REPUBLIQUE DU CAMEROUN
Paix – Travail – Patrie

REPUBLIC OF CAMEROON
Peace – Work - Fatherland

MINISTRY OF SECONDARY EDUCATION
MINISTERE DES ENSEIGNEMENTS SECONDAIRES

INSPECTORATE GENERAL OF EDUCATION
INSPECTION GENERALE DES ENSEIGNEMENTS

PHYSICS TEACHING SYLLABUS FOR THE SECOND CYCLE
(LOWER AND UPPER SIXTH SCIENCES FORMS)
OF SECONDARY GENERAL EDUCATION

INSPECTORATE OF PEDAGOGY IN CHARGE OF SCIENCES

INSPECTION DE PEDAGOGIE CHARGEE DE L'ENSEIGNEMENT DES SCIENCES

2019

Observe and interact with your environment to make a suitable training choice to succeed in life

REPUBLIC OF CAMEROON Peace-Work-Fatherland --------------------- MINISTRY OF SECONDARY EDUCATION ---------------------------- INSPECTORATE GENERAL OF EDUCATION ----------------------------------- INSPECTORATE OF PEDAGOGY IN CHARGE OF OF SCIENCES	REPUBLIQUE DU CAMEROUN Paix-Travail-Patrie ----------------------- MINISTERE DES ENSEIGNEMENTS SECONDAIRES --------------------------------------- INSPECTION GENERALE DES ENSEIGNEMENTS -- INSPECTION DE PEDAGOGIE CHARGEE DES ENSEIGNEMENTS DES SCIENCES

LEARNING AREA: SCIENCE AND TECHNOLOGY

SUBJECT: PHYSICS

CLASSES: LOWER SIXTH AND UPPER SIXTH SCIENCES

PLANNING OF TEACHING/LEARNING & EVALUATION

ANNUAL WORKLOAD: **324 PERIODS (270 HOURS)**

WEEKLY WORKLOAD:
- **TEACHING: 07 PERIODS (05 HOURS)**
- **PRACTICALS: 03 PERIODS (2 HOURS)**

COEFFICIENT: 05

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I. GENERAL INTRODCTION

This Second Cycle Teaching Syllabus is to be covered as a two-year course in the Lower Sixth and Upper Sixth Forms. It has been written in the context of a new vision or approach to teaching/learning called “THE COMPETENCY BASED APPROACH”. This new approach largely seeks to ensure that while the syllabus is covered in length and breadth with the aim of enabling the learners succeed in certificate examinations, the teaching/learning activities should be done such that the learners see the relevance of what they learn in their day to day lives as well as being able to mobilize knowledge and other resources to propose feasible and sustainable solutions to daily life challenges. The teaching syllabus has been grouped into SIX (06) MODULES which are:

- Module 1: Physical quantities, measurements and experimental Physics.
- Module 2: Kinematics and Dynamics.
- Module 3: Every day uses of energy.
- Module 4: Matter, effects of energy and applications.
- Module 5: Field Phenomena.
- Module 6: Waves around us.

The Options are to be incorporated into the modules following the attainment of the class. The options allow students to do a wider scope study on certain areas. All schools are required to go through each section as they have a wide range of applicability and these are some of the domains of Physics where the world is currently researching and reaping the benefits in development, job creation and advancement in technology. The first Module which is more of an introduction needs to be done in the Lower Sixth form and carried on progressively as the notions cut through the entire syllabus. Some aspects of almost every other Module could be started from the Lower Sixth form and continued in the Upper Sixth form depending on the available Personnel. A school may allocate seven periods of 50 minutes each for teaching and it would be advisable to share the syllabus to two teachers to a maximum of three teachers to start from different modules per class. Sections of Modules like Kinematics and Dynamics, Thermal energy, Electrical energy, Waves and wave motion could be handled from lower sixth and progressively get into other sections/Modules later in the same class or in the Upper Sixth form but this is purely indicative. The need to start Practical work from the beginning of the Lower Sixth Form cannot be over-emphasized. Some teachers say they need to cover material before getting into practical work but this is completely unfounded. This will enable students to learn about reading scales, and working with the precisions of measuring instruments and make use of these either to measure lengths in mechanics, for temperature measurement in energetics, for measurements of electric currents and potential differences, for measurement of angles in geometrical optics and the list is quite long. Planned and structured experimental work shall be carried out by the learners during the two year course in the school laboratory. The other resources and projects in the specified sections should go beyond these laboratory investigations to involve applications of physics to practical life situations. Teachers should challenge learners to use the knowledge acquired in classroom situations.

