MINISTRY OF EDUCATION, SCIENCE AND SPORTS

Republic of Ghana

TEACHING SYLLABUS FOR PHYSICS
(SENIOR HIGH SCHOOL)

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RATIONALE FOR TEACHING PHYSICS

Physics, as a discipline, deals with the nature of matter and energy, their interactions and measurements. The study of Physics has had, and continues to have, a big impact on the world community. The ideas, skills and attitudes derived from the study of the physics are being widely applied in various scientific and technological developments. As an example, development in renewable energy is serving the world profoundly and it is hoped that it will become more available in Ghana to complement other sources for meeting the energy needs of the country. The specific example of renewable energy is solar, that transforms in appropriate forms such as electrical energy for operating simple equipment, and machinery, and for domestic use. The principles and applications of physics cut across the various spectrum of everyday life activities like walking, lifting objects, seeing and taking photographs.

GENERAL AIMS

The aims of the Senior High School Physics programme are to:

i. provide, through well designed studies of experimental and practical physics, a worthwhile hands on educational experience to become well informed and productive citizens.
ii. enable the Ghanaian society function effectively in a scientific and technological era, where many utilities require basic physics knowledge, skills and appropriate attitudes for operations.
iii. recognise the usefulness, utilization and limitations of the scientific methods in all spheres of life.
iv. raise the awareness of inter-relationships between physics and industry, Information, and Communication Technology (ICT), Agriculture, Health and other daily experiences.
v. develop in students, skills and attitudes that will enable them to practise science in the most efficient and cost effective way.
vi. develop in students desirable attitudes and values such as precision, honesty, objectivity, accuracy, perseverance, flexibility, curiosity and creativity.
vii. stimulate and sustain students' interest in physics as a useful tool for the transformation of society.

SCOPE OF CONTENT

This syllabus builds upon the foundation laid in the Junior High School Integrated Science at the Basic level and SHS Integrated Science. The topics have been selected to enable the students acquire the relevant knowledge, skills and attitudes needed for tertiary level education, other institutions, apprenticeship and for life. The syllabus embodies a wide range of activities such as projects, experiments, demonstrations and **scientific inquiry skills** designed to bring out the resourcefulness and ingenuity of the physics student.

PRE-REQUISITE SKILLS AND ALLIED SUBJECTS

A good knowledge of Science and Mathematics at the Junior High School or its equivalent, and proficiency in reading and communication in English are necessary for effective study of Physics at the Senior High School level. Students offering Physics are advised to take Chemistry and Elective Mathematics in addition.

ORGANIZATION OF THE SYLLABUS

The syllabus has been structured to cover three years of SHS programme. Each year's work consists of a number of sections with each section comprising a number of units. There are six main sections. These are;

SECTION ONE: MOTION, FORCES AND ENERGY
In this section, different types of motion are to be discussed. These include rectilinear motion, **projectile motion**, circular motion, oscillatory motion and **rotational motion**. The effects of force on motion and on matter are to be discussed in this section. The nature of energy, the conversion and conservation of energy are to be treated with special emphasis on the **ways of harnessing renewable energy resources.**

SECTION TWO: THERMAL PHYSICS
In this section, heat and temperature are to be discussed. The study of temperature, its measurement and the effect of temperature changes are to be discussed. The quantity of heat given out or absorbed and the physical changes due to heat transfer are also to be discussed. Natural modes of heat transfer, with special emphasis on related concepts of **thermal conductivity** and **black body radiation** and their applications in building **heat storage** for use as a **thermal battery,** are to be given special emphasis. The behaviour of gases as a result of thermal energy possessed by gas molecules in random motion is to be discussed. A special mode of heat transfer called **cooling and evaporative heat transfer** and its application in designing **heat pipes** for use in industry where cooling is desired is given special emphasis.

SECTION THREE: WAVES
The general characteristics of wave motion including that of light and sound waves are to be discussed in this section. The nature, generation and detection of **seismic waves** are to be given special emphasis. The utilization of electromagnetic waves, especially that of **microwaves** in communication and industry and application of sound waves are given special emphasis. **Fiber optics** and **lasers** which have wide applications in industry and medicine are new topics introduced in the elective physics syllabus with special emphasis on how they can be utilized.

SECTION FOUR: ELECTRIC AND MAGNETIC FIELD
Special emphasis is given to the study of magnets since magnets play a major role in instrumentation and machinery. The utilization of electromagnetic fields in the **generation and storage of electricity** and in **electromagnetic relay** are given special emphasis in this syllabus. The phenomenon of **thermoelectric effect** and its application is also to be treated in this section.

SECTION FIVE: ATOMIC AND NUCLEAR PHYSICS
The characteristics of the atom and that of the nucleus are to be discussed in this section. The concept of photoelectric effect and its applications, the x-rays and the peaceful uses of nuclear energy are to be discussed in this section.

SECTION SIX: ELECTRONICS
From primary one to Senior High School, electronics has been introduced into Natural Science and Integrated Science with hands on activities. In this section, another dimension of electronics is to be treated to include the characteristics and applications of semi-conductor diode and transistors in **voltage stabilization, amplification** of signals and **electronic switching.**

The structure of the syllabus is as follows:

STRUCTURE OF THE PHYSICS SYLLABUS

YEAR TWO	YEAR THREE	YEAR FOUR
***Section 1 : Motion, Forces and Energy*(Pg 1-6)** Unit 1: Physical quantities…… Unit 2: Kinematics ……. Unit 3: Dynamics ……. Unit 4: Forces ……	***Section 1 : Motion, Forces and Energy* (Pg23-29)** Unit 1: Deformation of matter…… Unit 2: Circular motion, the planets and gravity Unit 3: Energy Unit 4: Oscillatory motion	***Section 1: Motion, Forces and Energy*** ***(pg 48)*** Unit 1 : Rotational motion of solid objects
***Section 2 : Thermal Physics* (Pg 7-8)** Unit 1: Temperature and its measurement	***Section 2 : Thermal Physics* (pg 30-32)** Unit 1 : Measurement of heat energy Unit 2: Heat transfer	***Section 2: Thermal Physics* (pg 49-50)** Unit 1 : Gases
Section 3 : Waves (pg 9-13) Unit 1 : Reflection of light from plane and curved mirrors Unit 2: Refraction of light Unit 3: Basic Fiber optics	***Section 3: Waves(pg 33-38)*** Unit 1: Thin lenses and optical instruments Unit 2 : Wave motion Unit 3 : Sound	***Section 3 : Waves(pg51)*** Unit 1: Introduction to Laser
Section 4 :Electric and Magnetic Field ***(pg 14-19*** Unit 1 : Direct current circuit analysis Unit 2: Electrostatics Unit 3: Capacitors	***Section 4: Electric and Magnetic Field* (pg 39-42)** Unit 1 : Magnets Unit 2 : Electromagnetism	***Section 4 Electric and Magnetic Field*** ***(pg 52-54)*** Unit 1: Electromagnetic Induction Unit 2: Alternating Current (A.C.) theory
Section 5 : Atomic and Nuclear Physics(pg 20) Unit 1: Models of the atom and atomic structure	***Section 5 : Atomic and Nuclear Physics(pg 43-45)*** Unit 1 : Photoelectric effect and wave particle duality Unit 2 : Thermionic emission, cathode rays and x-rays	***Section 5 : Atomic and Nuclear Physics*** ***(pg55-56)*** Unit 1 : The nucleus and nuclear energy
Section 6: Electronics(pg 21-22) Unit 1: Semi conductor P-N Junction diode	***Section 6 : Electronics(pg 46-47)*** Unit 1: Bipolar Junction Transistor (BJT) and Junction Field-Effect Transistor (JFET)	***Section 6*: *Electronics(pg 57)*** Unit 1: Operational amplifiers and their applications. Unit 2: Digital electronics

DURATION OF COURSE: 3 Years

PERIOD ALLOCATION PER WEEK

A total of eight periods per week is allocated to the teaching of Physics in each year, with each period consisting of forty minutes. The teaching periods are divided as follows:

YEAR	PRACTICALS	THEORY	TOTAL
2	3	5	8
3	3	5	8
4	3	5	8

Note **:** (1) Teachers should ensure that students are adequately prepared in the theory before each practical class.
(2) Teachers should also ensure that practical classes are started in SHS 2 alongside the theory classes.

SUGGESTIONS FOR TEACHING THE SYLLABUS

The syllabus is presented in a teaching sequence. However the teacher may change the teaching order in a particular year provided the linkage between the sections and the respective units is maintained and the syllabus for the year completed by the end of each year. It is important that classroom teaching be supplemented with field trips wherever appropriate.

Besides the above advice, the teacher's attention is drawn to some new concepts that have been introduced in the new set of syllabuses to help improve instructional delivery and learning. Please read this section very carefully and relate the information to your repertoire of teaching methods and skills.

New concepts in the design and use of the syllabus

General Objectives:

General Objectives have been listed at the beginning of each Section. The general objectives are a summary of the specific objectives of the various units contained in that Section. Read the general objectives very carefully before you start teaching the section. After teaching all the units of the section, go back and read the general objectives again to be sure you have covered the objectives adequately in the course of your teaching.

Sections and Units:

The syllabus has been planned on the basis of Sections and Units. Each year's work is divided into sections. A section consists of a fairly homogeneous body of knowledge within the subject. Within each section are units. A unit consists of a more related and homogeneous body of knowledge and skills.

Columns

The syllabus is structured in five **columns**: Units, Specific Objectives, Content, Teaching and Learning Activities and Evaluation. A description of the contents of each column is as follows:

Column 1 - Units: The units in Column 1 are divisions of the major topics of the section. You are expected to follow the unit topics according to the linear order in which they have been presented. However, if you find at some point that teaching and learning in your class will be more effective if you branched to another unit before coming back to the unit in the sequence, you are encouraged to do so.

Column 2 - Specific Objectives: Column 2 shows the Specific Objectives for each unit. The specific objectives begin with numbers such as 1.3.5 or 2.1.1. These numbers are referred to as "Syllabus Reference Numbers". The first digit in the syllabus reference number refers to the section; the second digit refers to the unit, while the third digit refers to the rank order of the specific objective. For instance, 1.3.5 means: Section 1, Unit 3 (of Section 1) and Specific Objective 5. In other words, 1.3.5 refers to Specific Objective 5 of Unit 3 of Section 1. Similarly, the syllabus reference number 2.1.1 simply means Specific Objective number 1 of Unit 1 of Section 2. Using syllabus reference numbers provide an easy way for communication among teachers and other educators. It further provides an easy way for selecting objectives for test construction. For instance, that Unit 2 of Section 2 has five specific objectives: 2.2.1 - 2.2.5. A teacher may want to base his/her test items/questions on objectives 2.2.3 and 2.2.4 and not use the other three objectives. In this way, a teacher would sample the objectives within units and within sections to be able to develop a test that accurately reflects the importance of the various skills taught in class.

You will note also that specific objectives have been stated in terms of the student i.e., *what the student will be able to do after* instruction *and learning in the unit*. Each specific objective therefore starts with the following, "The student will be able to." This in effect, means that you have to address the learning problems of each individual student. It means individualizing your instruction as much as possible such that the majority of students will be able to master the objectives of each unit of the syllabus.

Column 3 - Content: The "content" in the third column of the syllabus presents a selected body of information that you will need to use in teaching the particular unit. In some cases, the content presented is quite exhaustive. In some other cases, you could add more information to the content presented. In a few cases the content space has been left blank for you to develop.

Column 4 -Teaching and Learning Activities (T/L): T/L activities that will ensure maximum student participation in the lessons are presented in column 4. Try to avoid rote learning and drill-oriented methods and rather emphasize participatory teaching and learning, and also emphasize the cognitive, affective and psychomotor domains of knowledge in your instructional system wherever appropriate. You are encouraged to re-order the suggested teaching and learning activities and also add to them where necessary in order to achieve optimum student learning. As we have implied already, the major purpose of teaching and learning is to make students able to apply their knowledge in dealing with issues both in and out of school. A suggestion that will help your students acquire the habit of analytical thinking and the capacity for applying their knowledge to problems is to begin each lesson with a practical problem. Select a practical problem for each lesson. The selection must be made such that students can use knowledge gained in the previous lesson and other types of information not specifically taught in class. At the beginning of a lesson, state the problem, or write the problem on the board. Let students analyze the problem, suggest solutions etc., criticize solutions offered, justify solutions and evaluate the worth of possible solutions. There may be a number of units where you need to re-order specific objectives to achieve such required effects. The emphasis is to assist your students to develop analytical thinking and practical problem solving techniques.

Column 5 - Evaluation: Suggestions and exercises for evaluating the lessons of each unit are indicated in Column 5. Evaluation exercises can be in the form of oral questions, quizzes, class assignments, essays, structured questions, project work etc. Try to ask questions and set tasks and assignments that will challenge your students to apply their knowledge to issues and problems as we have already said above, and that will engage them in developing solutions, and positive scientific attitudes as a result of having undergone instruction in this subject. The suggested evaluation tasks are not exhaustive. You are encouraged to develop other creative evaluation tasks to ensure that students have mastered the instruction and behaviours implied in the specific objectives of each unit. For evaluation during class lessons, determine the mastery level you want students to achieve in their answers and responses. If for instance, you take 80% as the mastery level, ensure that each student's answer to questions asked in class achieve this level of mastery.

PROFILE DIMENSIONS

A central aspect of this syllabus is the concept of profile dimensions that should be the basis for instruction and assessment. A 'dimension' is a psychological unit for describing a particular learning behaviour. More than one dimension constitute a profile of dimensions. A specific objective as follows: The student will be able to describe...etc. contains an action verb "describe" that indicates what the student will be able to do after teaching and learning have taken place. Being able to "describe" something after the instruction has been completed means that the student has acquired "knowledge". Being able to explain, summarize, give examples etc. means that the student has understood the lesson taught. Similarly, being able to develop, plan, construct etc. means that the student can "apply" the knowledge acquired in some new context. You will note that each of the specific objectives in this syllabus contains an "action verb" that describes the behaviour the student will be able to demonstrate after the instruction. "Knowledge", "Application" etc. are dimensions that should be the prime focus of teaching and learning in schools. Instruction in most cases has tended to stress knowledge acquisition to the detriment of other higher level behaviours such as application, analysis etc. We are therefore attempting in this syllabus and in all others, to move teaching and learning from the didactic acquisition of "knowledge" to a new position where students will be able to apply their knowledge, develop analytical thinking skills, synthesize information, and use their knowledge in a variety of ways to deal with learning problems, and with problems and issues in their lives. The new type of education simply aims at producing problem solving persons. Each action verb indicates the underlying profile dimension of each particular specific objective. Read each objective carefully to know the profile dimension toward which you have to teach.

