point charges. – Analyze relation between equipotential surfaces and electric field lines. – Describe and sketch the trajectory of a charge moving in cathode ray tube. – Derive an expression for gravitational potential due to one or more point masses.	– Appreciate underlining assumptions applied in derivation of escape speed. – Appreciate the effects of electric field in a cathode tube of television set and computer monitor.	– Electric potential energy and potential difference. – Electric potential and electric field. – Electric potential due to point charges. – Potential due to electric dipole. – Conservation of electric energy. – Cathode ray tube: (TV, computer monitors and cathode ray oscilloscope). – Electrodynamics. – Gravitational field and gravitational potential. – Energy conservation in electric and gravitational fields.	– In groups, discuss the calculations of potential due to one or more-point charges. – In group discussion, determine potential due to one or more point masses. – In groups, analyze and interpret the path of a charge in cathode ray tube and report – Discuss in groups and present, the difference between electric and gravitational potential. – Using ICT tools to simulate electric and gravitational potential.

	– Derive an expression of escape speed for a planet. – Compare electric and gravitational fields. – Analyze work done in moving a point charge between two points in an electric field independent of the path.		– Solve problems on electric and gravitational fields.	
Links to other subjects: *Electrocardiography (Medicine), ICT.*				
Assessment criteria: *Learner can differentiate between electric field potential and gravitational potential and solve problems related to gravitational field.*				
Materials: *Cathode ray tube, computer monitors and cathode ray oscilloscope.*				

TOPIC AREA: MOTION IN FIELD				
S5 Physics	**Unit 8: Motion in Orbits**			**Number of periods: 20**
Key unit Competence: Evaluate Newton's law of gravitation and apply Kepler's laws of planetary motion				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Explain Newton's law of gravitation – Explain acceleration due to gravity near earth's surface – Explain principles of satellites and rockets – Explain universe and solar system – State and explain Kepler's law of planetary motion.	– Apply Newton's laws of gravitation to explain the universe and solar system. – Apply knowledge of Kepler's laws of planetary motion. – Analyze and explain orbits and period of rotation of planets around the sun. – Evaluate the work done in gravitation fields – Describe the work done in gravitation and explain cosmic velocities – Solve problems related to gravitation, planetary motion and cosmic velocities.	– Appreciate the importance of earth orbital motion to human life – Acquire – knowledge of planetary motion and use it to explain planet motion. – Acquire capacity to observe the universe and identify planets.	– Newton's law of gravitation. – Kepler's laws of planetary motion. – Verification of Kepler's third law of planetary motion. – Verification of acceleration due to the gravity at the surface of the Earth. – Variation of gravity above and below the earth surface. – Satellites and Rockets. – Satellites and their applications. – Work done in planetary motion. – Cosmic velocity (first, second and third). – Problems on motion in orbits.	– Use simulators to – demonstrate Kepler's laws of planetary motion and present – In groups, – discuss Kepler's laws of planetary motion and present summary. – Discuss in groups cosmic velocities and present findings. – Work in groups to compute problems related to planetary motion and cosmic velocities. – Search on internet for details on planetary motion.

	– Relate the orbital motion of the earth to seasons and other phenomena such as eclipse.			
Links to other subjects: *Electron motion (Chemistry) and solar system (Geography).*				
Assessment criteria: *Learner can correctly explain Newton's law of gravitation and apply Kepler's laws of planetary motion in solving problems.*				
Materials: *Simulator software GPS (Geographic positioning system).*				

TOPIC AREA: ATOMIC PHYSICS		SUB-TOPIC AREA: QUANTUM PHYSICS		
S5 Physics		**Unit 9: Atomic models and photoelectric effect.**		**Number of periods: 22**
Key unit Competence: Evaluate the atomic model and photoelectric effect				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Recall duality nature of light. – Explain the structure of the atom. – Explain atomic radiation spectra. – Explain evidence of energy levels in atom. – Identify factors influencing thermionic emission. – Explain how C.R.O and T.V. tubes function. – Explain the photoelectric effect. – Explain factors affecting photoelectric emission.	– Evaluate excitation and ionization of an atom. – Analyse electric current production when sun radiation shines a metal surface. – Investigate electron deflection in electric and magnetic fields in cathode tubes. – Distinguish fluorescent and phosphorescent materials. – Evaluate applications of photoelectric effect. – Explain why Compton effect fails when light is considered as a wave.	– Appreciate the difference between fluorescent and phosphorescent materials. – Appreciate the use of solar and photocells in real life. – Appreciate the use of cathode ray tube in television to display images. – Recognize the types of rays using cathode ray oscilloscope (C.R.O). – Appreciate the importance of emitted rays (α-rays, β-rays, γ- rays and X-rays) in daily life.	– Structure of atom. – Atomic models (Rutherford's atomic model and Bohr's atomic model). – Energy levels and spectral lines. – Thermionic emission (thermo electronic emission). – Applications of cathode rays (oscilloscope and TV tubes) – Photoelectric emission laws. – Photoelectric effect – Factors affecting photoelectric emission – Photon, work function and Plank constant – Einstein's equations for photoelectric effect.	– Use simulators to demonstrate emission of spectra lines from various materials. – In groups discuss Rutherford and Bohr atom models (enumerate similarities and differences). – Discuss thermo electronic emission phenomenon in TV tubes. – Establish mathematically the deflection of an electron in an electric field. – Describe photoelectric emission experiments. – Establish the Compton wavelength using the laws of conservation of linear momentum and energy.