The learners can come up with productions carried out individually or in teams. These can be done at home using local materials and others gotten from scraps. The learners have to clearly spell out how their productions function and identify the daily life challenges which can be redressed by the use of their productions. The productions can be exhibited during science club activities and science open door days involving the school administration as well as the entire educational community when necessary. In this way the students will not only leave secondary school with certificates but with a new spirit of creativity, self-esteem and problem solving. It is also very important for teachers to do team work in reading these programs, preparing lessons and selecting one participant to present while others observe such that pertinent criticisms are done at the end for amelioration. This will both re-enforce teachers' capacities as well as lay the foundation for the team-work spirit we seek to pass onto the learners.

END - OF - SECOND CYCLE LEARNER'S EXIT PROFILE

The second cycle of Secondary General Education admits mostly students who have undertaken a first cycle course ending with the writing of the GCE Ordinary Level Examination aged between sixteen and eighteen years. The general objectives at this level are not only to build intellectual, civic and moral skills in these learners but also competences and fundamental knowledge which will either enable them to foster their education in the university, or to prepare them for a smooth insertion into the job market after professional training.

Thus, within the framework of these new syllabuses, the learner is expected, after the second cycle of secondary education, to be able to use his/her competences to solve problems through a family of situations relating to domains of life as indicated in the table below:

The learner should then be able to **express their scientific and social know-how** which should enable him/her to be able to:

- apply scientific reasoning to solve real life situations;
- explain natural phenomena;
- meet with the challenges of life, through the use of scientific approach in problem solving;
- manage the environment in a sustainable manner;
- safeguard his/her health and that of all others in his/her surrounding;
- imbibe the scientific method;
- use process skills to acquire knowledge;
- read and interpret security notices;
- communicate his/her results;
- relate the learning of Physics to everyday life.

In order to achieve these objectives, the learner should be able to mobilize, within the various disciplines and constructive areas of learning of the syllabuses, all the pertinent resources in terms of knowledge, knowhow and attitudes.
For the sciences, the following table outlines some of the plausible opportunities for those students who successfully go through the second cycle.

II. PLAUSIBLE CAREER OPPORTUNITIES FOR EACH SERIES COMBINATION

S1	S2	S3	S4
✓ Aeronautics ✓ Aerospace engineering ✓ Chemical engineering ✓ Civil engineering ✓ Electrical engineering ✓ Industrial engineering ✓ Mechanical engineering ✓ Renewable energy engineering ✓ Nuclear engineering ✓ Telecommunication engineering ✓ Software engineering ✓ Military enlistment ✓ Teaching ✓ Computer engineering ✓ Petroleum engineering ✓ Scientific researcher	✓ Medicine ✓ Nursing ✓ Biotechnology ✓ Midwifery ✓ Pharmacy ✓ Biomedical engineering ✓ Anaesthesiology ✓ Epidemiology ✓ Laboratory technology ✓ Radiology ✓ Telecommunication engineering ✓ Military enlistment ✓ Teaching ✓ Agricultural engineering ✓ Veterinary medicine ✓ Petroleum engineering ✓ Forestry ✓ Scientific researcher	✓ Agricultural science ✓ Chemical engineering ✓ Biotechnology ✓ Medicine ✓ Nursing ✓ Pharmacy ✓ Anaesthesiology ✓ Laboratory technology ✓ Biomedical engineering ✓ Veterinary medicine ✓ Military enlistment ✓ Teaching ✓ Statistician ✓ Midwifery ✓ Forestry ✓ Food technology	✓ Agricultural engineering ✓ Biotechnology ✓ Geological mining ✓ Geotechnical engineering ✓ Laboratory technology ✓ Midwifery ✓ Nursing ✓ Military enlistment ✓ Teaching ✓ Petroleum engineering ✓ Geological researcher