Lastly, please bear in mind that the syllabus cannot be taken as a substitute for lesson plans. It is therefore, necessary that you develop a scheme of work and lesson plans for teaching the units of this syllabus.

DEFINITION OF PROFILE DIMENSIONS

As already stated, profile dimensions describe the underlying behaviours for teaching, learning and assessment. In Physics, the three profile dimensions that have been specified for teaching, learning and testing are:

Knowledge and Comprehension	30%
Application of Knowledge	40%
Scientific Inquiry Skills	30%

Each of the dimensions has been given a percentage weight that should be reflected in teaching, learning and testing. The weights, indicated on the right of the dimensions, show the relative emphasis that the teacher should give in the teaching, learning and testing processes. The focus of this syllabus is to get students not only to acquire knowledge but also be able to understand what they have learnt and apply them practically. Combining the three dimensions in your teaching will ensure that Physics is taught not only at the factual knowledge level but that students will also acquire the ability to apply scientific knowledge to issues and problems, and will also acquire the capacity for practical and experimental skills that are needed for scientific problem solving. The explanation of the dimensions and the key action verbs associated with each profile dimension are as follows:

Knowledge and Comprehension (KC)

Knowledge The ability to:

remember, recall, identify, define, describe, list, name, match, state principles, facts and concepts. Knowledge is simply the ability to remember or recall material already learned and constitutes the lowest level of learning.

Comprehension The ability to:

explain, summarize, translate, rewrite, paraphrase, give examples, generalize, estimate or predict consequences based upon a trend. Understanding is generally the ability to grasp the meaning of some material that may be verbal, pictorial, or symbolic.

Application of Knowledge (AK)

The ability to use knowledge or apply knowledge, as implied in this syllabus, has a number of learning/behaviour levels. These levels include application, analysis, synthesis, and evaluation. These may be considered and taught separately, paying attention to reflect each of them equally in your teaching. The dimension "Application of Knowledge" is a summary dimension for all four learning levels. Details of each of the four sub levels are as follows:

Application — The ability to:
apply rules, methods, principles, theories, etc. to concrete situations that are new and unfamiliar.
It also involves the ability to produce, solve, operate, plan, demonstrate, discover etc.

Analysis — The ability to:
break down a piece of material into its component parts; to differentiate, compare, distinguish, outline, separate, identify significant points etc., recognize unstated assumptions and logical fallacies, recognize inferences from facts etc. Analytical ability underlies discriminant thinking.

Synthesis — The ability to:
put parts together to form a new whole. It involves the ability to combine, compile, compose, devise, suggest (an idea, possible ways), plan, revise, design, organize, create, and generate new ideas and solutions. Ability to synthesize underlies convergent thinking.

Evaluation — The ability to:
appraise, compare features of different things and make comments or judgement, contrast, criticize, justify, support, discuss, conclude, make recommendations etc. Evaluation refers to the ability to judge the worth or value of some material based on some criteria.

A number of examination questions at the secondary school level begin with the word "Discuss". Discuss belongs to the evaluation thinking skill and implies the ability to analyze, compare, contrast, make a judgement etc. The word "discuss" asks for a variety of thinking skills and is obviously a higher order thinking behaviour. Students consequently do poorly on examination questions that start with "Discuss". For this reason, and also for the reason that discussion of issues, discussion of reports etc., are some of the major intellectual activities students will be engaged in, in work situations and at higher levels of learning after they have left secondary school, it will be very helpful if you would emphasize discussion questions etc. both in class and in the tests you set.

You will note from the above that evaluation is generally the highest form of thinking and learning skill and is therefore the most important behaviour. This, as implied already, accounts for the poor performance of students and people generally on tasks that call for evaluative thinking. Give your students lots of exercises to do evaluative thinking.

SCIENTIFIC INQUIRY SKILLS (SIS)

The Scientific Inquiry Skills involve the demonstration of the inquiry processes in science and refer to skills in planning and designing of experiments, observation, manipulation, classification, drawing, measurement, interpretation, recording, reporting, and conduct in the laboratory/field. Scientific inquiry skills refer to the psychomotor domain.

A summary of the Scientific Inquiry Skills (Sis) required for effective practical and experimental work are the following:

1. Make observation, raise questions and formulate hypothesis.
2. Design and conduct investigations.
3. Analyze and interpret results of scientific investigations
4. Communicate and apply the results of scientific investigation

SIS 1 Make observation, raise questions and formulate hypothesis.

The students should be able to:

- Observe the world around them from a scientific perspective.
- Pose questions and form hypothesis based on personal observation, scientific articles, experiments and knowledge.
- Read, interpret and examine the credibility and validity of scientific claims in different sources of information such as scientific articles, advertisements or media stories.

SIS 2 Design and conduct investigations.

The students should be able to:

- Articulate and explain the major concepts being investigated and the purpose of an investigation.
- Select required materials, equipment and conditions for conducting an experiment.
- Identify independent and dependent variables.
- Write procedures that are clear and replicable.
- Employ appropriate methods for accurately and consistently
  - making observations
  - making and recording measurements at an appropriate level of position
  - collecting data in an organized way.
- Properly use instruments, equipment and materials (such as scales, metre rule, stop watches) including: set-up, calculation (if required)technique, maintenance and storage.
- Follow safety guidelines

SIS 3 Analyze and interpret results of scientific investigations.

The students should be able to:

- Present relationships between variables in appropriate forms:
  - represent data and relationships between variables in charts and graphs
  - use appropriate technology and other tools
- Use mathematical operations to analyze and interpret data results.
- Identify reasons for inconsistent results, such as sources of error or uncontrolled conditions, and access the reliability of data.
- Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis.
- State questions raised by an experiment that may require further investigation.

SIS 4 Communicate and apply the results of scientific investigation

The students should be able to:

- Develop descriptions and explanations of scientific concepts that an investigation focuses on.
- Review information, explain statistical analysis and summarize data, collected and analyzed from an investigation.
- Explain diagrams and charts that represente relationships of variables.
- Construct a reasoned argument and respond appropriately to critical comments and questions.
- Use language and vocabulary appropriately: speak clearly and logically and use appropriate technology and other tools to present findings.
- Use and refine scientific models that stimulate physical processes or phenomena.

***ATTITUDES*:** For success in any endeavour, the individual needs to cultivate attitudes relevant to that area of endeavour. The learning of Physics should aim at acquisition of the following attitudes by students:

i. Curiosity: the inclination or feeling toward seeking informing about how things work in a variety of fields

ii. Perseverance : the ability to continuously pursue an investigation until results are achieved.

iii. Flexibility in ideas : tolerance and willingness to change opinion in the face of more plausible evidence.

iv. Respect for evidence : willingness to collect and use data in one's investigation and also have respect for data collected by others and respect for the scientific conclusions others have arrived at.

v. Reflection : the habit of critically reviewing ways in which an investigation has been carried out to see possible faults and other ways in which the investigation could be improved upon.

The action verbs and the definitions provided in the explanations of the three profile dimensions should help you to structure your teaching such as to achieve the effects needed. Select from the action verbs provided for your teaching, in evaluating learning before, during and after the instruction. Use the action verbs also in writing your test questions. This will ensure that you give your students the chance to develop good thinking skills, and the capacity for excellent performance in Integrated Science and in examinations. Check the weights of the profile dimensions to ensure that you have given the required emphasis to each of the dimensions in your teaching and assessment.

FORM OF ASSESSMENT

It must be emphasized again that it is important that both instruction and assessment be based on the profile dimensions of the subject. In developing assessment procedures, try to select specific objectives in such a way that you will be able to assess a representative sample of the syllabus objectives. Each specific objective in the syllabus is considered a criterion to be achieved by the student. When you develop a test that consists of items or questions that are based on a representative sample of the specific objectives taught, the test is referred to as a "Criterion-Referenced Test". In many cases, a teacher cannot test all the objectives taught in a term, in a year etc. The assessment procedure you use i.e. class tests, home work, projects etc. must be developed in such a way that it will consist of a sample of the important objectives taught over a period.

The example given on page 3 xi and xii shows an examination consisting of three papers, Paper 1, Paper 2, Paper 3 and School Based Assessment. Paper 1 will usually be an objective-type paper; Paper 2 will consist of structured questions or essay questions, essentially testing "Application of Knowledge", but also consisting of some questions on "Knowledge and Understanding". Paper 3 will be the practical test paper, and School Based Assessment will be based on all three dimensions as indicated. The distribution of marks for the objective test items, essay type questions and the practical questions in the three papers and in the School Based Assessment should be in line with the weights of the profile dimensions already indicated and as shown in the last column of the table.

SCHEME OF WEST AFRICAN SCHOOL CERTIFICATE (WASSCE) EXAMINATION

There will be two papers both of which must be taken for a total mark of 160.

PAPER 1 (50 marks)

It will be a practical test lasting 2 ¾ hours comprising three questions out of which candidates will be expected to answer any two to secure the maximum mark of 50. Each question of this paper will have two parts: A and B**.**

i. **Part A** will be an experiment for *21 marks*. Candidates will be required to state the precautions taken in the experiment during the examination and the reason for taking such precautions.
ii. **Part B** will consist of two structured questions that are related to the experiment for *4 marks*.

PAPER 2 **: (110 marks)**

It will consist of two sections A and B and will last for 2 ¾ hours.

Section A will comprise 50 multiple choice objective questions drawn from common areas (i.e. area common to all Member Countries) of the syllabus. It will last for 1¼ hours for 50 marks.
Section B will last for 1½ hours and will comprise of two parts, I and II.

Part I. will consists of ten short structured questions drawn from the portions of the syllabus peculiar to Ghana. Candidates will be expected to answer five questions for 15 marks.

Part II. will comprise *five essay type* questions drawn from the common areas of the syllabus. Candidates will answer three questions for 45 marks.

PAPER 3 (50 marks)

It will be alternative to Paper 1 for private candidates. It will be a test of practical work lasting 2 ¾ hours for 50 marks.

Paper 1 will be the Practical Test Paper

Paper 2A will be an objective type paper

Paper 2B will consist of structured questions or essay questions, essentially testing Application of Knowledge but also consisting of some questions on Knowledge and Understanding.

School Based Assessment will be based on all three dimensions as indicated. The distribution of marks for the objective test items, essay type questions and practical question in the three papers and in the School Based Assessment should be in line with the weights of the profile dimensions indicated and as shown in the last column of the table that follows:

PAPER 3 ALTERNATIVE TO PRACTICAL TEST will consist of 3 practical questions and students are required to answer any two questions. In the examination structure which follows, Paper 1 is marked out of 50. Paper 2A is marked out of 50. Paper 2B is marked out of 60, Paper 3 is marked out of 50, and School Based Assessment is allotted 68 marks, giving a total of 200 marks. The last row shows the weight of the marks allocated to each of the four test components. The three papers are weighted differently. Paper 2 is a more intellectually demanding paper and is therefore weighted more than Papers 1 and 3.

DISTRIBUTION OF EXAMINATION PAPER WEIGHTS AND MARKS

DIMENSIONS	PAPER 1		PAPER 2	SCHOOL BASED ASSESSMENT	TOTAL MARKS	% WEIGHT OF DIMENSION
	1A	1B				
Knowledge and Comprehension	-	10	40	20	70	30
Application of Knowledge	-	40	20	30	90	40
Scientific Inquiry Skills	50	-	-	20	70	30
Total Marks	50	50	60	68	230	-
% Contribution of Papers	22		48	30	-	100

You will note that Paper 1 has a contribution of 22% to the total marks; Paper 2 has a contribution of 48% to the total marks; and School Based Assessment has a contribution of 30% the total marks. The numbers in the cells indicate the marks to be allocated to the items/questions that test each of the dimensions within the respective test papers.

The last but one column shows the total marks allocated to each of the dimensions. Note that the numbers in this column are additions of the numbers in the cells and they agree with the profile dimension weight indicated in the last column.

Of the total marks of 228, 90 marks (equivalent to 40% of the total marks), are allocated to Knowledge and Comprehension. 69 marks, equivalent to 30% of the total marks are allocated to each of Application of Knowledge and Scientific Inquiry skills. The weight of each of the three dimensions are indicated in the last column. of the table. The ratio of theory to practical in physics is 70:30.

Item Bank: Obviously the structure of assessment recommended in this syllabus will need a lot of work on the part of the teacher. In preparation for setting examination papers, try to develop an item bank. The term “item bank” is a general term for a pool of objective items, a pool of essay questions or a pool of practical test questions. As you teach the subject, try to write objective test items, essay questions, structured essay questions and practical test questions to fit selected specific objectives which you consider important to be tested. If you proceed diligently, you will realize you have written more than 100 objective test items, and more than 30 essay questions in a space of one year. Randomly select from the item bank to compose the test papers. Select with replacement.

This means, as items/questions are selected for testing, new ones have to be written to replace those items/questions already used in examinations. Items and questions that have been used in examinations may also be modified and stored in the item bank. An important issue in the preparation for a major examination such as the WASSCE, is the issue of test wise ness. To be test wise means that the student knows the mechanics for taking a test. These mechanics include writing your index number and other particulars accurately and quickly on the answer paper; reading all questions before selecting the best questions to answer; apportioning equal time to each question or spending more time on questions that carry more marks; making notes on each question attempted before writing the answer; leaving extra time to read over one's work; finally checking to see that the personal particulars supplied on the answer sheet are accurate. Some good students sometimes fail to do well in major examinations because of weakness in the mechanics of test taking; because they are not test wise. Take your students through these necessary mechanics so that their performance in major examinations may not be flawed by the slightest weakness in test taking.

GRADING PROCEDURE

To improve assessment and grading and also introduce uniformity in schools, it is recommended that schools adopt the following grade boundaries for assigning grades on students' test results.