– Explain functioning of photo cells (photo emissive and photovoltaic cells).			– Applications of photoelectric effect. – Compton effect.	– Search on internet for applications of photoelectric emission.
Links to other subjects: *Chemistry (Atomic structure) Security (Alarm systems), Medicine, Archaeology.*				
Assessment criteria: *Learner can describe the structure of an atom and give evidence of particle nature of light correctly.*				
Materials: *Cathode ray oscilloscope, internet or other CD video, light source.*				

TOPIC AREA: DIGITAL TECHNOLOGY		SUB-TOPIC AREA: ANALOG AND DIGITAL SIGNALS		
S5 Physics		**Unit 10: Analog and digital signals.**		**Number of periods: 15**
Key unit Competence: Differentiate analog from digital signals.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Explain types of information used in communication. – Differentiates digital and analog system of communication. – Identify and explain simplex, duplex and multiplex in communication. – State advantages of digital system over analog system. – State laws of digital numbers and their representation.	– Explain terms used in communication systems. – Analyse analog and digital systems. – Evaluate the advantages and disadvantages of digital and analog systems. – Distinguish simplex from duplex communication systems. – Judge which system best to use. – Solve problems involving digital numbers.	– Appreciate advantages of digital over analog system. – Enjoy converting natural numbers to digital system.	– Types of information and requirements. – Simplex, duplex and multiplex communications. – Frequency and bandwidth. – Analog signal system. – Principle of digital signal systems – Advantages of digital technology. – Examples of messages.	– Work in groups and discuss about analog and digital system of communication. – Role play advantages of digital system and compare with analog system. – Work in groups to analyse logic gates (AND, NAND, OR, NOR, NOT…) and report.
Links to other subjects: *blood circulation, transport, transmission of information Computer (number representation)*				
Assessment criteria: *Learner can effectively differentiate analog and digital signals.*				
Materials: *Logic gates, electronic circuits.*				

TOPIC AREA: DIGITAL TECHNOLOGY		SUB-TOPIC AREA: ANALOG AND DIGITAL SIGNALS		
S5 Physics		**Unit 11: Mobile phone and radio communication.**		**Number of periods: 12**
Key unit Competence: Distinguish mobile phone system from radio system of communication.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Recall the concepts of transmission systems. – Differentiate telephone and radio transmission. – Identify and explain modulations used in communication.	– Explain exactly the simple cellular radio principles. – Differentiate terms AM, FM and PM radio transmission operations.	– Appreciate roles of telephone and radio transmission systems. – Appreciate types of modulations (AM, FM, and PM) applied in communication systems.	– Concepts of transmission system. – Principle of cellular radio – Structure of cellular network. – Principle of cellular network. – Mobile communication systems. – Radio transmission (AM, FM, PM). – Post, telegraph and telephone (PTT).	– Discuss the difference in telephone and radio systems. – Role play in groups about types of modulation. – Work in groups and assemble simple cellular radio.
Links to other subjects: *blood circulation (Biology and Medicine), transport networks, transmission of information...*				
Assessment criteria: *Learner can distinguish mobile phones and radio systems of communication*				
Materials: *Electric wires, microphone, mobile phone, loudspeaker.*				