NEW SERIES COMBINATIONS

N^o	S1	S2	S3	S4
1	**Maths with Mechanics**	**Biology**	**Biology**	**Biology**
2	**Chemistry**	**Chemistry**	**Chemistry**	**Chemistry**
3	**Physics**	**Physics**	**Mathematics**	**Geology**
4	F. Maths *	Maths with Mechanics *	Food Science & Nutrition *	Physics *
5	Computer Science *	F. Maths *	ICT *	Maths with Statistics *

NB:

- The First Three Subjects in Bold are obligatory to each student per series, and serve as the basic or entry qualification for admission into LSS.
- Students who deem it necessary can go in for a fourth and even fifth subject within the table specifications; but this is reserved for the high performing students.
- Subjects such as English Language, French and others shall be taught to Advanced Level Science students as enabling subjects.
- Students who wish to study English Language, French, Philosophy and others as Major Examination disciplines MUST go for the appropriate Arts Series.
- The construction of appropriate science laboratories, the purchase of materials and the inspection of such structures prior to commencement of second cycle sciences by a competent team of National/Regional Pedagogic Inspectors is obligatory for new schools. Both old and new schools must also regularly carry out maintenance and update the states of their laboratories alongside other education partners to facilitate demonstrations, investigations and practical sessions for the effective implementation of the CBA.

The number of teaching hours per week for the teaching/learning of Physics is outlined in the following table among other science subjects. Whenever practical exercises shall not be carried out the time allocated should be used for teaching the theory part of the work. The hours indicated here are per student per week and in situations where the practical exercises are done in the afternoons, they are still counted as the teacher's weekly workload.

N°	**Subject**		**LSS1**	**LSS2**	**LSS3**	**LSS4**	**USS1**	**USS2**	**USS3**	**USS4**
1	Maths		8		8		8		8	
2	F. Maths		4	4			8	8		
3	Physics	Theory	6	6			6	6		
		Practical	2	2			2	2		
4	Chemistry	Theory	6	6	6	6	6	6	6	6
		Practical	2	2	2	2	2	2	2	2
5	Biology	Theory		6	6	6		6	6	6
		Practical		2	2	2		2	2	2
6	Geology	Theory				6				6
		Practical				2				2
7	Food Science & Nutrition	Theory			4				4	
		Practical			2				2	
8	Computer Science/ICT	Theory	4				6			
		Practical	2				2			

**On all Wednesdays, 12:30 – 3:30 pm is reserved for extra-curricular activities such as clubs, etc.*

LEARNING AREA:SCIENCE AND TECHNOLOGY

SUBJECTS: PHYSICS

CLASSES: LOWER SIXTH AND UPPER SIXTH FORMS

ANNUAL HOURS: 240 hours

WEEKLY WORKLOAD: 07 periods of 50 minutes each plus 02 hours of practical work

Mathematical prerequisites;

Arithmetic:

Be able to;