Grade A:	80 - 100%	-	Excellent
Grade B:	70 - 79%	-	Very Good
Grade C:	60 - 69%	-	Good
Grade D:	45 - 59%	-	Pass
Grade E:	35 - 44%	-	Weak
Grade F:	≤ 34%	-	Very weak

In marking your class examination scripts, it is very important that you develop a marking scheme. A marking scheme, consists of the points for the best answer you expect for each question, and the mark allocated for each point raised by the student as well as the total marks for the question. For instance, if a question carries 20 marks, and you expect 6 points in the best answer, you could allocate 3 marks or part of it (depending upon the quality of the points raised by the student) to each point , hence totaling 18 marks, and then give the remaining 2 marks or part of it for organization of answer. For objective test papers you may develop an answer key to speed up the marking.

In assigning grades to students' test results, you may apply the above grade boundaries and the descriptors which indicate the meaning of each grade. The grade boundaries are also referred to as grade cut-off scores. For instance, the grade cut-off score for a B grade is 70% in the example. When you adopt a fixed cut-off score grading system as in this example, you are using the criterion-referenced grading system. By this system a student must make a specified score to be awarded the requisite grade. This system of grading challenges students to study harder to earn better grades. It is hence a very useful system for grading achievement tests.

GUIDELINES FOR SCHOOL BASED ASSESSMENT

The different components of School Based Assessment may be grouped as follows: projects, class tests, homework, terminal test and assessment of laboratory and field work. Important considerations in each of the above School Based Assessment components are as follows:

1. Laboratory Work:
   Students will be required to keep laboratory notebook. It is of utmost importance that records be neatly and accurately kept by both student and teacher.

2. Home Work: This is an assignment to be completed within a day or a couple of days. Homework may consist of essays, summaries, and other problems to be solved.

3. Class Tests: These will essentially consist of written assignments.

4. Projects/Field Work: These are tasks assigned to students to be completed over an extended time.

   These will involve the following:
   i) practical work
   ii) experiment
   iii) investigative study (including case study)

   A report must be written for each project undertaken.

5. Terminal Examination: A terminal examination is a summative evaluation method for assessing the subject content, skills and the profile dimensions taught. In developing the terminal test, please ensure that the test will have high content validity.

SENIOR HIGH SCHOOL – YEAR 2

SECTION 1

MOTION, FORCES AND ENERGY

General Objective: The student will

1. appreciate the importance of making accurate measurements of physical quantities and their applications in science and technology.
2. recognize the various types of motion and the laws which govern them and their applications.
3. recognize the various forms in which forces affect the state of a body and their applications.
4. appreciate the various forms of energy and energy resources and the ways to harness the renewable sources of energy.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1	The student will be able to:		Let students:	
PHYSICAL QUANTITIES	1.1.1 distinguish between basic (fundamental) and derived physical quantities and their units.	Basic (Fundamental) Quantities. Derived Quantities.	discuss the basic (fundamental) and derived quantities and their corresponding S. I. units.	List five basic and six derived quantities and their corresponding S.I units.
	1.1.2 measure with various measuring instruments.	Measuring Instruments: metre rule, vernier calliper,micrometer screw gauge, beam balance, spring balance, stop watches/clocks (digital and analogue).	discuss the use of the under listed measuring instruments: i. a metre rule. ii. vernier callipers. iii. micrometer screw gauge. iv. beam balance, electronic balance and spring balance. v. stopwatches/ clocks. - discuss the relationship between period and frequency. - take accurate measurements of selected objects using each of the instruments listed in the Content.	Compare the accuracy in measuring the diameter of a wire with micrometer screw gauge and vernier callipers.
	1.1.3 explain uses of dimensional analysis in terms of the relationship between basic and derived quantities.	Dimensional analysis and its uses in physics.	use dimensions to verify the dimensional correctness of a given equation. use dimensional analysis to derive the relationship between quantities.	What are the dimensions of the following physical quantities: force, density, pressure, work and power?

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1 **PHYSICAL QUANTITIES (CONT'D)**	The student will be able to: 1.1.4 identify scalars and vectors from a list of physical quantities.	Scalar and vector quantities. Vector representation. Addition and resolution of vectors.	Let students: - discuss scalar and vector quantities. - use force board to determine the resultant of two forces. - determine the resultant of two vectors by graphical method and by calculation.	
UNIT 2 **KINEMATICS**	1.2.1 list and describe the various types of motion.	Types of motion: rectilinear, circular, spin, rotational, oscillatory, random and translational motions.	- demonstrate the different types of motion such as the following; i. tie a pendulum bob and whirl in a circle ii. use pendulum to demonstrate oscillatory motion.	
	1.2.2 distinguish between distance and displacement, speed and velocity, average velocity and instantaneous velocity.	Distance, displacement, speed, velocity, acceleration, uniform velocity, instantaneous velocity and average velocity.	- discuss using appropriate examples to distinguish between various types of motion: distance, displacement, speed, velocity, acceleration, uniform velocity, instantaneous velocity and average velocity. - measure displacement, velocity, and acceleration of a moving object.	
	1.2.3 derive the equations of uniformly accelerated motion.	Equations of uniformly accelerated motion. Motion of free fall due to gravity.	- derive equations of uniformly accelerated motion. - use equations to solve problems of uniformly accelerated motion. - discuss motion of free fall due to gravity.	A bus starts from rest and accelerates uniformly at $2ms^{-2}$ for 10s. It maintains the maximum speed attained for further 10s and decelerates at $1ms^{-2}$ gradually to rest. Find a. the maximum velocity attained b. the time taken c. the total distance covered d. the average velocity.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 2	The student will be able to:		Let students:	
KINEMATICS (CONT'D)	1.2.4 interpret graphical representations of linear motion.	Displacement-time graph, velocity-time graph.	- draw and interpret graphs to illustrate uniformly accelerated motion. - use displacement -time graphs to determine velocity. - use velocity-time graph to determine: i. distance covered ii. acceleration iii. the instantaneous velocity at a given time.	Use velocity-time graph to illustrate accelerated motion.
	1.2.5 investigate the motion of a battery-powered toy car.	Plotting of a displacement- time graph.	-observe the motion of a battery-powered toy car moving in a straight line. Make measurement of distances in some time intervals. Draw a displacement-time graph. Repeat for different surfaces. Analyze the motion and draw conclusions. Present a report. **NOTE:** observe students go through the skills of observing, measuring time and distance, collecting data, interpreting data, inferring, communicating and drawing conclusions.	
	1.2.6 explain the concept of relative velocity.	Relative velocity.	- discuss the concept of relative velocity. - use the concept of relative velocity to explain the motion between two vehicles moving in: i. them same direction ii. opposite directions iii. perpendicular direction.	A car moves at $30ms^{-1}$ whiles the velocity of a bus is $40ms^{-1}$. Find the velocity of the bus relative to the car when the two vehicles are moving i. in the same direction ii. in opposite directions iii. in perpendicular directions.
	1.2.7 describe the motion of a projectile.	Projectile motion - horizontal range - maximum height	- discuss the motion of a projectile.	The horizontal range, R of a projectile is given by the equation $R = \frac{u^2 \sin 2\theta}{g}$ i. What does θ in the equation represent? ii. For what value of θ would R be maximum?

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 3 **DYNAMICS**	The student will be able to: 1.3.1 state Newton's three laws of motion and explain the concept of inertia.	Newton's Laws of motion. Inertia.	Let students: - discuss the Newton's laws of motion and relate them to practical examples such as the reaction of passengers when a car suddenly stops or moves. - explain the concept of Inertia.	State Newton's laws of motion and deduce the expression F = ma
	1.3.2 explain force and relate force to momentum and acceleration.	Force. Momentum. Impulse of a force.	- brainstorm to bring out the meaning of force. - use Newton's laws of motion to derive an expression for force. - explain the term Impulse.	A car of mass 2000kg is accelerating at $2ms^{-2}$. What force is exerted by the engine?
	1.3.3 explain the concept of conservation of linear momentum.	Conservation of linear momentum.	- discuss the law of conservation of linear momentum. - discuss the recoil of a toy gun when fired. - use a timing device and trolley to verify the law of conservation of momentum..	Explain why the police insist that passengers should wear seat belts when cars are in motion.
	1.3.4 Differentiate between elastic and inelastic collisions.	Elastic and inelastic collisions.	- discuss elastic and inelastic collisions. The discussion should include perfectly elastic and perfectly inelastic collisions. **Note:** stress that for a perfectly elastic collision the relative speed of approaching objects is equal to the relative speed of their separation.	A bullet of mass 20g is fired horizontally into a suspended wooden block of mass 180g with a velocity of $100ms^{-1}$. Calculate the common velocity with which the embedded wooden block moves.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 4	The student will be able to:		Let students:	
FORCES	1.4.1 distinguish between different types of forces.	Types of forces: -contact forces -field forces	Discuss contact forces and field forces.	Differentiate between contact forces and field forces.
	1.4.2 describe different types of forces and how they affect the state of a body.	Types and effects of forces (torsional, shear, frictional, tensile, compressional).	- discuss the effect of forces on objects in motion using relevant examples.	List any six different types of forces. Describe the forces involved in the following i. grating cassava ii. blending of vegetables iii. weaving a sisal rope .
	1.4.3 define friction and explain the laws of friction.	Friction Laws of friction Coefficient of static and dynamic friction.	- brainstorm to bring out the meaning of friction. - discuss the laws of friction. (The discussion should include the coefficient of static and dynamic friction). - discuss the methods by which friction can be reduced.	
	1.4.4 explain viscosity and the coefficient of viscosity.	Viscosity. Coefficient of viscosity.	- brainstorm to bring out the meaning of viscosity. - discuss the coefficient of viscosity in terms of frictional force and velocity gradient.	
	1.4.5 explain terminal velocity and compare the viscosities of different types of fluids.	Terminal velocity Stoke's law. Comparison of viscosities of various liquids.	- discuss the term terminal velocity. - discuss the forces acting on an object at terminal velocity. - determine the time of movement of a given stone in different liquids.	
	1.4.6 explain surface tension	Surface tension.	- explain surface tension in terms of intermolecular forces. - demonstrate surface tension.	a. What is surface tension? b. state two methods by which the surface tension of a liquid can be reduced.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 4 (CONT'D)	The student will be able to:		Let students:	
FORCES	1.4.7 describe the moment of a force in terms of its turning effects.	Turning effect of forces.	- discuss the turning effect of forces. - demonstrate how to find the centre of gravity of a lamina.	
	1.4.8 demonstrate the principle of moments of a body in equilibrium.	Principle of moments.	- discuss the moment of a force about a point. - discuss the principle of moments. - verify the principle of moments using a lever and standard masses. - discuss the conditions necessary for a body to be in equilibrium .	A uniform metre rule is balanced by hanging a 30g mass at 90cm mark. If the pivot is at the 30cm mark, calculate the mass of the metre rule. a. State the principle of moments. b. A load of 200g is placed at the 10cm mark of a uniform metre rule and balances with the pivot at the 35cm mark. Calculate the mass of the rule.
	1.4.9 determine the relative density of a metal using the principle of moments.	Application of the principle of moments.	- design and carry out an experiment to determine the relative density of a metal. Indicate the applications of the principle of moments. Present a report. **NOTE:** encourage students to demonstrate the following inquiry skills: designing experiments, measuring, observing, controlling variables, collecting data, interpreting data, communicating and drawing conclusions.	

SENIOR HIGH SCHOOL- YEAR 2

SECTION 2

THERMAL PHYSICS

General Objectives: The student will

1. understand the concept of heat, its relationship with temperature and its effects on substances.
2. appreciate the principles involved in the measurement of temperature.
3. recognise heat as a form of energy and how it can be measured and stored.
4. be aware of the various modes of heat transfer.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1	The students will be able to:		Let students:	
TEMPERATURE AND ITS MEASUREMENT	2.1.1 explain temperature and heat.	Temperature. Heat.	- discuss to bring out the meaning of the concept of temperature. - discuss to distinguish between heat and temperature.	Distinguish between heat and temperature.
	2.1.2 outline the steps and principles involved in the measurement of temperature.	Thermometric property. Temperature scales: (Celsius, Fahrenheit and Kelvin scales). Upper and lower fixed points.	- discuss thermometric property and associated characteristics. - discuss the Celsius, Fahrenheit and Kelvin scales of temperature and the relation between them. - discuss the processes involved in establishing the Celsius scale and the Kelvin scale. - Carry out activities to demonstrate the lower and upper fixed points in the measurement of temperature.	Describe how you would determine the upper fixed point of a liquid-in-glass thermometer.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1 (COND'T) TEMPERATURE AND ITS MEASUREMENT	The students will be able to: 2.1.3 describe the features and uses of different types of thermometers.	Types of thermometers: Liquid-in-glass thermometer, Resistance thermometer, Thermocouple, Constant volume gas thermometer, Pyrometer.	Let students: - discuss the main features, uses and limitations of the listed thermometers.	State four advantages that mercury has over alcohol as a thermometric liquid.
	2.1.4 analyse the effect of temperature change on the dimensions of substances.	Thermal expansion. Types of expansivity: linear, area and volumetric.	- discuss what happens in a substance undergoing temperature change. - discuss the anomalous expansion of water. - determine linear, area and volumetric expansivity.	The length of a liquid column in a glass tube reads 2cm, 25cm and 15cm respectively if the bulb is placed in ice, steam and hot liquid. Calculate the temperature of the hot liquid. Explain the anomalous expansion of water. a. Define linear expansivity. b. A metal rod of length 40cm and of temperature 30^0C is heated to 105^0C. Calculate the increase in length of the rod. Linear expansivity of the metal is $4.0x10^{-5}K^{-1}$,

SENIOR HIGH SCHOOL- YEAR 2

SECTION 3

WAVES

General Objectives: The student will

1. understand that waves transmit energy as they travel through media or vacuum.
2. become aware of the properties and transmission of light in various media and their applications.
3. appreciate the principles underlying the production, transmission and applications of sound.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1	The students will be able to:		Let students:	
REFLECTION OF LIGHT FROM PLANE AND CURVED MIRRORS.	3.1.1 describe reflection of light from plane surfaces.	Reflection of light from plane surfaces.	- discuss reflection of light from plane surfaces. - trace the path of a ray reflected from the surface of a plane mirror using optical pins and measure angle of incidence (i) and angle reflection (r).	Use optical diagram to locate the image of a point object in a plane mirror.
	3.1.2 state and verify the laws of reflection.	Laws of reflection.	- discuss the laws of reflection. - discuss regular and irregular reflection.	
	3.1.3 locate and describe the image formed in a plane mirror and its characteristics.	Image formed in a plane mirror.	- discuss the characteristics of image formed in the plane mirror. - construct a periscope and kaleidoscope and discuss their applications. - discuss the general formula . $n = \frac{360}{\theta}$ Where **n** = total number of images seen in two mirrors inclined at an angle **θ**.	Find the number of images formed by an object placed between two plane mirrors inclined at 30^{0}.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1 (CONT'D)	The students will be able to:		Let students:	
REFLECTION OF LIGHT FROM PLANE AND CURVED MIRRORS.	3.1.4 distinguish between diverging and converging mirrors.	Converging mirrors and diverging mirrors. (Spherical mirrors).	- observe and discuss diverging and converging mirrors as segments of a hollow sphere.	How many images are formed in two parallel mirrors.
	3.1.5 trace light rays to locate the positions of the images formed by spherical mirrors and describe their characteristics.	Formation of images in spherical mirror and their characteristics.	- use ray box or optical pins to determine the position and characteristics of images formed in spherical mirrors. - use mirror formula and magnification formula to solve simple problems .	compare converging and diverging mirrors in terms of : i. image formation. ii. magnification.
	3.1.6 determine the focal length of a converging mirror.	Determination of the focal length of a converging mirror.	- perform an experiment to determine the focal length of converging mirror using any appropriate method. Present a report on your work. **NOTE:** observe students go through the skills of observing, measuring, controlling variables, collecting data, interpreting data, communicating and drawing conclusions.	An object is placed 20cm in front of a converging mirror of focal length 15cm.Determine the position of the image.
	3.1.7 explain the uses of spherical mirrors.	Uses of spherical mirrors.	- discuss the uses of spherical mirrors with examples.	