TOPIC AREA: RELATIVITY AND PARTICLE PHYSICS		SUB-TOPIC AREA: CONCEPTS AND POSTULATES OF SPECIAL RELATIVITY	
S5 Physics		**Unit 12: Relativity concepts and postulates of special relativity**	**Number of periods: 15**
Key unit Competence: Analyse the relativity concepts and postulates of special relativity.			
Learning Objectives			**Content** / **Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**	
– Explain space, time, mass and frame of reference. – Explain the two postulates of special theory of relativity. – State two postulates of the special theory of relativity.	– Relate space, time, and mass. – Analyse Galilean equation of transformation. – Interpret postulates of special theory of relativity. – Describe the concept of simultaneity. – Create simulations to demonstrate postulates of special relativity.	– Appreciate the significance of frame of reference in life. – Acquire scientific technique and, reasoning to analyzing theories and equations. – Acquire scientific reasoning and attitudes for interpreting simultaneity. – Problems on relative velocity and Galilean Equations of transformation.	**Content:** – Definition of relativity. – Concept of space, time and mass. – Concept of Frame of reference. – Galilean equation of transformation. – Postulates of special theory of relativity. – Concept of simultaneity. **Learning Activities:** – Use simulations and role plays to demonstrate relativity and postulates of special relativity. – In groups discuss space, time and mass and report results. – Discuss in groups frame and inertial frame of reference and present. – Discuss in groups Galilean equation of transformation. – Solve problems involving relative velocity using Galilean transformation equation. – Discuss in groups simultaneity. – Search on internet for relativity and postulates of special relativity.
Links to other subjects: *Space (Geography).*			
Assessment criteria: *learner can accurately discuss concept of space, time, mass, frame of reference and simultaneity. And can solve problems involving relative velocity using Galilean transformation equation.*			
Materials: *Environment and scientific journals.*			

3.4. Senior Six

3.4.1. Key competences for senior six

- Analyze the effects of Sound waves in elastic medium.
- Evaluate the applications of Physics in Agriculture.
- Evaluate fossil and non fossil fuel and power production.
- Analyze atomic nuclei and radioactivity decay.
- Differentiate optical fiber transmission and other transmitting systems.
- Construct and analyze block diagram of telecommunication systems.
- Analyze the nature of particles and their interactions.
- Organize the properties and basic principles of quarks.
- Analyze and evaluate the effects of x-rays.
- Analyze the applications of LASER.
- Analyze the processes in medical imaging.
- Analyze the effect of Cosmology, Galaxies and the expanding universe.

3.4.2. Senior Six Units

TOPIC AREA: OSCILLATIONS AND WAVES		SUB-TOPIC AREA: WAVES.		
S6 Physics		**Unit 1: Sound waves**		**Number of periods:21**
Key unit Competence: Analyze the effects of Sound waves in elastic medium.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Review the reflection and transmission of waves at boundary of two media. – Explain the applications of Snell's law in waves. – Explain the diffraction of waves. – Explain the Principle of superposition of waves. – Explain the sound waves production. – Explain Doppler's effect in sound waves.	– Describe the reflection and transmission of waves at boundary of two media. – Apply Snell's law in sound waves. – Analyze the – diffraction of sound waves. – Analyze the Principle of superposition for sound waves. – Perform an experiment to produce sound waves. – Analyze Doppler's effect in sound waves.	– Appreciate the application of sound waves. – Recognize the applications of diffraction of waves in life. – Acquire ability to logically and systematically analysis sound waves phenomena. – Adapt scientific method of thinking applicable to wave phenomena. – Enjoy analyzing Doppler Effect in sound waves.	– Reflection and transmission of waves at boundary of two media. – Snell's law and waves. – Diffraction of waves. – Principle of superposition of waves. – Production of sound waves. – Properties of sound waves (reflection, refraction, diffraction and interference) – Speeds of sound in various medium. – Characteristics of sound waves (amplitude, loudness, frequency, pitch, quality and overtones, frequency limits of audibility).	– Discuss in groups the reflection and transmission of sound in two media. – Perform an experiment to demonstrate diffraction of waves. – Demonstrate interference using two loudspeakers and signal generator. – Perform an experiment to illustrate propagation of sound wave. – Solve problems on fundamental frequency of stretched strings. – Devise an experiment to illustrate Doppler effect and report. – In groups discuss and solve question on Doppler's effect in sound waves.