- Recognize, convert and use expressions in decimal and standard forms (scientific or power - of -10 notation), recognize conversions such as $10^{-12}, 10^{-9}, 10^{-6}10^{3}, 10^{6}, 10^{9}$ etc;
- Recognize, convert and use prefixes correctly (including; kilo, mega, gega,micro, milli, etc);
- Use an electronic calculator for addition, subtraction, multiplication, and for finding arithmetic means, reciprocals, squares, square roots sines, cosines, tangents, exponentials and logarithms, and their inverses;
- Take account of accuracy and precision in numerical work and use rules on significant figures such that precision and accuracy are neither lost unnecessarily nor carried beyond what is justified;
- recognize and calculate errors and uncertainties in experimental works;
- Make approximate evaluations of numerical expression (eg, π^2=10) and use such approximations to check the order of magnitudes in all calculations

Algebra

Be able to;

- Change the subject of an equation.
- Solve simple algebraic equations.
- Formulate simple algebraic equations as mathematical models, of physical situations, recognize and use the logarithmic forms of expressions like; a^b, x^n, e^{kx}.
- Derive, recognize and use linear, quadratic and differential equations from physical situations like movement of objects, charges, waves etc.
- Express and convert from relative to absolute uncertainties and vice versa.
- Comprehend and use mathematical symbols such as $>, <, \gg, \geq, \leq, \approx, \cong \sum x, \delta x, < x >, dx$

Geometry and trigonometry

Be able to;

- Recognize and calculate the areas of right angled triangles, circumferences and areas of circles, surface areas and volumes of rectangular blocks, cylinders and spheres.
- Use Pythagoras's theorem, similarity of triangles, and the sum of interior angles of a triangle as well as the relation between the sum of the interior angles and external angles of triangles.
- Recognize physical situations with trigonometric solutions and use sines, cosines and tangents to solve physical problems.
- Recall that sin θ$\approx tan\theta \approx \theta, cos\theta \approx 1$ for small angles expressed in radians.
- Use correctly the relationship between degrees and radians ($defined\ as\ \frac{arc}{radius}$).

Vectors

Be able to;

- Recognize and use vector analysis to treat some physical situations occurring in space.
- Find the resultant of coplanar vectors recognizing situations where vector addition is appropriate.
- Obtain expressions for components of a vector in a perpendicular direction recognizing situations where vector resolution is appropriate.
- Use vector algebra, addition and multiplication (scalar and vector products).
- Recognize, determine and use unit vectors in all directional orientations.

Vector Algebra:

Be able to:

- Distinguish between scalar and vector quantities, giving examples of each.
- Recognize whether or not a physical quantity is a vector or a scalar, from definition.
- Represent a vector geometrically and analytically.
- Obtain the modulus and unit vector for a given vector.
- Add and subtract coplanar vectors geometrically and analytically.
- Represent a vector in terms of two perpendicular or rectangular components.
- Calculate dot products and demonstrate cross products of vectors giving examples of these in Physics.
- Identify areas in Physics where vector applications are necessary.
- Use vector algebra in solving problems, where applicable.

Graphs

Be able to;

- Convert information into graphical, numerical, algebraic and verbal forms.
- Recall and characterize the standard linear equation $y = mx + c$ and rearrange relationships into linear forms where appropriate.
- Appropriately choose variables associated with axes and determine scales for graph plotting.
- Determine the gradient and intercept of a linear graph, allocate appropriate physical units to them.
- Determine by inspection the best line of fit which will serve as a straight line through a set of data points presented graphically.
- Sketch and recognize the forms of plots of common expressions like $\frac{1}{X}, x^2, \frac{1}{x^2}, sinx, cosx, e^x$.
- Use logarithmic plots (log or ln), to test exponential and power law variations, understand and use the gradient of a tangent to a curve.
- Understand the notation $\frac{dx}{dt}$ for the rate of change of a physical quantity, x with respect to time, t.
- Understand, measure and interpret the area between a curve and an appropriate axis.

Calculus
Be able to;

- Differentiate and integrate simple functions (also for vectors).
- Recognize and interpret the significance of differentiation and integration for some physical phenomena.