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 2 **REFRACTION OF LIGHT**	The student will be able to: 3.2.1 state the laws of refraction.	Refraction at plane surfaces. Laws of refraction.	Let students: - discuss the concept of refraction and the terms used. - discuss the laws of refraction.	
	3.2.2 explain refractive index.	Refractive Index.	- discuss refractive index. - trace rays through a rectangular prism. - measure and compare the angle of incidence and the angle of refraction. - relate lateral displacement to the angle of incidence and angle of refraction. - discuss refractive index in terms of real and apparent depth. - discuss refractive index in terms of the speed of light in different media.	In an experiment to determine the refractive index of a glass in the form of a rectangular prism, the angle of incidence, and the angle of refraction were 30^0 and 19.5^0 respectively. Determine the refractive index of the material of the glass.
	3.2.3 design and carry out an experiment to determine the refractive index of glass.	Determination of the refractive index of glass.	- perform an experiment to determine the refractive index of substances (e.g. glass block, water) using appropriate methods. Present a report on your work. **NOTE:** observe students go through the following inquiry skills: designing experiments, measuring, collecting data, interpreting data, controlling variables, communicating and drawing conclusion.	One method of determining the refractive index of a transparent solid is to measure the critical angle when the solid is in air. If the critical angle is found to be 40.5^0. What is the refractive index of the solid?

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 2 (CONT'D)	The student will be able to:		Let students:	
REFRACTION OF LIGHT	3.2.4 trace rays of light through a triangular prism to determine its refractive index.	Refraction through triangular prism. - angle of the prism (A) - angle of incidence (i) - angle of refraction (r) - angle of emergence (e) - angle of deviation (D) $n = \frac{\mathrm{Sin}\left(\frac{A + D_{min}}{2}\right)}{\mathrm{Sin}\left(\frac{A}{2}\right)}$	- discuss the path of rays of light through a triangular prism. - use appropriate graph to show the relationship between the measured angles and deduce the minimum deviation. - Perform an experiment to determine the refractive index of a triangular prism using appropriate methods. Present a report on your work. **NOTE:** observe students go through the following inquiry skills: measuring, collecting data, interpreting data, controlling variables, communicating and drawing conclusions.	
	3.2.5 explain the concepts critical angle and total internal reflection.	Critical angle (C) and total internal reflection(n). $n = \frac{1}{\mathrm{Sin}\,C}$	-discuss critical angle and total internal reflection. -perform an experiment to determine critical angle, and show total internal reflection.	Explain the following terms: (i) critical angle (ii) total internal reflection.
	3.2.6 describe some applications of total internal reflection.	Applications of total internal reflection: refracting prism, binoculars, mirage.	- discuss some applications of total internal reflection.	

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 3 **BASIC FIBER OPTICS**	The student will be able to: 3.3.1 explain the concept of fiber optics.	Fiber optics.	Let students: - discuss what is meant by fiber optics.	
	3.3.2 describe an optical fiber and the principle of its operation.	Optical fiber: * Structure. * Mode of operation.	- discuss an optical fiber. Draw the cross section of an optical fiber showing the core, cladding layer, buffer layer and the jacket. Discuss the principle of operation of an optical fiber.	Explain what is meant by fiber optics and outline the principle involved in transmission of light using optical fiber.
	3.3.3 demonstrate the efficient transmission of light through an optical fiber	Demonstration of light transmission through an optical fiber.	Perform an experiment to demonstrate the use of optical fiber to transmit light **NOTE:** You may use the following materials in setting up the experiment. (i) triangular glass prism (ii) white light source (white LED) (iii) a length of optical fiber cable (iv) a screen made of roughened surface of one side of a transparent perspex or milk perspex sheet. Design a set up to investigate the transmission of light through the optical fiber. Present a report on your work. **NOTE:** observe students go through the following inquiry skills: designing experiments, observing, collecting data, interpreting data, communicating and drawing conclusion.	
	3.3.4 describe the applications of fiber optics.	Applications of fiber optics.	- discuss the applications of fiber optics in areas such as communication, e.g. Local Area Networks (LANs), medicine, sensing devices, carrying laser beams.	Outline three applications of fiber optics.

SENIOR HIGH SCHOOL- YEAR 2

SECTION 4

ELECTRIC AND MAGNETIC FIELD

General Objectives: The student will

1. be aware that electrical charges can be stored in electrostatic field.
2. understand the laws governing direct current circuits and their applications.
3. appreciate the nature and properties of magnets and their applications.
4. recognise the effects of electromagnetic fields on conductors and current-carrying conductors.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1	The student will be able to:		Let students:	
DIRECT CURRENT CIRCUIT ANALYSIS	4.1.1 list and describe sources of electricity.	Sources of electricity: Primary and Secondary cells, Generators, solar cells, fuel cells. Thermoelectric effect.	- discuss different sources of electricity. - discuss the limitations in the applications of each source. - discuss the concept of internal resistance of a voltage source.	(a) What is i Polarization, ii Local action, as applied to primary cells? iii. Explain how polarization and local action can be minimized
	4.1.2 apply thermoelectric effect to generate electric power.	Application of thermoelectric effect.	design a thermocouple and indicate the reference cold and hot junctions.. Make the necessary measurements of output voltage and the temperature difference between the junctions. Investigate how the output e.m.f can be increased. **NOTE:** Assist students to acquire the following scientific inquiry skills: measuring, collecting data, interpreting data, problem solving, communicating and drawing conclusions.	Describe how an accumulator is charged.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT1 (CONT'D)	The student will be able to:		Let students:	
DIRECT CURRENT CIRCUIT ANALYSIS	4.1.3 state Ohm's law and explain the factors that affect the resistance of a conductor.	- Ohm's law - Experiment to demonstrate ohm's law.	- discuss Ohm's law. - perform an experiment to verify Ohm's law. Present a report on your work. **NOTE:** Assist students to acquire the skills of measuring, collecting data, controlling variables, interpreting data, communicating and drawing conclusions.	(a) define resistivity. (b) calculate the resistance of a 2m wire with diameter 0.5mm and resistivity $1.5x10^{-7}\Omega m$.
		Factors that affect resistance of canducter.	- discuss the factors that affect the resistance of a conductor. - discuss resistivity.	
		- Resistivity.	- discuss the temperature co-efficient of resistance of a wire.	
		- Temperature co-efficient of resistance.	- discuss thermistors as temperature dependent resistors and their uses.	
	4.1.4 determine the effective resistance of resistors in a circuit.	- Thermistors. Resistors in series and parallel. Potential divider. Colour code.	- derive expressions for resistances in series and parallel. - arrange resistors in series and parallel and measure the effective resistance. Compare with calculated values. - discuss the use of potential divider. - classify resistors according to their magnitude using colour code.	A resistor has a colour code of green, blue, red and silver in that order. Find the resistance of the resistor.
	4.1.5 describe the measurement of d.c. voltage across high resistances.	Measurement of d.c. voltage.	discuss the concept of input resistance in electrical voltage measurements. Measure the d.c. voltages across a range of resistances up to 500 KΩ using analogue and digital voltmeters Compare the results obtained with each instrument with the calculated values using the potential divider principle.	Which instrument will you use to measure a very high resistance, a digital or analogue voltmeter? Give reasons for your answer.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1 (CONT'D)	The student will be able to:		Let students:	
DIRECT CURRENT CIRCUIT ANALYSIS	4.1.6 state Kirchhoff's laws of electrical network and explain them.	Kirchhoff's laws of electrical network.	- discuss Kirchhoff's laws and illustrate the laws with appropriate diagrams.	State Kirchhoff's laws. Draw diagrams to illustrate them.
	4.1.7 describe and explain the uses of a metre bridge.	Experiment using metre bridge to determine: - resistance - resistivity - temperature coefficient of resistance Metre bridge and its uses.	- describe the metre bridge and derive the balanced bridge equation. - Mention should be made of the Wheatstone bridge - Perform experiments using metre bridge to determine (i) resistance (ii) resistivity (iii) temperature coefficient of resistance. **NOTE:** observe students go through the skills of observing, measuring, controlling variables, collecting data, interpreting data, communicating and drawing conclusions.	
	4.1.8 perform an experiment to demonstrate the uses and principles of a potentiometer.	- Experiment using Potentiometer - Principles of a potentiometer - Applications of a potentiometer	- discuss the principle of a potentiometer. - discuss the applications of a potentiometer as a variable potential divider. Perform an experiment to determine the internal resistance of a cell using the potentiometer. Present a report on your work. **NOTE:** Assist students to acquire the following scientific inquiry skills: observing, measuring, controlling variables, collecting data, interpreting data, drawing conclusions and communicating result.	

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 2	The student will be able to:		Let students:	
ELECTROSTATICS	4.2.1 classify materials as conductors, insulators, and semi-conductors.	Conductors, insulators, and semi-conductors.	- discuss the properties of conductors, insulators, and semi-conductors. - classify given materials into conductors, insulators, and semi-conductors.	Give two examples each of: (i) conductors (ii) semi-conductors (iii) insulators.
	4.2.2 outline the methods of charging materials.	Methods of charging materials – friction, contact, induction, and conduction.	- demonstrate the various methods of charging materials.	Briefly describe how a conductor can be charged positively by induction.
	4.2.3 describe the distribution of charges on a pear-shaped and spherical conductors.	Distribution of charges on surfaces of conductors.	- investigate the charge distribution on pear shaped and spherical conductors.	
	4.2.4 explain the action of charges at sharp points.	Action of charges at sharp points.	- discuss the action of charges at sharp points. - discuss the structure and functioning of lightning conductors.	
	4.2.5 explain the concepts of an electric field and electric field intensity.	Electric Field. Electric field intensity.	- discuss electric field in terms of electric lines of force. - discuss the electric field intensity as force per unit charge $E = F/Q$	

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 2 (CONT'D)	The student will be able to:		Let students:	
ELECTROSTATICS	4.2.6 explain Coulomb's law for point charges.	Coulomb's law	- discuss Coulomb's law. - solve problems involving the use of Coulomb's law.	Calculate the force between two charges 50μc and 10μc when they are placed 50cm apart in a vacuum. $(4\pi\ \varepsilon_o)^{-1} = 9.0 \times 10^9 Nm^2c^{-2}$
	4.2.7 explain electric potential, potential difference and electric potential energy.	Electric potential. Potential difference. Electric potential energy.	- discuss electric potential, potential difference and electric potential energy.	Find the electric potential at a point which is 120cm from a charge of +200μC.
	4.2.8 deduce the relationship between the potential gradient and the electric field intensity.	Electric field intensity. Potential gradient.	- deduce the relationship between potential gradient and electric field intensity.	Two positive charges +10μC and + 20μC are separated by a distance of 3m in a vacuum. Find the position where the electric field intensity is zero The electric field intensity between two charged plates is 1.5×10^3N/C. The plates are 0.08m apart. What is the potential difference between the plates?

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 3 **CAPACITORS**	The student will be able to: 4.3.1 describe the structure and operation of capacitors.	Capacitors • structure • operation	Let students: - discuss the structure and operation of the capacitor. (The discussion should include types of capacitors based on the dielectric material used).	
	4.3.2 explain capacitance.	Capacitance (i) $C = Q/V$ (ii) $C = \frac{\varepsilon A}{d}$	- discuss capacitance in terms of the charge and potential difference across it. - discuss capacitance in terms of the area, displacement between plates, and permittivity of the dielectric.	Calculate the capacitance of parallel plate capacitor. If the area of overlapping plate is $50cm^2$, and the distance between the plates is 5mm, dielectric constant is 6.7. ($\varepsilon_o=8.85x10^{-12}C^2/Nm^2$)
	4.3.3 describe the charging and discharging process of a capacitor.	Capacitor charging and discharging.	- perform an experiment on charging and discharging of a capacitor. Take measurement and draw: (i) the current/time graph (ii) voltage/time graph - discuss wave forms of the charging and discharging of capacitor. - discuss time constant..	
	4.3.4 derive the formulae for the capacitance of the series and parallel arrangements of capacitors.	Arrangement of capacitors in series and parallel.	- discuss the arrangement of capacitors in series, and in parallel.	Three capacitors of capacitances 1µC, 2µC and 3µC, are connected in series and parallel. A 50V battery is connected in turn across the arrangement. Determine, for each arrangement, (a) the effective capacitance (b) the charge on each capacitor.
	4.3.5 derive the expression for energy stored in a charged capacitor.	Energy stored in a charged capacitor.	- discuss energy stored in a charged capacitor.	
	4.3.6 describe the behaviour of a capacitor in d.c. and a.c. circuits.	Behaviour of capacitor in a d.c. circuit. Behaviour of capacitor in an a.c. circuit.	- discuss the behaviour in a capacitor in a d.c. circuit. - discuss the behaviour of a capacitor in a a.c. circuit. - discuss the uses of capacitors e.g. filtering, timing devices, sequential and clock circuits, digital measurement instrumentation.	