			– Resonance, vibrations in strings and pipes (frequency and length pipe). – Harmonics in strings and pipes. – Sound Intensity. – Doppler's effect in sound waves. – Solve problems concerning Doppler's effect.	– Project work; Work in groups and report on Doppler's Effect observed for moving car sound.
Links to other subjects: *biology (anatomy of ears).*				
Assessment criteria: *Learner can perform an experiment to illustrate propagation of sound wave and solve problems related to Doppler Effect.*				
Materials: *Elastic medium open tubes/pipe tuning fork.*				

TOPIC AREA: ENERGY, POWER AND CLIMATE CHANGE		SUB-TOPIC AREA: AGRICULTURAL PHYSICS	
S6 Physics	**Unit 2: Application of Physics in Agriculture.**		**Number of periods: 17**
Key unit Competence: Evaluate the applications of Physics in Agriculture.			
Learning Objectives		**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**	
– Describe the atmosphere and its constituents. – Explain heat and mass transfers in the atmosphere. – Outline variation of atmospheric pressure, air density and water vapour with altitude. – Explain the physical properties of a soil (soil Texture and structure).	– Describe the atmosphere and its constituents. – Evaluate how heat and mass transfers occur in the atmosphere. – Apply knowledge of physics to illustrate changes in water vapour atmospheric pressure, and air with altitude. – Evaluate physical properties of soil (soil Texture and structure). – Evaluate why air, temperature and rainfall limit economical activities in Agriculture.	– Appreciate the role and properties of physical processes in plant growth. – Be aware of the moral and ethical issues associated with mechanical weathering. – Recognise the value of physics in increasing productivity in Agriculture.	– Atmosphere constituents. – Heat and Mass transfer. – Water vapour in the atmosphere, Variation of atmospheric pressure, air density and water vapour with altitude. – Physical properties of soil (soil texture and structure). – Mechanical weathering (Temperature changes, freezing of water in rocks and different rates of expansion and mineral composition, soil erosion and deposition from water, ice and wind).	– Undertake fieldwork and make group presentation on the applications of physics in Agriculture. – Discus in groups physical properties of soil. – Search on internet for the application of Physics in Agriculture.
Links to other subjects: *Graphs in mathematics, Photograph interpretations in Geography, compounds in Chemistry , Environment in Agriculture.*			
Assessment criteria: *evaluate application of Physics in Agriculture and search on internet for applications of physics in agriculture.*			
Materials: *Environment, Simulation's software, Journals and scientific reports, pluviometer, thermometer.*			

TOPIC AREA: ENERGY, POWER AND CLIMATE CHANGE				
S6 Physics		**Unit 3: Fossil and non fossil fuel and power production**		**Number of periods: 18**
Key unit Competence: Evaluate fossil and non-fossil fuel and power production				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Outline historical and geographical reasons for use of fossil fuels. – Explain energy density of fossil fuels and power station demand. – Discuss advantages and disadvantages associated with the transportation and storage of fossil fuels. – State efficiency of power station fueled by fossil fuels. – Explain environmental problems associated with recovery of fossil fuels after use in power stations. – Outline safety issues and risks of nuclear power.	– Distinguish fossil fuel and non fossil fuel. – Distinguish between controlled fission and uncontrolled fission. – Evaluate advantages and disadvantage associated with the transportation and storage of fossil fuels. – Estimate the rate of fuel consumption at power stations. – Apply knowledge attained to identify safety issues and risks of nuclear power.	– Appreciate that industrialization requires larger deposits of fossil fuels. – Be aware of moral and ethical issues associated with nuclear weapons. – Appreciate the need to think scientifically in producing nuclear power. – Recognize the value of adapting scientific method of storing fossil fuels.	– Definition of Fossil fuel and non fossil fuel. – Controlled and uncontrolled nuclear fission. – Controlled fission (power production) and uncontrolled fission (nuclear weapons). – Energy transformations in a nuclear power station. – Problems associated with the production of nuclear power. – Advantages and disadvantages associated with transportation and storage of fossil fuels. – Environmental problems of fossil fuels. – Safety issues and risks associated with nuclear power.	– Scientific research for environmental problems associated with use of fossil fuels in power stations. – Discuss in groups and present on problems of using nuclear power. – Discuss in groups and make presentations on safety issues and risks of nuclear power stations. – Search on internet for cleaner energy sources
Links to other subjects: *Graphs in Mathematics and Geography, Elements and fission in Chemistry, Data presentations and interpretations in Geography.*				
Assessment criteria: *Learner can clearly evaluate fossil and non fossil fuel for power production and can discuss safety issues and risks associated with nuclear power stations.*				
Materials: *Scientific Journals and Computer simulations.*				