Physical interpretation of mathematical solutions:
Be able to:

- Understand and use significant figure rules on mathematical solutions to physical equations.
- Associate the correct magnitudes, precisions and units to mathematical solutions to physical equations.
- Recognize, interpret and use slopes from graphs with physical significances.

PHYSICS TEACHING SYLLABUS FOR THE LOWER SIXTH AND UPPER SIXTH FORMS.

MODULE 1: PHYSICAL QUANTITIES, MEASUREMENTS AND EXPERIMENTAL PHYSICS.

PHYSICAL QUANTITIES.

CONTEXTUAL FRAMEWORK		COMPETENCIES		RESOURCES			
FAMILIES OF SITUATIONS	EXAMPLES OF SITUATIONS	CATEGORIES OF ACTIONS	EXAMPLES OF ACTIONS	CONTENT (CORE KNOWLEDGE)	OBJECTIVES		OTHER RESOURCES / (projects)
					APTITUDE (SKILLS)	ATTITUDES	
1.1 PHYSICAL QUANTITIES	**1.11 Measurements for applications in various areas of learning and daily life. Examples in technology, engineering, medicine, economic activities, etc**	• Base quantities and S. I. base units. • Derived quantities and units. • Dimensions • Homogeneity of physical equations.	• Writing down the magnitudes of physical quantities. • Working out derived units in terms of base units. • Demonstrating /testing homogeneity of given physical equations.	• **Physical quantities and units.** • Physical quantities and dimensions in terms of the three fundamental quantities (mass, length and time). • The magnitude of a physical quantity • **Base quantities and S.I base units.** • Base quantities and base units. • Base quantities (length, mass, time, temperature interval, electric current, amount of substance, luminous intensity and corresponding S.I base units. • **Derived quantities and**	• Define physical quantity and state the unit • Define base/primary quantities/state units. • Understand that base/primary quantities and their units are fixed by convention and form one possible minimum set in terms of which all other physical quantities and units may be defined. • Identify the seven base quantities/units of the international system (SI) • Explain the implications of the definition of the ampere for the value of the permeability of free space (μ_o). • Define derived/secondary quantities/units. • Express derived/secondary units as products and/or quotients of base units and use appropriate names for units. • Recognize that some physical quantities may not have units.	Consciousness of the scalar or vector nature of quantities and appropriate treatment of these in real life situations. Appreciate the precisions of measuring instruments. Appreciate the three important characteristics of physical quantities magnitudes, precision and units in relation to graduations on measuring instruments. Appreciation	Planned and structured experimental work shall be carried out by the learners during the two year course in the school laboratory. The other resources / projects in this section should go beyond these laboratory investigations. Teachers should challenge learners to use the knowledge acquired in class. The learners

	1.12 Dimensions physical of quantities	• Dimensions of Base quantities • Dimensions of Derived quantities Dimensional analysis	• Writing down the dimensions of base quantities • Working out dimensions of derived quantities in terms of base quantities • Determining the homogeneity of physical equations through dimensional analysis Manipulating dimensional symbols.	**units (SI)** • Derived/secondary quantities (as word equations) • Note: an equation given in terms of symbols is acceptable as a definition only if the symbols are explained. • The use of limiting values in some definitions is to be understood and known to be given by the gradient of the relevant graph. • The ultimate dependence of definitions of derived units on base units. • **Homogeneity of a physical equation** Homogeneity in terms of base units or derived units or dimensions. Tests for homogeneity of a physical equation • Homogeneity and correctness of physical equations.	• Explain homogeneity of a physical equation. • Use base units, derived units or dimensions to show whether or not a given physical equation is homogeneous. • Understand and explain why homogeneity is not a sufficient test for the correctness of a physical equation. Calculate the magnitudes of physical quantities, giving answers reflecting the accuracy of the data used.	of units in relation to practical examples and quantities.	can come up with productions carried out individually or in teams. These can be done at home using local materials and others gotten from scraps. The learners have to clearly spell out how their productions function and identify the daily life challenges which can be redressed by use of the productions. The productions can be exhibited during science club activities and science open door days.
1.2 Experimental Physics	**1.21 Scientific investigation**	• Measurements for basic civil	• Measuring physical	• Use of instruments and techniques.	• Understand the distinction between accuracy, sensitivity and precision of measuring	Awareness of the limitations of different	Improvising measuring instruments