SENIOR HIGH SCHOOL- YEAR 2

SECTION 5

ATOMIC AND NUCLEAR PHYSICS

General Objectives: The student will

1. develop an understanding of the structure of the atom.
2. appreciate the structure of the nucleus.
3. be aware of the peaceful application of nuclear energy.
4. be aware of the importance of photoelectric effect.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1	The student will be able to:		Let students:	
MODELS OF THE ATOM AND ATOMIC STRUCTURE	5.1.1 describe the models of the atom.	Models of the atom: Thompson's model. Rutherford's model. Bohr's model. Wave Mechanical model.	- discuss the various models of the atom, high-lighting on the limitations of each model. (The discussion should include Rutherford's alpha scattering experiment).	Describe Rutherford's alpha scattering experiment and explain the observations, deductions and the conclusion. State Bohr's postulates for the hydrogen atom.
	5.1.2 explain the existence of quantized energy levels in an atom.	Energy quantization. Energy level diagrams. Line spectra. Ionization Potential and ionization energy. Excited states and excitation energy.	- discuss the existence of energy levels in an atom. - discuss the transition of electrons between energy levels. - draw energy level diagrams and use them to determine energy changes between the levels. - discuss ground state, excited state, excitation energy, ionization potential and ionization energy.	Explain briefly what is meant by (I) ground state (ii) first excited state (iii) ionization energy. What are the main characteristics of line spectrum?
	5.1.3 describe the types of spectra and their uses.	Types of atomic spectra(line, band, continuous) and their uses.	- discuss the various types of atomic spectra and their uses.	Explain briefly how line spectra are used to identify elements.

SENIOR HIGH SCHOOL- YEAR 2

SECTION 6

ELECTRONICS

General Objectives: The student will

1. appreciate the characteristics of the P-N junction diode and their applications in electronics .
2. understand the construction and characteristics of the bipolar and junction field-effect transistors and their applications.
3. recognise the various configurations of the operational amplifier and their applications.
4. appreciate the use of digital electronics in electronic switching.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1	The student will be able to:		Let students:	
ELECTRONIC SEMI-CONDUCTOR P-N JUNCTION DIODE	6.1.1 distinguish among conductors, semi-conductors and insulators.	Conductors, semi-conductors and insulators. Energy bands.	- discuss and distinguish conductors, semi-conductors and insulators. - discuss the band theory explanation for electrical conduction in conductors, semi-conductors and insulators.	a. What is a semi-conductor? b. Explain the mode of charge movement in a (i) a semi-conductor (ii) metallic conductor
	6.1.2 distinguish between Intrinsic and extrinsic semi-conductors and their productions.	Intrinsic and extrinsic semi-conductors:	- discuss the terms extrinsic, and intrinsic semi-conductors. - discuss the production of P-type and N-type semi conductors. (The discussion should include doping, acceptor and donor atoms, majority and minority charge carriers).	Why does the conductivity of an intrinsic semi-conductor increase as temperature increases? Explain the production of P and N type semi-conductors.
	6.1.3 describe the formation and action of P-N junction diode.	P-N junction formation. Forward and reverse bias of P-N junction diode. current - voltage (I-V) characteristics.	- discuss the formation of a P-N junction. - discuss the characteristics of P-N junction diodes. - discuss forward and reverse biasing of P-N junction diodes. - discuss the current – voltage characteristics of P-N junction diode.	Explain the following terms as used in semi-conductors (i) donor (ii) acceptor (iii) majority carriers (iv) minority carriers.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1 (CONT'D)	The student will be able to:		Let students:	
ELECTRONICS SEMI-CONDUCTOR P-N JUNCTION DIODE	6.1.4 describe the types of P-N junction diodes and their uses.	Types of P-N junction diodes: - Rectifier diodes - Signal diodes - Light emitting diodes (LED) - Zener diodes - Varactor diodes - Photo diodes	- discuss the types of diodes as listed in the content. - discuss the uses of the various types of P-N junction diodes.	In a bridge rectifier circuit containing 4 diodes, one of the diodes breaks down so that an open circuit occurs at that point. Describe and explain the shape of the output wave form for a sinusoidal a.c input
	6.1.5 describe the half wave and full wave rectification of ac, and explain the smoothing or filter capacitor action.	Rectification: half and full wave. Use of reservoir capacitor for peak d.c. voltage storage.	- discuss the half wave and full wave rectification of a.c. - discuss the reservoir capacitor in peak voltage development and storage.	
	6.1.6 describe voltage regulation, voltage multipliers and d.c. voltage stabilization.	-d.c. voltage regulation. - d.c. voltage stabilization using reverse biased diode (zener diode). - voltage multipliers.	- discuss voltage regulation and use of reservoir capacitor. - discuss the use of zener diode in stabilized d.c. voltage supplies: - discuss voltage multiplication using junction diodes and capacitors when arranged as doublers, triplers and quadruplers. **PROJECT:** - design and construct a 12V regulated power supply using zener diode circuit, capable of delivering 10mA of current to a resistive load. Arrange seven (7) 2mm LEDS in series as your load. Connect the power supply and confirm that your design works. **NOTE:** Assist students to acquire the following scientific inquiry skills: making models, measuring, controlling variables, collecting data, interpreting data, communicating and drawing conclusions.	

SENIOR HIGH SCHOOL- YEAR 3

SECTION 1

MOTION, FORCES AND ENERGY

General Objectives: The student will

1. appreciate the importance of taking accurate measurements of physical quantities and their applications in science and technology.
2. recognize the various types of motion and the laws which govern them and their applications.
3. recognize the various forms in which forces affect the state of a body and their applications.
4. appreciate the various forms of energy and energy resources and the ways to harness the renewable sources of energy.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1 **DEFORMATION OF MATTER**	The student will be able to: 1.1.1. explain that a force may produce a change in the size and shape of a substance. 1.1.2. perform experiment to demonstrate the types of forces that produce deformation. 1.1.3. explain the behaviour of elastic materials under stress.	Deformation: Elastic deformation. Plastic deformation. Experiment to demonstrate types of forces: Tensile, compressive, shear and bulk force. Hooke's law. Elastic limit. Yield point.	Let students: - discuss the effects of forces on shape and size of substances. - discuss elastic and plastic deformations. - perform experiments to demonstrate the types of forces that produce deformation. Perform an experiment to determine the relationship between load and extension. Take measurements. Plot a load-extension graph. Discuss the features of the load-extension graph. **NOTE:** Assist students to acquire the following scientific inquiry skills: observing, measuring, controlling variables, collecting data, interpreting data, communicating and drawing conclusions.	A rubber cord of a catapult has a cross sectional area of 1.0 mm^2 and total unstretched length of 10.0cm. It is stretched to 15cm and released to project a missile of mass 5.0g rubber. Calculate the energy stored in the rubber cord. Use the sketch of the force – extension graph to explain the following: elastic limit, yield point proportional limit, plastic deformation, elastic deformation.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1 (CONT'D)	The student will be able to:		Let students:	
DEFORMATION OF MATTER	1.1.1 explain the terms stress, strain and Young's modulus.	Young's modulus.	- discuss stress, strain and Young's modulus - describe an experiment to determine Young's modulus of a wire. - appreciate the use of stress-strain graph in analyzing and predicting the behaviour of materials under stress.	
	1.1.2 compare bulk and shear moduli.	Bulk and Shear moduli.	- discuss bulk modulus and shear modulus	
	1.1.3 deduce the strain energy from a load extension graph.	Strain energy.	- discuss and bring out the use the load-extension graph to deduce the strain energy per unit volume.	The velocity of a wire 2m long and cross-sectional area $10^{-5}m^2$ is stretched by 1mm by a force of 40N in the elastic region. Calculate i. the strain ii. Young's modulus iii. the energy stored in the wire.
UNIT 2				
CIRCULAR MOTION, THE PLANETS AND GRAVITY	1.2.1 explain angular displacement, angular velocity and angular acceleration.	Angular displacement, angular velocity and angular acceleration.	- discuss to bring out the definition of angular displacement, angular velocity and angular acceleration. - discuss the relationship between speed and angular velocity .	Define the following terms. i. angular displacement ii. angular velocity iii. angular acceleration. Derive an expression for the angular velocity of a body moving at a constant speed V in the circle of radius r.
	1.2.2 explain centripetal force.	Centripetal force. Centripetal acceleration.	- derive the expression for centripetal acceleration and relate it to centripetal force. - discuss centrifugal force - demonstrate centripetal and centrifugal forces.	An object of mass 2.0kg moves in a circle of radius 10m with a constant speed of $6.0ms^{-1}$ Calculate i. the angular velocity ii. centripetal force.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 2 (CONT'D)	The student will be able to:		Let students:	
CIRCULAR MOTION, THE PLANETS AND GRAVITY	1.2.3 explain the applications of circular motion.	Application of circular motion i. banking of roads ii. centrifuge iii. conical pendulum iv. negotiating a bend	- discuss circular motion and explain the listed applications. (See list in Content)	Explain the uses of the following. i. banking of roads ii. centrifuge.
	1.2.4 describe planetary motion and state Kepler's laws of planetary motion.	Planetary motion Kepler's laws of planetary motion.	- explain how the planets move around the sun. - discuss Kepler's laws of planetary motion.	State Kepler's laws of planetary motion.
	1.2.5 explain gravitational field and state Newton's universal law of gravitation.	Gravitational field. Gravitational field strength $g = \frac{F}{M}$ Newton's Universal law of gravitation. $F = G\frac{(M_1M_2)}{r^2}$ $g(r_e)^2 = GM_e$	- discuss the gravitational field. - discuss Newton's universal law of gravitation - discuss the relationship between acceleration due to gravity(g) and universal gravitational constant (G), and deduce the mass of the earth, M_e - solve simple problems involving the gravitational law.	a. Distinguish between universal gravitational constant and acceleration due to gravity. b. Determine the acceleration due to gravity at a height of 1,200km. (Radius of the Earth = 6.4×10^6m Acceleration due to gravity = $9.81ms^{-2}$)

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 2 (CONT'D) **CIRCULAR MOTION, THE PLANETS AND GRAVITY**	The student will be able to: 1.2.6 describe satellites and distinguish between artificial and natural satellites.	Natural and artificial Satellites. Parking orbit, geostationary satellites and period of revolution of a satellite.	Let students: - discuss to bring out the meaning of satellites. - compare artificial and natural satellites. - discuss the period of revolution and the speed of a satellite. - outline the uses of artificial satellites.	A body on the Earth surface is 500kg and is given a velocity such that it just leaves the Earth gravitational field. Find its velocity. $g=9.81ms^{-2}$ $R=6.4 \times 10^{6}m$.
	1.2.7 explain gravitational potential and escape velocity.	Gravitational potential. $V = -\frac{GM}{r}$ Escape Velocity. $v = \sqrt{2gr_e}$	- derive and discuss the gravitational potential. - discuss escape velocity. - calculate the escape velocity of a rocket from the earth's gravitational field.	Define the following terms i. artificial satellites ii. parking orbit iii. period of a satellite. Outline some uses of artificial satellites.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 3 **ENERGY**	The student will be able to: 1.3.1 list and describe the various forms of energy.	Forms of energy: - Potential Energy - Kinetic Energy	Let students: - list and discuss different forms of energy. - demonstrate that an object may have energy due to its position or motion. - solve simple problems using expressions for potential energy and kinetic energy.	A ball of mass 4kg is pushed off the edge of a table that is 2.0m above the floor. Find the speed of the ball as it strikes the floor. [take g=10ms^{-2}]
	1.3.2 describe energy conversion and transformation.	Conversion and conservation of energy. Law of conservation of Energy. 1st law of thermodynamics.	- give examples of conversion of energy from one form to another. - discuss the conservation of mechanical energy. - apply the principle of energy conservation to solve simple problems. - discuss the law of conservation of energy. - discuss 1st law of thermodynamics.	State the law of conservation of energy. Give two examples to illustrate your answer.
	1.3.3 explain the concept of work and power.	Work. Power.	- discuss the concept of work in terms of the product of force and distance moved in the direction of the force - discuss how work done can be expressed as change in mechanical energy. - discuss the concept of power as work done per time. - establish that power is the product of force and velocity.	What must the power output be of an elevator motor that can lift a mass of 10000kg and give the elevator a constant speed of 5ms^{-1}

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 3 (CONT'D) **ENERGY**	The student will be able to: 1.3.4 describe the energy sources in the earth's system.	Renewable energy sources. Non-Renewable Energy sources.	Let students: - discuss the energy sources in the earth's system. - describe how electricity or other forms of energy may be obtained from the renewable sources.	What is meant by the following terms? a. renewable energy b. biomass c. solar energy What are the main environmental implications of using as an energy source i. fossil fuel ii. nuclear fuel iii. solar devices iv. wind energy v. hydroelectric power vi. biomass.
	1.3.5 carry out simple projects to harness solar energy, biomass and wind energy.	Harnessing energy from renewable energy sources.	**PROJECTS:** 1. Design and construct a means to collect and store solar energy. Take appropriate measurements. 2. Design and construct a means of harnessing wind energy. Measure the speed of the wind. 3. Build a digester. Use waste agricultural products to produce methane gas for use in cooking. Propose how electricity can be generated from the gas produced. Write a report. **NOTE:** Assist students to acquire the following scientific inquiry skills: problem solving, designing experiments, measuring, collecting data, controlling variables, interpreting data, communicating and drawing conclusions.	
	1.3.6 describe the effect of the use of both renewable and non-renewable sources of energy on the environment and carbon cycle.	Global warming: Green house effect.	-discuss the effect of the use of both renewable and non-renewable sources of energy on the environment and carbon cycle. Discuss green house effect and the role it plays in determining the earth's temperature.	List the advantages and disadvantages of two primary energy sources which are (a) non renewable (b) renewable.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 4 **OSCILLATORY MOTION**	The student will be able to: 1.4.1 describe oscillatory motion.	Oscillatory motion.	Let students: - discuss oscillatory motion.	
	1.4.2 describe and illustrate simple harmonic motion (SHM).	Simple Harmonic Motion (SHM) - simple pendulum - loaded spiral spring - loaded test tube in a water - bifilar suspension - cantilever	- define and describe simple harmonic motion and give examples as listed in content.	a. Define simple harmonic motion, amplitude and frequency. b. An object moving in simple harmonic motion has amplitude of 0.02m and frequency 40Hz. Calculate i) The period of oscillation. ii) The acceleration at the middle and the end of an oscillation. iii) The velocities at the corresponding positions.
	1.4.3 investigate the relationship between the period of oscillation and; i. Length of a simple pendulum ii. Mass of a loaded spring iii. Mass of a loaded cantilever i. Length of a bifilar suspension.	Experiments on simple harmonic motion.	Perform experiments to determine the relationships between the period of oscillation and : i. Length of a simple pendulum ii. Mass of a loaded spring iii. Mass of a loaded cantilever iv. Length of a bifilar suspension. Deduce the acceleration due to gravity from the relationship between period and length of a simple pendulum. **NOTE:** observe students go through the skills of measuring, controlling variable, collecting, interpreting data, analyzing, communication, and drawing conclusions.	
	1.4.4 describe the velocity, acceleration and energy of a body exhibiting simple harmonic motion.	Velocity, acceleration and energy of simple harmonic motion a body exhibiting.	- discuss the velocity, acceleration and energy of a body exhibiting simple harmonic motion.	
	1.4.5 interpret graphical representation of simple harmonic motion.	Graphical representation of simple harmonic motion. $y = a\sin\omega t$.	- sketch graphs to illustrate simple harmonic motion and establish the link between simple harmonic motion and uniform circular motion.	