TOPIC AREA: ATOMIC PHYSICS		SUB-TOPIC AREA: NUCLEAR PHYSICS		
S6 Physics		**Unit 4: Atomic nuclei and radioactive decay.**		**Number of periods: 22**
Key unit Competence: Analyze atomic nuclei and radioactivity decay				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Define atomic mass and atomic number. – Identify the constituents of a nucleus. – Explain the existence of nuclear energy levels. – Explain emission/ absorption spectra from X- rays. – Explain Einstein's mass-energy relation. – Define Nuclei fusion and fission. – Recognize the hazards and safety precautions of radioactivity.	– Analyze determinations of a mass of nuclei is using Bainbridge mass spectrometer. – Derive the relationship between decay constant and half-life. – Determine the stability of a nuclei. – Describe the properties of different radiations. – Describe the creation of artificial isotopes. – Identify the applications of radioactivity in life. – Plot a graph of binding energy against nucleon and explain its features. – Calculate the decay rate of unstable isotopes.	– Appreciate the safety precautions to be taken when handling radioactive materials. – Make responsive decisions about health and environment when disposing radioactive materials. – Appreciate that the nucleus of an atom and quantum system has discrete energy levels.	– Atomic nuclei-nuclide. – Radioactivity and nuclei stability. – Unified atomic mass. – Equivalent of atomic mass in electro volt. – Einstein's mass-energy relation. – Binding energy and mass defect. – Nuclei fusion and fission. – Radioactivity radiations. – Radiation detectors. – Properties of emitted radiations. – Radioactive decay. – Application of radioactivity.	– Discus and establish characteristics of radiations. – Work in groups and establish the exponential decay rate equation. – Discus methods of radiations detecting. – Role-play radioactivity decay. – Discuss ways of protection against radiations. – Group discussion on the hazards and precautions of radiations. – Make group presentation on the applications of radioactivity and write a report.

	– Describe hazards and safety precautions to be observed while handling radioactivity.		– Hazards and safety precautions of when handling radiations.	– Search on internet to for details photoelectric emission.
Links to other subjects: *Radioactivity and mutation (Biology, and Chemistry), History (carbon dating), Medicine (treatment of cancer), Archaeology (carbon dating), Geology (radioactive).*				
Assessment criteria: *learner can correctly describe atomic nuclei and solve problems on radioactive decay.*				
Materials: *Elastic Simulation and video (CD), Bainbridge- mass spectrometer.*				

TOPIC AREA: DIGITAL TECHNOLOGY	SUB-TOPIC AREA: ANALOG AND DIGITAL SIGNALS	
S6 Physics	**Unit 5: Application of optical fiber in telecommunication systems.**	**Number of periods: 18**

Key unit Competence: Differentiate optical fiber transmission and other transmitting systems.

Learning Objectives			Content	Learning Activities
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Explain functioning of optical fiber. – Explain the attenuation in optical fiber. – Identify and explain the components in optical fiber system. – Explain attenuation and solve problems related to attenuation giving answers in decibels.	– Describe the telecommunication system. – Distinguish optical fiber and other telecommunication systems. – Describe functions of amplifies in optical fiber transmission. – Describe noise production in optical fiber.	– Appreciate significance of optical fiber in telecommunication system. – Recognize the importance of optical fiber in communication. – Acknowledge reshaping of signals transmitted along an optical fiber which reduces noise effects.	– Definition of optical fiber. – Types of optical fiber: single mode, multi-mode and special purpose optical fiber. – Principle of operation of optical fiber: refraction index of light, total internal reflection and optical amplification. – Mechanism of attenuation: light scattering and absorption. – Light sources (transmitters and receivers). – Repeater attenuation, regenerator and optical amplifiers. – Optical transmitter and optical receiver. – Advantages of digital communication and optical fiber over other communication systems.	– Discuss terms used in optical fiber installation. – Roles play on optical fiber transmission and communication. – Search on internet for functioning of optical fiber transmission.

Links to other subjects: *ICT (Internet, mobile phone, computers etc), in social sciences and in research.*

Assessment criteria: *Learner can compare optical fiber transmission and other systems.*

Materials: *Repeaters, regenerators, switches, spicing, receivers, transmitters, light sources and fiber cables.*

TOPIC AREA: DIGITAL TECHNOLOGY		SUB-TOPIC AREA: ANALOG AND DIGITAL SIGNALS		
S6 Physics		**Unit 6: Block diagram of telecommunication system.**		**Number of periods: 17**
Key unit Competence: Construct and analyze block diagram of telecommunication systems.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Identify parts of a block diagram of telecommunication system. – Differentiate oscillator, modulator and amplifier. – Outline the function of a microphone and antenna.	– Describe terms applied in telecommunication systems. – Construct, analyze and judge block diagrams of a telecommunication n system.	– Appreciate the function of each component of a block diagram of communication. – Realize that parts of a telecommunication system are dependent.	– Microphone. – Definition of: Audio frequency (AF), amplitude modulation (AM), frequency modulation (FM), audio- amplifier, short wave (SW), and medium wave (MW). – Carrier wave, and Modulator. – Oscillator, Radio frequency amplifier, Power amplifier. – Types of antennae. – Block diagrams of telecommunication systems.	– Discuss in groups parts of block diagram. – Roles play communication of microphone and antenna and present.
Links to other subjects: *Biology-blood circulation transport, transmission of information etc.*				
Assessment criteria: *Learner can construct and analyze correctly block diagrams of telecommunication systems.*				
Materials: *Microphone, antenna, electronic components.*				