	s **1.22** **Practical measurements of physical quantities in mechanical engineering, civil engineering, electrical engineering, electronics, thermodynamics applications.**	engineering applications. • Measurements involving thermodynamic heat and quantities. • Measurements involving electrical, magnetic and electronic quantities. • Uncertainty in measurements	quantities using standard instruments. • Accuracy, precision and sensitivity in measurements. • Describing uncertainty and error. • Handling systematic and random errors in measurements. • Expressing errors in absolute and relative forms. • Designing, planning, executing and reporting of experiments.	• Null methods • Use of standard instruments for measuring physical quantities. • Accuracy, sensitivity and precision. • Uncertainty and error. • Systematic and random errors. • Expressions of absolute and relative errors. • Need to calibrate measuring instruments. • Use of standard instruments and technics. • Use of the CRO and the electronic oscilloscope.	instruments. • Distinguish between uncertainty and error. • Distinguish between systematic and random errors and take account of them in measurements. • Display an understanding of the techniques for the measurement of length, mass, volume, plane angle, time interval, temperature, electric current, electrical potential difference, electrical resistance, etc). • State the uncertainty in a measured quantity. • Ability to design, plan simple experiments, select methods and / or techniques, carry out experiments, obtain data, process data appropriately, analyse data and interpret properly. • Present a report on an experiment using a defined scientific format accompanied by 2-D diagrams. • Use measuring instruments (meters) confidently and accurately. • Calculate relevant physical quantities from data collected in experiments. • Give physical significance to experimental results. • Use a galvanometer in null methods • Appreciate the limitations of the techniques used and take	measuring instruments and techniques and suitable handling of errors in measurement in real-life situations. Confidence and dexterity in handling equipment/measuring instruments. Positivity, critical thinking, objectivity in presenting experimental data.	e.g: 1) using a simple pendulum to measure time; 2) a helical spring to measure mass; 3)a locally made thermometer to measure temperature

					appropriate precautions. • Calibrate measuring instruments • Use the CRO/EO with a known resistor as a voltmeter, ammeter and as a clock • Use a CRO/EO to measure time, alternating current and alternating p.d.		

MODULE 2: KINEMATICS AND DYNAMICS
CLASSICAL MECHANICS

CONTEXTUAL FRAMEWORK		**COMPETENCIES**		**RESOURCES**			
FAMILIES OF SITUATIONS	**EXAMPLES OF SITUATIONS**	**CATEGORIES OF ACTIONS**	**EXAMPLES OF ACTIONS**	**CONTENT (CORE KNOWLEDGE)**	**OBJECTIVES**		**OTHER RESOURCES/ (projects)**
					APTITUDE (SKILLS)	**ATTITUDES**	
2.1 KINEMATICS	**2.11 Kinematics of particles** **Explaining motion** **Analysing motion, predicting motion, applying principles governing**	• Description of motion in everyday life	Running a race, Moving on foot, travelling by car, air and others Kicking a ball from one person or position to another. Selecting a means of moving persons and objects with time considerations.	• The equations of uniformly accelerated motion and their derivations. • Displacement - time, velocity - time, acceleration - time graphs and their interpretations. • Experimental measurement of speed, velocity and acceleration using ticker tape timers, linear air tracks.	• Define the terms: displacement, distance, speed, velocity, acceleration, linear momentum and state units where applicable • Appreciate and make use of the vector nature of displacement, velocity and acceleration • Distinguish between average and instantaneous values for velocity and acceleration • Calculate velocity and acceleration using vector algebra and calculus • Measure velocity and		**Measuring the speed of a stream** An inflated floating balloon or proof bag, a stop watch, a measuring tape or metre rule. **Measurement of**