SECTION 2

THERMAL PHYSICS

General Objectives: The student will

1. understand the concept of heat, its relationship with temperature and its effects on substances.
2. appreciate the principles involved in the measurement of temperature.
3. recognise heat as a form of energy and how it can be measured and stored.
4. become aware of the various modes of heat transfer.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1 **MEASUREMENT OF HEAT ENERGY**	The student will be able to: 2.1.1 explain the concept of heat.	Heat.	Let students: - discuss heat as a form of energy.	
	2.1.2 explain heat capacity and specific heat capacity and describe the methods for measuring them.	Heat capacity. Specific heat capacity method of mixtures Newton's law of cooling cooling curve method electrical method. Experiment to determine heat capacity and specific heat capacity.	- define and discuss heat capacity and specific heat capacity. - discuss Newton's law of cooling. - use method of mixtures, cooling curve method and electrical method to determine the specific heat capacities of solids and liquids. - Perform experiments to determine the specific heat capacities of liquids and solids using the methods outlined above **NOTE:** observe students go through the skills of observing, measuring, problem solving, collecting data, interpreting data, analyzing, communicating and drawing conclusions.	Distinguish between heat capacity and specific heat capacity. A body of mass 2kg is heated from $20^{o}C$ to $30^{o}C$ in 40s. Find the average power supplied. (Specific heat capacity of water is $4200JKg^{-1}K^{-1}$).
	2.1.3 explain the concept of latent heat and specific latent heat.	Latent heat and specific latent heat (of fusion and vaporization).	- discuss the concept of latent heat of fusion and vaporization. - determine the specific latent heat of fusion and vaporization using, i. method of mixtures ii. electrical method.	Describe an experiment to determine the specific latent of fusion of ice.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1(CONT'D) **MEASUREMENT OF HEAT ENERGY**	The student will be able to:		Let students: Perform an experiment to determine the latent heat of fusion of ice by the method of mixtures. Present a report. **NOTE:** assist students go through the skills of observing, measuring, problem solving, interpreting data and drawing conclusions.	
	2.1.4 explain the concept of melting .	Melting.	- discuss melting. - determine the melting point of naphthalene using the cooling curve method.	State the effects o pressure on the melting point of a substance.
	2.1.5 distinguish between boiling and evaporation.	Boiling. Evaporation.	- perform experiments to determine the boiling points of liquids. - discuss evaporation and explain how evaporation affects the cooling of substances.	List the similarities and differences between boiling and evaporation.
	2.1.6 investigate the effect of insulation on the rate of cooling of water.	Effect of insulation on the rate of cooling.	Design and carry out an experiment to investigate the effect of insulation on the rate of cooling. Select suitable insulating material for each test. Take appropriate measurements. Produce graphs and draw appropriate conclusions. **NOTE:** Assist students to acquire the following scientific inquiry skills: designing experiments, observing, measuring, collecting data, interpreting data, inferring, communicating and drawing conclusions.	
UNIT 2 **HEAT TRANSFER**	2.2.1 explain the different modes of heat transfer.	Heat transfer - conduction - convection - radiation	- discuss conduction, convection and radiation of heat. - demonstrate conduction of heat in a metal rod. - demonstrate convection current in water or air. - perform experiment to demonstrate radiation or absorption of radiant energy.	Explain the terms; conduction, convection and radiation of heat.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 2 (CONT'D)	The student will be able to:		Let students:	
HEAT TRANSFER	2.2.2 explain the principle underlining heat pipes and describe its applications.	Heat Pipes: Cooling and evaporative heat transfer.	- discuss the construction and mode of operation of heat pipes utilizing cooling and evaporating heat transfer - discuss the applications of heat pipes.	Describe the mode of operation of a heat pipe
	2.2.3 explain thermal conductivity.	Thermal conductivity.	- discuss thermal conductivity. - derive expressions for the rate of flow of heat through a thin parallel-sided slab, and a composite wall. - discuss the rate of flow of heat through lagged and unlagged slabs.	a. Explain the term thermal conductivity b. explain what is meant by temperature gradient. c. an ideally lagged copper rod 25cm long and thickness 1.2cm thick. has one free end maintained at $100^{o}C$ and the other end at $90^{o}C$. Calculate i) the temperature gradient ii) the rate of flow of heat at the steady state. Thermal conductivity of copper=$390Wm^{-1}K^{-1}$
	2.2.4 describe a black body.	Black body.	- discuss black body using suitable illustration.	
	2.2.5 explain black body radiation.	Black body radiation.	- discuss black body radiation.	
		Stefan-Boltzmann's law.	- discuss the variation of intensity of black body radiation with wavelength at different temperatures.	With the aid of a diagram, describe a black body.
	2.2.6 build a heat storage device.	Heat storage device.	Design and construct a heat storage device. **HINT.** You may use any of the following materials. i. kaolin(a heat barrier material) ii. a glass plate or sheet of transparent plastic iii. thermometer iv. metal box with a lid v. pebbles from the sea shore vi. matt black paint (one tin). Your objective is to harness heat energy and store it. Identify the source of heat. Construct the storage device. Through measurements, determine the degradation of heat stored with time. Write a report. **NOTE:** Assist students go through to the skills of problem solving, applying concepts, observing, measuring, collecting data, interpreting data, communicating and drawing conclusions.	a. Define thermal conductivity. b. The rate of flow of heat through a parallel sided slab of cross-sectional area $2.0X10^{-2}m^{2}$ and length 0.15m is $400Js^{-1}$. At the steady state, the temperature difference between the two surfaces is $80^{o}C$. Calculate the thermal conductivity of the slab.

SECTION 3

WAVES

General Objectives: The student will

1. develop an understanding that waves transmit energy as they travel through media or vacuum.
2. be aware of the properties and transmission of light in various media and their applications.
3. appreciate the principles underlying the production, transmission and applications of sound.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1 **THIN LENSES AND OPTICAL INSTRUMENTS**	Student will be able to: 3.1.1 explain focal length and the power of lenses and discuss the images formed by lenses.	Types of lenses Focal length and power of a lens Formation of images using converging and diverging lenses.	Let students: - discuss the types of lenses and the focal length of Lenses. - discuss the power of a lens. - discuss images formed by lenses. - use ray diagrams to locate positions of mages formed by converging and diverging lenses. - use the lens and linear magnification formulae to solve simple problems.	
	3.1.2 determine the focal length of a lens.	Determination of the focal length of a lens.	Perform experiments to determine the focal length of a lens using: i. Newton's formula method ii. Lens formula method iii. Displacement method Write a report on each experiment. **NOTE:** Assist students go through the skills of observing, measuring, controlling variables, collecting data, interpreting data, communicating and drawing conclusions.	
	3.1.3 explain visual angle and angular magnification.	Visual angle and angular magnification.	- With sketches, discuss visual angle and angular magnification.	

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1 (CONT'D)	The student will be able to:		Let students:	
THIN LENSES AND OPTICAL INSTRUMENTS	3.1.4 explain the structure and operation of optical instruments.	Optical Instruments: Simple camera, the human eye, film projector, simple and compound microscopes, terrestrial, astronomical and Galilean telescopes, prism binoculars.	- observe and draw the structure of the various optical instruments and discuss their operations. - compare the structure and function of the human eye and the camera.	Compare the formation of image in the human eye and a camera.
	3.1.5 explain defects of vision.	Defects of vision and their corrections.	- discuss the defects of vision and their corrections.	What are the defects of vision? With ray diagrams, show how two of the defects can be corrected.
	3.1.6 describe the defects of lenses and their corrections.	Defect of lenses: Chromatic aberration and Spherical aberration.	- discuss the defects of lenses and their corrections.	
	3.1.7 design and construct a compound microscope or a telescope.	Construction of a compound microscope and a telescope.	**PROJECT:** Use two lenses of different focal lengths to construct either a compound microscope or a telescope. Investigate how to increase the field of view and how to minimize aberrations. Write a report. **NOTE:** Assist students go through the skills of making models, measuring, inferring, communicating and drawing conclusions.	
UNIT 2				
WAVE MOTION	3.2.1 describe a wave motion and explain its measurable properties.	Production of waves. Measurable properties:- i. displacement ii. amplitude iii. frequency iv. phase v. wavelength vi. velocity vii. phase difference vii. period	- demonstrate wave motion by means of slinky ropes and ripple tanks. - discuss the relationship between the measurable properties (as listed in content) - illustrate crest and trough of a wave profile.	Define the following terms i. amplitude ii. phase iii. period iv. crest The velocity of sound in air is $340ms^{-1}$ .Calculate (i) the wavelength when the frequency is 256Hz (ii) the frequency when the wavelength is 0.85m.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 2 (CONT'D)	The student will be able to:		Let students:	
WAVE MOTION	3.2.2. classify waves.	Classification of waves: transverse longitudinal stationary progressive electromagnetic mechanical	- distinguish between transverse and longitudinal waves. - distinguish between stationary and progressive waves. - distinguish between electromagnetic and mechanical waves.	Distinguish between progressive and stationary waves;
	3.2.3 describe seismic waves and explain how they are detected.	Seismic waves - body waves (P-type and S-type) - surface waves	- discuss the causes of seismic waves. - discuss the different types of seismic waves. - discuss the use of the seismograph to detect seismic waves.	
	3.2.4 represent waves graphically.	Wave profiles (Graphical representation of waves)	- Plot graphs of : i) displacement against time ii) displacement against- distance of a wave motion.	
	3.2.5 compare progressive and stationary waves.	Progressive and stationary waves	- discuss and demonstrate progressive and stationary waves and compare the two.	The equation $y = r\sin(\omega t - kx)$ represent a wave travelling in a medium along a given direction r being the amplitude and y the displacement at time t. i. Is that wave travelling in the positive or negative x direction? ii. If $r = 1.0 \times 10^{6}$m, $w = 6.6 \times 10^{2}$ rads^{1} $k = 20$ per metre. Calculate the velocity of the wave iii. what is the displacement when x = 0 and t = 10s
	3.2.6 derive the progressive wave equation and stationary wave equation.	Progressive wave equation: $y = A\sin\left(\omega t + \frac{2\Pi x}{\lambda}\right)$ Stationary wave equation $y = 2A\sin\frac{2\Pi}{t}\cos\frac{2\Pi}{\lambda}$	- discuss the progressive wave equation. - discuss the formula for stationary wave.	
	3.2.7 explain the properties of waves and the principle of superposition	Properties of waves: Reflection, refraction, diffraction, interference and Polarization Coherence Superposition of waves	- use the ripple tank to demonstrate the properties of waves. - discuss the following: i. reflection and refraction of waves. ii. discuss the diffraction of waves. iii. discuss the principle of interference of waves. iv. discuss polarization of waves and its application in polaroids. v. discuss the term coherence. vi. discuss the principle of superposition of wave.	

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 2 (CONT'D)	The student will be able to:		Let students:	
WAVE MOTION	3.2.8 describe the main features and uses of electromagnetic spectrum.	Electromagnetic waves: i. Gamma rays ii. X-ray iii. Ultra violet iv. Visible v. Infrared vi. Microwave vii. Radio waves	- discuss electromagnetic wave and electromagnetic spectrum. - build a chart showing the orders of the magnitude of wavelengths of the principal radiations from radio waves to gamma rays. - describe the various uses of electromagnetic waves.	List in order of increasing frequency the kinds of waves that make up the electromagnetic spectrum. Name one use for each. Explain how radio waves are used to find the speed of a moving object.
	3.2.9 investigate the use of microwave energy.	Uses of microwave energy as a remote switch.	Demonstrate how to use microwave energy to perform the function of a switch. Construct the circuit. State the necessary precautions. Draw conclusions from the experiments. Present a report. **NOTE:** Assist students go through the skills of designing experiments, observing, applying concepts, inferring, communicating, and drawing conclusions.	
UNIT 3				
SOUND	3.3.1 describe the production and nature of sound by vibrating sources.	Production, nature and transmission of sound.	- demonstrate the production of sound by different vibrating sources. - discuss the longitudinal nature of sound. - experiment to establish that sound travels through material medium. - discuss the reflection and the refraction of sound. (The discussion should include the uses of echo).	Describe an experiment to show that sound needs a material medium for its transmission.
	3.3.2 describe the frequency ranges of sound.	-infra sonic, audio sonic (audible) and ultrasonic.	- discuss the frequency ranges of infrasonic, audible and ultrasonic sound waves and their uses.	