TOPIC AREA: RELATIVITY AND PARTICLE PHYSICS		SUB-TOPIC AREA: PARTICLES AND INTERACTIONS		
S6 Physics		**Unit 7: Nature of particles and their interactions**		**Number of periods: 18**
Key unit Competence: Analyze the nature of particles and their interactions.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Explain classification of elementary particles. – Explain classes of particles by spin. – Explain the concept of an antiparticle. – State Pauli's exclusion Principle. – Outline fundamental interactions by exchange of particles. – Explain uncertainty principle for time and energy and particle creation. – Explain the concepts of matter and antimatter.	– Describe elementary particles. – Classify and describe particles by spin. – Interpret concept of an antiparticle. – Analyse Pauli's exclusion Principle. – Analyse fundamental interactions by exchange of particles. – Discuss uncertainty principle for time and energy in the context of particle creation.	– Appreciate application of elementary particles. – Acquire scientific attitudes of reasoning to interpret elementary particle phenomena. – Acquire scientific techniques for identifying elementary particles.	– Elementary particles. – Classification of elementary particles. – Classification of particles by spin. – Antiparticle. – Pauli's exclusion Principle. – Fundamental interactions by particle exchange. – Uncertainty Principle for time and energy and particle creation. – Matter and antimatter (pair production and annihilation).	– Discuss in groups the elementary particles and their identifications. – Describe and discuss elementary particles in terms of mass and quantum numbers. – Discuss classification of particles by spin. – Research on antiparticles and report. – Discuss fundamental interactions in terms of exchange particles. – Discuss in groups uncertainty principle for time and energy in the context of particle creation and report. – Search on internet for details on matter and antimatter.
Links to other subjects: *Nuclear chemistry in Chemistry.*				
Assessment criteria: *Learner can outline, explain and classify elementary particles.*				
Materials: *scientific reports*				

TOPIC AREA: RELATIVITY AND PARTICLE PHYSICS			SUB-TOPIC AREA: QUARKS	
S6 Physics		**Unit 8: Properties and basic principles of quarks.**		**Number of periods: 18**
Key unit Competence: Organize the properties and basic principles of quarks.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– List the types of quarks. – Identify quarks, antiquarks and hadrons (baryons and mesons). – Outline the quarks as components of proton and neutron. – Define baryon number and state the law of conservation of baryon number. – Explain how colour forms bound states of quarks. – State colours of quarks and gluons.	– Explain types of quarks. – Discuss and describe quarks, antiquarks and hadrons (baryons and mesons) – Explain quark as components of proton and neutron. – Interpret the baryon number and apply the law of conservation of baryon number. – Formulate the spin structure of hadrons (baryon and mesons) – Explain how colour forms bound states of quarks. – Explain colour of quarks and gluons. – Deduce the spin structure of hadrons (baryon and mesons).	– Acquire ability to pursue a line of thoughts logically and systematically. – Adapt scientific thinking about particle elements. – Acquire knowledge of analyzing and modelling behaviour of quarks	– Types of quarks. – Terms quarks, antiquarks and hadrons (baryons and mesons). – The quarks as constituent of proton and neutron. – Baryon number and the law of conservation of baryon number. – Spin structure of hadrons (baryon and mesons). – Colour in forming of bound states of quarks. – Colour as component of quarks and gluons.	– Discuss in groups quarks, antiquarks and hadrons (baryons and mesons) – Discuss in groups the quarks as contents of proton and neutron. – Discuss in groups baryon number and law of conservation of baryon number. – Discuss in groups the spin structure of hadrons (baryon and mesons) – Discuss in groups how colour forms bound states of quarks.
Links to other subjects: *molecules, fluids, intermolecular force.*				
Assessment criteria: *Learner can discuss in groups the quarks contents of proton and the neutron.*				
Materials: *colour, internet*				