	motion in daily life.			• Measurement of the magnitude of the acceleration of free fall	acceleration using any suitable apparatus • Analyse experimental results to calculate velocity and acceleration, e.g. ticker-tape, linear air track. • Draw and sketch graphs of distance, displacement, velocity, and acceleration versus time • Use the graphs above to obtain relevant quantities from the slopes and areas under the relevant graphs • Derive and use equations of uniformly accelerated motion in calculations • State some applications of "g", the acceleration of free fall.		**displacement, speed and acceleration for a moving object. Determination of the local value of the acceleration due to gravity. Determination of terminal velocity**
2.2 DYNAMICS, NEWTON'S LAWS OF MOTION AND FORCE	**2.21 The dynamic nature of forces** **2.22 Newton's laws of motion, The laws, the principle of conservation of linear momentum.**	• Definition and classification of forces. • The vector nature of force. • The effects of forces • The basic forces of	• Taking cognizance of the vector nature of forces in all situations. • Defining and classifying forces into gravitational, electromagnetic, weak and strong forces. • Making use of forces in everyday life. • Analysing systems by	• Force as a vector quantity • Force as a pull, push or resultant of both. • Contact and non-contact forces - distinction and examples. • Familiarity with forces such as: weight, tension, upthrust, normal contact force, frictional force, viscous drag, aerodynamic lift, electromagnetic forces (electric and magnetic forces). • The gravitational pull of the earth (or other massive body) on an object to be	Being able to: • Define force and state its S I unit, the newton. • Classify forces into contact and non-contact forces. • Appreciate the vector nature of forces. • State and explain the effects of a force on an object. • Identify and describe the basic forces of nature (gravitational, electromagnetic, weak and strong forces). • State examples of basic forces in nature. • Draw free body diagrams	Awareness of the vector nature of force and treating forces as such in situations involving forces in operation. Drawing and / or extracting information from force diagrams. Recognize situations requiring practical applications of Newton's laws of motion and respond	**Experimental work on Newton's second law of motion and the law of conservation of linear momentum.** Light gates, mass riders, trolleys, ticker timers, linear air tracks and accessories, newtonmeters, data loggers, laptops, measuring tapes, metre

	2.23 Collisions / Explosions	nature. • Statements of Newton’s laws of motion. • Explanation of Newton’s laws of motion • Analysis of Newton’s laws of motion to bring out their implications. • Applications of Newton’s laws of motion and the principle of conservation of linear momentu	drawing free body diagrams for different parts of a given system.	called its weight. • Friction in everyday life and the importance of lubricants. • Dependence of drag forces on speed. • Force diagrams and what they represent. • Force on a mass in a Gravitational Field • *{Force on a moving or stationary charge in an Electric and/or magnetic field.* • *Force on a conductor carrying current /charged object moving in an electric and/or Magnetic Field.* • The concept of inertia in relation to static and dynamic equilibrium and Newton’s first law of motion. • **Newton’s second law of motion;** Statement of the law to show the relationship between the rate of change of linear momentum and the resultant force. $\vec{\boldsymbol{F}} = \frac{d\vec{\boldsymbol{P}}}{dt} = \frac{d(m\vec{v})}{dt}$,	• Write vector equations of forces acting on an object. • Calculate magnitudes of forces from their vector equations. • Use of value of force to determine acceleration and application in the equations for uniformly accelerated motion to obtain distance covered as a function of time, trajectory and others. • Find resultants of coplanar forces using Newton balances or pulleys. • Define linear momentum and appreciate its vector nature. • Solve simple problems on linear momentum • State Newton’s laws of motion. • Explain what is meant by inertia. • Distinguish between static and dynamic equilibrium, giving examples. Derive the equations: $\vec{F} = m\frac{d\vec{v}}{dt} = m\vec{\boldsymbol{a}}$ and $\vec{\boldsymbol{F}} = \vec{\boldsymbol{v}}\frac{dm}{dt}$ as special cases of Newton’s second law of motion. • Define the newton from	appropriately e.g. putting on seat belts, using headrests in cars, wearing helmets when riding bikes, bending knees on landing after jumping. Using Newton’s laws to improve performance in sporting events such as stopping a ball by a goal keeper, throwing the javelin or hammer, etc.	rules, other necessary apparatus. **Constructing an accelerometer** **Construction and calibration of a spring balance** Helical spring, metre rule, standard weights, plastic tube, other materials for enclosure and finishing. **Measurement of the upthrust on an object immersed in water.** Newtonmeter, overflow can, chosen objects, beakers, various liquids, etc