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 3 (CONT'D) **SOUND**	The student will be able to:		Let students:	
	3.3.3 investigate the use of ultrasound as a distance measuring device. .	Use of ultrasound.	**PROJECT:** Use an ultrasonic transmitter and its matched receiver to design a distance-measuring device. Build the circuit (device). Investigate how the principle may be used to aid the movement of a visually impaired person. Write a report detailing how you surmounted problems and challenges. Present graphs as part of your analyses. **NOTE:** observe students go through the following scientific inquiry skills: designing experiments, measuring, problem solving, collecting data, interpreting data, communicating and drawing conclusions.	
	3.3.4 demonstrate the modes of vibrations in a stretched string.	Vibration in strings Experiment to show the dependence of frequency on length, tension and linear density.	- discuss .forced vibration, harmonics and overtones. - discuss to bring out the vibration of strings in violin, guitar, piano, and harp. - use the sonometer box to demonstrate the dependence of frequency on length, tension and linear density. perform an experiment to show the dependence of frequency on the length of the vibrating string on a sonometer box. Present a report on your work. **NOTE:** observe students go through the following scientific inquiry skills: observing, measuring controlling variables, collecting data interpreting data, communicating and drawing conclusions.	A wire whose mass per unit length is 10^{-3} kg m^{-1} is stretched by a load of 4kg over the two bridges of a sonometer 1m apart. If it is plucked at the midpoint determine the wave-length of its fundamental vibration. $g=10ms^{-2}$
	3.3.5 demonstrate the modes of vibration in pipes and explain end correction and resonance.	Vibration of air in open and closed pipes. Resonance. End correction.	- demonstrate types of sound given by open and closed pipes. - discuss end correction. - discuss resonance. Perform an experiment using a resonance tube to measure the speed of sound in air. Present a report on your work. **NOTE:** observe students go through the skills of observing, measuring, controlling variables, collecting data, interpreting data, communicating and drawing conclusions.	

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 3 (CONT'D)	The student will be able to:		Let students:	
SOUND	3.3.6 outline the characteristics of musical notes.	Music and noise. Pitch, loudness and quality (Timbre).	- discuss the differences between music and noise. - discuss the characteristics of a musical note.	
	3.3.7 explain the concept of Doppler effect.	Doppler effect.	- discuss Doppler effect. - use whistle, moving car or siren to demonstrate Doppler effect.	Explain what is meant by Doppler effect.
	3.3.8 describe beats and explain its production and applications.	Beats.	- discuss beats. - use two tuning forks of nearly equal frequency to demonstrate beats. - use beats to tune musical Instruments.	Two tuning forks A and B are sounded together producing beats with a frequency of 10Hz. If a small piece of plasticine is fixed to fork B, the beat frequency decreases. If fork A has a frequency of 300Hz, what is the original frequency of B?

SECTION 4

ELECTRIC AND MAGNETIC FIELD

General Objectives: The student will

1. be aware ê that electrical charges can be stored in electrostatic field.
2. understand the laws governing direct current circuits and their applications.
3. appreciate the nature and properties of magnets and their applications.
4. appreciate the effects of electromagnetic fields on conductors and current-carrying conductors.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1	The student will be able to:		Let students:	
MAGNETS	2.1.5 distinguish among a magnet, magnetic and non-magnetic materials.	Magnet, magnetic and non magnetic materials.	- discuss magnets, magnetic and non-magnetic materials. - discuss the properties of magnets.	Outline the differences among magnetic and non-magnetic materials.
	2.1.6 describe magnetic field.	Magnetic field.	- discuss to bring out the meaning of magnetic field (The discussion should include magnetic flux and magnetic flux density). - plot a magnetic field using a permanent magnet and a compass or iron filings.	
	2.1.7 outline the processes involved in magnetization and demagnetization.	Magnetization. Demagnetization.	perform experiments to make magnets by the following methods. i. single touch ii. double touch i. electrical. - discuss demagnetization methods.	Describe how you would magnetize a steel bar by electrical method.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1(CONT'D) **MAGNETS**	The student will be able to: 2.1.8 investigate the factors that affect the strength of a magnet produced by electrical method.	Strength of magnets.	Let students: Perform activities to investigate the effects of current, number of turns of coil and the dimensions of a steel bar on the strength of magnets produced by electrical method. Indicate the application of the findings. Write a report. **NOTE:** Assist students go through the skills of observing, controlling variables, interpreting data, inferring, communicating and drawing conclusions.	
	4.1.5 explain the concept of magnetic domains.	Magnetic domains. Permeability. Paramagnetic, ferromagnetic and diamagnetic materials.	- discuss magnetic domains - discuss relative permeability - discuss ferromagnetic, paramagnetic and diamagnetic materials and the effect of temperature on such materials.	Describe the effects of temperature on ferromagnetic, paramagnetic and diamagnetic materials.
	4.1.6 explain hysteresis.	Hysteresis. Hysteresis loop. Saturation. Coercivity. Retentivity (remanence).	- discuss hysteresis and hysteresis loop. - discuss saturation, coercivity and retentivity of ferromagnetic materials.	Explain the terms hysteresis, coercivity and retentivity of ferromagnetic materials.
	4.1.7 describe the uses of magnets and ferromagnetic materials.	Uses of magnets and ferromagnetic materials.	- discuss the use of magnets and ferromagnetic materials.	

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 2 **ELECTRO-MAGNETISM**	The student will be able to: 4.2.1 explain the concept of electromagnetic field.	Magnetic field created by electric current.	Let students: - discuss the concept of electromagnetic field. - use compass or iron filings to demonstrate magnetic field lines of force around: i. a straight wire carrying a current. ii. a narrow circular coil carrying a current. iii. a solenoid carrying a current.	With a well labeled diagram describe a magnetic field pattern created by a current through i) a straight conductor ii) narrow circular coil.
	4.2.2 list and explain the factors that affect the magnetic force on current-carrying conductor in a uniform magnetic field.	Force on a current-carrying conductor in a magnetic field. $F = BIL\,Sin\theta$ Fleming's Left Hand Rule.	- demonstrate the force exerted on a current-carrying conductor in a magnetic field. - discuss Fleming's left hand rule. - discuss the factors that affect the magnitude of the magnetic force on a current-carrying conductor in a magnetic field.	
	4.2.3 explain the forces set up between parallel current-carrying conductors in a uniform magnetic field.	Forces set up between conductors carrying current in a magnetic field.	- demonstrate the repulsive and attractive forces between parallel current-carrying conductors in a magnetic field.	A straight conductor of length 0.5m is placed in a magnetic field of flux density 4 tesla and carrying a current of 2A. Determine the force exerted if the wire is i) at an angle of 30^o to the field ii) parallel to the field.
	4.2.4 describe the torque produced by a current-carrying rectangular coil in a uniform magnetic field.	Torque on rectangular current-carrying coil in a magnetic field. $\tau = BAINcos\theta$	- derive the torque formula on a rectangular coil placed in a uniform magnetic field.	

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 2 (CONT'D)	The student will be able to:		Let students:	
ELECTRO-MAGNETISM	4.2.5 describe the structure and action of electric motion and moving coil galvanometer.	Electric motor. Moving coil galvanometer.	- draw and discuss the operation of electric motor. - design and construct an electric motor and demonstrate how it works. - draw and discuss the principle of a moving coil galvanometer. - discuss the factors that affect the current sensitivity of the galvanometer. - discuss how a galvanometer can be adapted as (i) an ammeter (ii) a voltmeter	A beam of electrons travels at $3.0X10^{6}ms^{-1}$ through a uniform magnetic field of $4.0X10^{-2}T$. Calculate the magnitude of force acting on each electron if the beam is at right angle to the magnetic field.
	4.2.6 describe the force exerted on a charged particle moving in electric and magnetic fields, and their applications.	Force on a charged particle in a magnetic field. $F=Bqrsin\theta$. Force on a moving charged particle in an electric field. $F=qE$. Force on a moving charged particle in a crossed field (Lorentz force).	- discuss the effect of the force on a charged particle moving in a magnetic field. - discuss the effect of force on a moving charged particle in an electric field. - discuss crossed field. - discuss the effect of force on a moving charged particle in a crossed field. - discuss the force on moving charged particle in electric and magnetic fields, such as in T.V, mass spectrometer, cathode ray tube, cathode ray oscilloscope.	
	4.2.7 describe electromagnetic switches.	Electromagnetic switches (the relay).	- discuss the construction and application of relays.	
	4.2.9 investigate the use of a relay to switch on a motor or fan or light.	Use of a relay.	**PROJECT:** Design and construct a relay to switch on a light or motor. Make the relay switch these loads : i. separately ii. both at the same time. Investigate to learn how to energize the relay. Draw and construct the circuit and make it work. Write a report. **NOTE:** observe students go through the skills of applying concepts, problem solving, inferring, communicating and drawing conclusions.	

SECTION 5

ATOMIC AND NUCLEAR PHYSICS

General Objectives: The student will

1. understand the structure of the atom.
2. recognise the structure of the nucleus.
3. be aware of the peaceful uses of nuclear energy.
4. be aware of the importance of photoelectric effect.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1	The student will be able to:		Let students:	
PHOTOELECTRIC EFFECT AND WAVE-PARTICLE DUALITY	5.1.1 explain photoelectric effect.	Photoelectric effect.	- discuss photoelectric effect.	What is photoelectric effect?
	5.1.2 outline Einstein's quantum theory explanation of photoelectric effect.	Quantum theory explanation of Photoelectric effect. Einstein's photoelectric equation.	- discuss Einstein' s quantum theory explanation of photoelectric effect. (Discussion should include the particle nature of light).	Outline Einstein's quantum theory explanation of photoelectric effect
		Threshold frequency. Threshold wavelength. Work function.	- discuss Einstein's photoelectric equation. (Discussion should include explanation of work function, threshold frequency and threshold wavelength).	A photo-emissive surface has a work function of $1.33X10^{-16}$ev. Calculate threshold frequency 1ev= $1.6X10^{-19}$J Planck's constant h=$6.6X10^{-34}$Js
	5.1.3 state and explain the laws of photoelectric effect.	Laws of photoelectric effect.	- discuss the laws of photoelectric effect.	
	5.1.4 describe applications of photoelectric effect.	Applications of photoelectric effect.	- discuss the applications of photoelectric effect in TV, camera, etc.	

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1 (CONT'D) **PHOTOELECTRIC EFFECT AND WAVE-PARTICLE DUALITY**	The student will be able to: 5.1.5 use P-N junction devices to harness solar energy.	Harnessing solar energy using P-N junction devices.	Let students: Use glass encapsulated silicon diode or LED as photo-detector. Design a circuit using the photo-detector to utilize solar energy to produce electricity. Explain how the electrical energy generated can be stored and how the output voltage can be increased. Indicate the limitations. Present a report. **NOTE:** observe students go through the skills of designing experiments, observing, measuring, applying concepts, inferring, communicating and drawing conclusions.	
	5.1.6 explain the wave-particle duality.	Wave-particle paradox. De Broglie's hypothesis. Electron diffraction.	- discuss the dual nature of light. - discuss the dual nature of matter (with examples like electron diffraction, - discuss De Broglie's hypothesis.	a. What is meant by wave particle duality of matter? b. Mention one physical phenomena, in each case, that can be explained in terms of the wave nature and the particle nature.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 2 **THERMIONIC EMISSION, CATHODE RAYS AND X-RAYS**	The student will be able to: 5.2.1 explain thermionic emission and describe its applications.	Thermionic emission. Thermionic diodes.	Let students: - discuss thermionic emission. - discuss the construction and mode of operation of thermionic diodes. - discuss some applications of thermionic emission.	Describe the construction and mode of operation of a thermionic diode.
	5.2.2 describe the nature, production and uses of cathode rays.	Cathode rays.	- discuss cathode rays. - discuss the production of cathode rays. - discuss some uses of cathode rays, such as in T.V.	Describe the production of cathode rays.
	5.2.3 describe the nature and production of x-rays.	Nature of x-rays. Production of x-rays.	- discuss the nature of x-rays. - discuss the production of x-rays from an x-ray tube.	Describe the production of x-rays from an x-ray tube.
	5.2.4 outline the properties, types and characteristics of x-rays.	Properties of x-rays. Types of x-rays (soft and hard). Characteristics of x-rays. Line spectrum. Continuous spectrum.	- discuss the properties of x-rays. - discuss the types of x-rays. - discuss the variation of intensity of x-rays against the wavelength and its special features.	Explain the following terms with respect to x-rays; i. intensity ii. hardness iii. quality .
	5.2.5 explain the uses and hazards of x-rays.	Uses of x-rays in: medicine agriculture industry Hazards of x-rays.	- discuss the uses of x-rays. - discuss the hazards of x-rays and safety measures available.	State four hazards of x-rays.

SECTION 6

ELECTRONICS

General Objectives: The student will

1. appreciate the characteristics of the P-N junction diode and their applications in electronics .
2. understand the construction and characteristics of the bipolar and junction field-effect transistors and their applications.
3. recognise the various configurations of the operational amplifier and their applications.
4. appreciate the use of digital electronics in electronic switching.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1	The student will be able to:		Let students:	
BIPOLAR JUNCTION TRANSISTOR (BJT) AND JUNCTION FIELD EFFECT TRANSISTOR (JFET)	6.1.1 describe the construction and action of the bipolar junction transistor.	The bipolar junction transistor as N-P-N and P-N-P types.	- discuss the construction of N-P-N and P-N-P type transistors. - identify the parts and symbols of a transistor. - discuss various currents flowing in the transistor when it is in conduction.	Describe the mode of operation of an N-P-N transistor as an amplifier
	6.1.2 describe transistor biasing.	Transistor biasing.	- discuss transistor biasing.	
	6.1.3 outline the characteristics of an N-P-N transistor as a small signal amplifier.	Transistor characteristics with reference to; - common base (C-B) - common collector (C-C) - common emitter (C-E) arrangements.	- discuss N-P-N transistor characteristics. - discuss load line selection, quiescent point determination and stability, input resistance, output resistance, voltage gain and current gain in C-B, C-C and C-E configurations. - discuss N-P-N transistor as an amplifier. **PROJECT:** Design and construct a common -emitter N-P-N transistor amplifier. Select biasing resistors, two coupling capacitors and a decoupling capacitor. Measure input and output voltages. Select suitable load for the amplifier. Determine the voltage gain. Write a report on your work.	