TOPIC AREA: ELECTROMAGNETIC WAVES			SUB-TOPIC AREA: X-RAYS	
S6 Physics	**Unit 9: Effects of x-rays**			**Number of periods: 15**
Key unit Competence: Analyze and evaluate the effects of x-rays.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Explain the production of X-rays. – State the properties of X-rays. – Draw and describe an x-ray spectrum. – Explain the origin and characteristic features of an x-ray spectrum. – Outline the applications of x-rays in medicine, industries, and scientific research.	– Describe and analyse production of x-rays. – Draw an x-ray spectrum. – Analyse the origins and characteristic features of x-ray spectrum. – Analyse applications of x-rays in medicine, industries, research and forensic science. – Solve problems involving accelerating potential and minimum wavelength of x-rays. – Analyze dangers of X-rays.	– Recognise how the intensity and quality of x-rays can be controlled. – Recognize the continuous and characteristic features of wavelength limit. – Appreciate the use of x- rays in medicine and industry – Acquire scientific techniques, reasoning and attitudes for analyzing applications of x-rays. – Acquire ability to logically and systematically pursue thinking related to dangers of x-rays.	– Production of X- rays. – Properties, uses and dangers of x-rays. – X-rays as part of the electromagnetic spectrum. – The origins and characteristic features of an x-ray spectrum. – Applications of x- rays in medicine, industries, security, and scientific research. – Problems involving accelerating potential and minimum wavelength.	– Discuss in groups production of x-rays. – Discuss in groups the origins of the features of characteristic x-ray spectrum. – Discuss in groups application of x-rays in medicine, industries, research and scientific investigations. – Solve problems on accelerating potential and minimum wavelength. – Search on internet for production of X-rays, spectrum characteristics and applications.
Links to other subjects: *Medicine (detection of fractures, cancer treatment), Transportation (detection of metal objects), Security departments,*				
Assessment criteria: *Learner can analyse the effects of x-rays correctly.*				
Materials: *X-ray tube, source of high voltage.*				

TOPIC AREA: ELECTROMAGNETIC WAVES			SUB-TOPIC AREA: LASER	
S6 Physics		**Unit 10: Effects of LASER**		**Number of periods: 15**
Key unit Competence: Analyze the applications of LASER.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Define a LASER beam. – State the properties of a LASER beam. – Explain: monochromatic, coherent sources of light, stimulated emission of light and spontaneous emission of light. – Explain LASER beam as a source of coherent light. – Outline production mechanism of LASER beam. – Outline applications of LASER.	– Explain and describe monochromatic and coherent sources of light. – Analyse a LASER light as a source of coherent light. – Analyse the mechanism for the production of LASER beam. – Analyse applications and dangers of LASER beam.	– Appreciate applications of LASER beams in life. – Acquire scientific reasoning and attitudes in analysing LASER beams. – Acquire knowledge for analysing and modelling LASER applications.	– Monochromatic and coherent sources of light. – Properties of a LASER beam. – LASER beam as a source of coherent light. – Production of LASER beam. – Applications and dangers of LASER beam.	– Working in groups, discuss and present meaning of monochromatic, coherent sources, stimulated emission and spontaneous emission. – Discuss in groups about LASER as a source of coherent light. – Discuss in groups production mechanism of LASER beam. – Discuss in groups and present on applications and dangers of LASER beams. – Search on internet and use ICT simulators to analyse characteristics properties of LASER beam.
Links to other subjects: *LASER application in telecommunication, Medicine (eye surgery) and in Mechanical engineering (drilling and welding of metals.*				
Assessment criteria: *Learners can explain the effects and applications of LASER correctly.*				
Materials: *LASER, Sources of light.*				

TOPIC AREA: ELECTROMAGNETIC WAVES			SUB-TOPIC AREA: MEDICAL IMAGING	
S6 Physics		**Unit 11: Medical Imaging**		**Number of periods: 20**
Key unit Competence: Analyze the processes in medical imaging.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Explain how sound pressure changes into larger pressure with fluid variation. – State range of audible frequencies for normal person. – State and explain change in observed sound intensity and ear response. – State and explain logarithmic response of the ear and intensity. – Outline specific purposes imaging techniques. – Explain the basic functioning principles of major medical imaging techniques. – Identify advantages and disadvantages of medical imaging techniques.	– Describe and illustrate how sound pressure varies in fluids. – Analyse the range of audible frequencies experienced by normal person. – Evaluate change in observed sound intensity and ear response. – Explain that there is a logarithmic response of the ear to intensity. – Explain the effects of various imaging techniques for particular purposes. – Explain the working principle of radiation for imaging.	– Show concern of how sound pressure in air changes into larger pressure with fluid variation. – Adapt scientific thinking about functioning principle of equipment used in medicine. – Acquire knowledge in analysing and modelling physical processes involved in medical imaging.	– Sound pressure and variation in fluids. – Frequency range for normal person – Observed sound intensity and ear response. – Logarithmic response of the ear versus intensity. – Specific purposes of imaging techniques. – Technology and radiation imaging (radiography and mammography). – Ultrasound (echography), Endoscopy, thermography.	– Discuss in groups how sound pressure in air changes into larger pressure with fluid variation. – Discuss in groups about the logarithmic response of the ear to intensity. – Discuss the effects of various imaging techniques and their purposes.

			– Radionuclide imaging – Magnetic resonance imaging (MRI).	
Links to other subjects: *Biology, medicine.*				
Assessment criteria: *Learner can discuss in groups to know why change in observed loudness is the response of the ear to a change in intensity and analyze the basic functioning principles of major medical imaging techniques.*				
Materials: *Radiography, mammography, echography, Endoscopy, MRI machine.*				

TOPIC AREA: ELECTROMAGNETIC WAVES			SUB-TOPIC AREA: RADIATION	
S6 Physics		**Unit 12: Radiation and Medicine.**		**Number of periods: 17**
Key unit Competence: Analyze the use of radiation in medicine.				
Learning Objectives			**Content**	**Learning Activities**
Knowledge and understanding	**Skills**	**Attitudes and values**		
– Explain radiation dosimetry. – Explain the terms: exposure, absorbed dose, quality factor (relative to biological effectiveness) and dose equivalent. – Outline safety precautions to be taken when handling radiations. – State the concept of balanced risk. – Explain the terms half-life, biological half-life and effective half-life. – Outline the basics of radiation therapy for cancer treatment.	– Differentiate the terms exposure, absorbed dose, quality factor (relative to biological effectiveness) and dose equivalent as used in radiation dosimetry. – Explain safety precautions when handling radiations. – Describe the concept of balanced risk. – Differentiate physical half-life, biological half-life and effective half-life. – Solve radiation dosimetry problems. – Analyse the basics of radiation therapy for cancer.	– Appreciate significance of radiation dosimetry quantities. – Show concern for shielding, distance and time for exposure. – Appreciate that code of practice has been developed for use of radiations. – Show concern for normal and malignant cells.	– Radiation dosimetry, exposure, absorbed dose, quality factor (relative to biological effectiveness) and dose equivalent. – Safety precautions to observed when handling radiations. – Concept of balanced risk. – Physical half-life, biological half-life and effective half-life. – Problems involving radiation dosimetry. – The basics of radiation therapy for cancer treatment.	– Discuss in groups the terms radiation dosimetry, exposure, absorbed dose, quality factor (relative biological effectiveness) and dose equivalent. – Discuss in groups safety precautions to taken while handling radiation. – Discuss in groups evaluate physical half-life, biological half-life and effective half-life. – Discuss in groups the basics of radiation therapy for cancer and present results.
Links to other subjects: *gases, molecules, biology(radiotherapy), tracer elements (agriculture)*				
Assessment criteria: *Learner can effectively discuss safety precautions to be taken while handling radiation.*				
Materials: *source of energy, radiation dosimeter.*				

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5. APPENDIX: SUBJECTS AND WEEKLY TIME ALOCATION FOR ASSOCIATE NURSING PROGRAM

No	Subjects	Weight	WEEKLY TIME ALLOCATION		
			S4	S5	S6
1	Fundamentals of Nursing *	11	7	7	7
2	Biology*	11	7	7	7
3	Chemistry*	11	7	7	7
4	Mathematics*	5	3	3	3
5	Physics*	10	6	6	6
6	Ethics and professional code of conduct	1	1	1	0
7	Medical Pathology	2	0	3	1
8	Surgical Pathology	1	0	1	1
9	Pharmacology	4	3	2	2
10	Maternal and Child health	7	4	4	4
11	Individual learning	5	3	1	5
12	Clinical attachment*	13	6	7	10
13	Kinyarwanda	3	2	2	0
14	English*	6	4	4	4

15	French	2	1	1	1
16	Entrepreneurship	2	2	1	0
17	Citizenship	2	2	1	0
18	ICT	2	1	1	1
19	Sports/ Clubs	2	1	1	1
Total periods / week		100	60	60	60
Total number of contact/years			2340	2340	2340
Total number of contact hours/year (39 weeks)			1560	1560	1560