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1 (CONT'D) **TRANSISTOR (BJT) AND JUNCTION FIELD EFFECT TRANSISTOR (JFET)**	The student will be able to:		Let students: **NOTE:** assist students to acquire the skills of designing circuits, making models, measuring, collecting data, interpreting data, communicating and drawing conclusions.	
	6.1.4 describe the N-P-N Transistor.	Transistor with feed back. Transistor as a voltage controlled switch.	- discuss small signal amplification with feedback. - discuss the N-P-N transistor as a voltage dependent switch.	Describe the BJT P-N junctions in an amplifier mode. Describe the JFET P-N junctions in amplifier mode. Compare their characteristic.
	6.1.5 describe the junction field effect transistor (JFET) and its use as a small signal amplifier.	Junction field effect transistor (JFET) and its characteristics Small signal amplifier.	- discuss the JFET and its characteristics. - discuss the JFET amplifier biasing. (Note the differences between BJT and JFET P-N junction constructions).	

SENIOR HIGH SCHOOL- YEAR 4

SECTION 1

MOTION, FORCES AND ENERGY

General Objectives: The student will

1. appreciate the importance of taking accurate measurements of physical quantities and their applications in science and technology.
2. recognize the various types of motion and the laws which govern them and their applications.
3. recognize the various forms in which forces affect the state of a body and their applications.
4. be aware of the various forms of energy and energy resources and the ways to harness the renewable sources of energy.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1 **ROTATIONAL MOTION OF SOLID OBJECTS**	The student will be able to: 1.1.1 describe rotational motion.	Rotational motion. - Angular(rotational) velocity. - Angular (rotational) acceleration.	Let students: - discuss rotational motion. - discuss angular (rotational) velocity and angular (rotational) acceleration. - discuss how rotational motion is related to linear motion.	
	1.1.2 explain moment of inertia (rotational inertia).	Moment of inertia (rotational inertia).	- discuss moment of inertia. - discuss expressions of moment of inertia for several objects rotating about an axis such as rod, uniform disc or cylinder, ring, uniform solid sphere.	Explain what is meant by moment of inertia.
	1.1.3 explain torque and angular momentum.	Torque. Angular momentum.	- discuss torque. - discuss angular momentum. - discuss the conservation of angular momentum.	A uniform disc with a mass of 5kg and radius 0.3m is rotating with angular velocity of $15rads^{-1}$. What is the angular momentum of the disc? ($I_{disc}=½mr^2$).

SENIOR HIGH SCHOOL- YEAR 4

SECTION 2

THERMAL PHYSICS

General Objectives: The student will

1. understand the concept of heat, its relationship with temperature and effects on substances.
2. be aware of the principles involved in the measurement of temperature.
3. appreciate heat as a form of energy and how it can be measured and stored.
4. appreciate the various modes of heat transfer.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1	The student will be able to:		Let students:	
GASES	2.1.1 outline the assumptions of the kinetic theory of gases.	Kinetic theory of gases.	- discuss the assumptions of the kinetic theory of gases.	State four assumptions of the kinetic theory of gases and derive the pressure formula.
	2.1.2 outline the gas laws and use the kinetic theory to explain them.	Gas Laws: Boyle's law, Charles' law and Pressure law, Equation of state for ideal gases:- $PV = nRT$	- discuss the gas laws. - perform experiments to verity the gas laws. - discuss the equation of state for ideal gases. - use the deduced equation to solve simple problems.	State the following gas laws i. Boyle's law ii. Charles' law iii. Pressure law.
	2.1.3 derive the Van der Waal's equation for real gases.	Van der Waal's equation. $\left(P + \frac{a}{v^2}\right)(v - b) = RT$	- discuss the derivation of ideal gas equation and bring out the limitations of the ideal gas.	

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1 **GASES**	The student will be able to: 2.1.4 use the kinetic theory to derive the pressure formula.	Pressure of gases: $P = \frac{1}{3}\rho C^{\bar{2}}$	Let students: - derive the pressure formula. - discuss most probable velocity, mean velocity and root mean square velocity.	
	2.1.5 establish a relation between the temperature of an ideal gas and its molecular kinetic energy.	Kinetic energy and temperature. $K.E = -\frac{1}{2}mc^{\bar{2}} = \frac{3}{2}KT$ $\frac{1}{2}mc^{\bar{2}} = \frac{3}{2}\frac{R}{N_A}T$	- discuss the relationship between temperature of an ideal gas and its molecular kinetic energy.	Calculate the kinetic energy of 4g of oxygen at 0^0C. Molecular mass=32 Avogadro constant $=6.02X10^{-23}mol^{-1}$ Boltzmann's Constant $= 1.38X10^{-23}JK^{-1}$

SECTION 3

WAVES

General Objectives: The student will

1. understand the principles associated with the production of laser.
2. appreciate the application of lasers and holography.
3. be aware of the properties and transmission of light in various media and their applications.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1	The student will be able to:		Let students:	
INTRODUCTION TO LASER	3.1.1 explain what is meant by laser.	The laser.	- discuss what is meant by laser.	Explain the term laser.
	3.1.2 describe the principles involved in the production of laser.	Principles of laser production.	- discuss the principles involved in the production of laser.	Outline the principles involved in the production of lasers.
	3.1.3 describe the types of lasers.	Types of lasers.	- discuss the types of lasers.	
	3.1.4 outline the applications of lasers.	Applications of lasers.	- discuss the applications of lasers in industry, scientific research, communication, medicine, military technology.	Describe three applications of lasers.
	3.1.5 describe laser safety.	Laser safety.	- discuss the dangers involved in the use of lasers. - discuss safety measures to be taken when using lasers.	
	3.1.6 describe holography.	Holography.	- discuss how holograms are created using laser beam. - discuss some applications of holography.	

SECTION 4

ELECTRIC AND MAGNETIC FIELD

General Objectives: The student will

1. understand the concept of electromagnetic induction
2. appreciate that electrical charges can be stored in electrostatic field.
3. appreciate the principles of operation dynamo, generators, inductors and transformers.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1 **ELECTRO-MAGNETIC INDUCTION**	The student will be able to: 4.1.1 explain the concept of electromagnetic induction.	Electromagnetic induction.	Let students: - discuss and demonstrate electromagnetic induction.	
	4.1.2 state the laws of electromagnetic induction and describe the factors affecting the magnitude of the induced e.m.f	Laws of electromagnetic induction - Faraday's law - Lenz law Factors affecting the magnitude of the induced e.m.f. Fleming's Right Hand Rule.	- discuss the laws of electromagnetic induction. - perform experiments to verify the laws of electromagnetic induction. - discuss the factors affecting the magnitude of the induced e.m.f. - discuss the direction of the induced current using Fleming's Right Hand Rule.	a. State the laws of electromagnetic induction. b. Describe an experiment to demonstrate electromagnetic induction.
	4.1.3 describe the principles of operation of a dynamo and a generator.	Dynamo. Generator.	- dismantle, draw and discuss the operations of a bicycle dynamo. - discuss the operations of a simple a.c. generator. - discuss the modification of an a.c. generator into d.c. generator.	A narrow coil of 20 turns and area $8x10^{-2}m^2$ is placed in a uniform magnetic field of flux density $2x10^{-2}$ tesla so that the flux links normally. Calculate the average induced e.m.f. in the coil if it is removed completely from the field.
	5.1.7 investigate the ways of ensuring constant bicycle dynamo output at both low and high speeds.	Maintaining constant brightness of bicycle light.	**PROJECT:** Design, build and test a unit for maintaining maximum brightness of the bicycle lights driven by a bicycle dynamo. Indicate any applications of such a unit. Write a report.	

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1 (CONT'D)	The student will be able to:		Let students:	
ELECTRO-MAGNETIC INDUCTION	4.1.5 describe the structure of an inductor and explain its behaviour in d.c and a.c circuits.	Inductor. Self Inductance. Mutual inductance. Time constant for L-R circuit.	- discuss the structure of an inductor. - discuss and illustrate self inductance and mutual inductance. - discuss the behaviour of the inductor in d.c circuit. - discuss the behaviour of the inductor in a.c circuit. - discuss time constant for inductor-resistor circuit.	Explain the term self inductance.
	4.1.6 demonstrate to show that energy is stored in an inductor.	Energy stored in an inductor. $E = \frac{1}{2} LI^2$	- discuss the energy stored in an inductor. - solve problems involving energy stored in an inductor.	
	4.1.7 describe Eddy current.	Eddy current.	- discuss Eddy current. - discuss how to minimize Eddy current. - discuss the applications of Eddy current in induction furnace, speedometer and in damping galvanometers.	
	4.1.8 describe the structure, use and the principle of operation of a transformer.	The transformer. Power transmission.	- discuss the structure, uses and mode of operation of a transformer. - discuss the principle of operation of a transformer. - discuss the factors that affect the efficiency of a transformer and ways of minimizing them. Discuss why high voltage is transmitted over pylons over long distances.	Describe the factors that reduce the efficiency of a transformer and how they can be minimized.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 2 **ALTERNATING CURRENT (A.C) THEORY**	The student will be able to: 4.2.1 describe the behavior of alternating current.	Alternating current , $I = I_o \sin \omega t$ Alternating voltage, $V = V_o \sin \omega t$	Let students: - discuss alternating current. - explain the terms: i. Peak current I_o ii. Peak voltage V_o iii. Root mean square value of alternating current $I_{rms.}$ iv. Root mean square value of alternating voltage $V_{rms.}$	A current of 2mA flows through a pure resistance of 4000Ω. Calculate the alternating voltage across the resistor.
	4.2.2 explain the a.c series connected circuit.	a.c series connected circuit: R-C, R-L, R-L-C series circuits Impedance Reactance	- use sketched graphs to explain the a.c. behaviour in; i. capacitors ii. inductors iii. resistors and determine the relationship between voltage and current. - derive the formula for the impedance using vector or phasor diagrams. - discuss the conditions for resonance in a.c circuits. - discuss the application of resonance in selecting a particular frequency in radio reception and transmission.	A p.d of 240V is established across a capacitor of 0.04μF. If the frequency is $50H_z$, calculate the current flowing. An alternating voltage of 40V and frequency 50Hz is applied to a pure inductive coil of 5H in series with a resistance of 500Ω. Determine the magnitude of the i. current ii. phase angle between the applied voltage and the current across the coil.
	4.2.3 explain the importance of power in a.c circuits.	a.c power $P = IV \cos\theta$	- discuss power factor.	

SENIOR HIGH SCHOOL- YEAR 4

SECTION 5

ATOMIC AND NUCLEAR PHYSICS

General Objectives: The student will

1. understand the structure of the nucleus.
2. understand radioactivity and nuclear instability.
3. appreciate the relationship between mass and energy.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1 **THE NUCLEUS AND NUCLEAR ENERGY**	The student will be able to:		Let students:	
	5.1.1 describe the structure of the nucleus.	Structure of the nucleus	- discuss to bring out the structure of the nucleus. - discuss atomic number (Z), mass number (A), nucleons, nuclides and isotopes.	Define the following terms and give their notations: i. and proton number ii. nucleons iii. isotopes iv. nuclides
	5.1.2 explain radioactivity and distinguish between natural and artificial radioactivity.	Radioactivity; types(Natural and artificial) and differences. .	- discuss the existence of radioactive emissions, (alpha particle, beta particles and gamma rays), their properties and uses.	In a tabular form compare the properties of radioactive particles under the following headings: * charge * mass * absorption power * ionization power * penetration power.
	5.1.3 discuss the methods of detecting radiations.	Radioactive radiation detection.	- use G-M counter and photographic plates to detect radiations.	
	5.1.4 explain nuclear instability.	Radioactive decay, half-life and decay constant.	- use nuclear equations to represent simple nuclear decay schemes. - discuss half-life	
	5.1.5 explain the relationship between mass and energy.	Einstein's energy equation $E = mc^2$ Binding energy and binding energy per nucleon.	- discuss the relationship between mass and energy. - discuss binding energy and the significance of binding energy per nucleon.	

SENIOR HIGH SCHOOL- YEAR 4

SECTION 6

ELECTRONICS

General Objectives: The student will

1. appreciate the various configurations of the operational amplifier and their applications.
2. appreciate the use of digital electronics in electronic switching.

UNIT	SPECIFIC OBJECTIVES	CONTENT	TEACHING AND LEARNING ACTIVITIES	EVALUATION
UNIT 1	The student will be able to:		Let students:	
OPERATIONAL AMPLIFIERS AND THEIR APPLICATIONS	6.1.1 describe the operational amplifier.	Operational amplifier.	- discuss the operational amplifier.	a. Describe the operational amplifier.
	6.1.2 describe the applications of operational amplifier in an inverting and non-inverting modes.	Applications of operational amplifier in inverting and non-inverting modes.	- discuss the operational amplifier in inverting as well as non-inverting modes. - discuss the operational amplifier in implementation of mathematical operations. **PROJECT:** Construct an inverting operational amplifier having a gain of 100.	b. Draw the symbol for operational amplifier.
UNIT 2				
DIGITAL ELECTRONICS	6.2.1 describe the use of basic transistor-transistor logic gates in contact less electronic switching.	Transistor-transistor logic gates: AND gate NAND gate OR gate NOR gate NOT gate	- discuss the characteristics of logic gates. - draw up the truth tables for each gate. - describe the timing diagrams for each gate.	
	6.2.2 explain sequential and combinational logic.	Sequential and Combinational logic.	- discuss how to combine several logic gates to perform desired functions.	
	6.2.3 design and construct an alarm circuit or multiple switching system.	Alarm circuit and Electronic switching.	**PROJECT:** Design an alarm circuit and electronic switch. **NOTE:** You may combine logic gates in your system design for: i. a fire alarm when there is smoke or it is too hot. ii. an electronic switch which puts on a fan only when a light is switched on and two windows are closed. Satisfy the stated conditions for each system. Identify the limitations in your design and propose how this may be eliminated. Write a Report.	