		m. • Problem solving using Newton's laws of motion and the principle of conservation of linear momentum		• Where: - for constant mass and variable velocity $\vec{\boldsymbol{F}} = m\frac{d\vec{v}}{dt} = m\vec{\boldsymbol{a}}$, and - for constant velocity and variable mass $\vec{\boldsymbol{F}} = \vec{v}\frac{dm}{dt}$. • Writing the impulse-momentum equation in the forms: $\vec{F}\Delta t = \Delta\vec{P} = \Delta(m\vec{v})$ $\overrightarrow{\Delta P} = \int_{t_1}^{t_2} \vec{F}.dt$ • Graphical analysis and implications of the formulae above. • Experimental investigation of Newton's second law: • $\vec{\boldsymbol{a}} \propto \sum \vec{\boldsymbol{F}}$, for $m = constant$; • $\lvert\vec{\boldsymbol{a}}\rvert \propto \frac{1}{m}\ for\ \boldsymbol{F} = constant$ **Newton's third law** • Statement of the law • Implications of the law • Action-reaction force pairs. • **Some examples of practical applications of Newton's first, second and third laws of motion**	Newton's second law of motion • Define impulse and state the relationship between impulse and linear momentum. • Interpret the impulse-momentum equation physically, algebraically and graphically. • Carry out experiments in the laboratory to demonstrate: $\vec{\boldsymbol{a}} \propto \sum \vec{\boldsymbol{F}}$, for $m = constant$; • $\lvert\vec{\boldsymbol{a}}\rvert \propto \frac{1}{m}\ for\ \vec{\boldsymbol{F}} = constant$, using linear air tracks, trolleys and ticker-tape or powder track timers, light gates and data loggers, etc. • Draw free-body diagrams and identify action-reaction pairs of forces, from Newton's third law • Appreciate the fact that both forces in an action-reaction pair cannot act on the same body as well as the implications of this for accelerated motion. • Explain the application of Newton's laws to simple practical situations e.g. seat belts, escalators, lifts, rocket propulsion, sports, ball games, etc).		**Explore the functioning of a parachute.** **Exploration of sporting activities to identify and explain the applications of Newton's laws and conservation of linear momentum in them.** Sporting facilities (long jump facility, high jump facility, javelin, football and handball pitches, etc), sports instructors, sport scientists. By incorporating a balloon into a system, investigate how the

				• **The law / principle of conservation of linear momentum.** • Statement of the law • The principle of conservation of linear momentum and Newton's laws of motion. • Experimental study of the conservation of linear momentum for collisions in one dimension only. **Collisions** • Elastic, and inelastic collisions • Collisions in one dimension: head-on collisions • Collisions in two dimensions or oblique collisions. • Application of conservation of linear momentum to simple collisions in one and two dimensions. **Explosions** • Simple explosions and momentum conservation	• State the law of conservation of linear momentum. • Derive the law of conservation of linear momentum from Newton's second and third laws of motion • Define collision and distinguish between elastic and inelastic collisions, giving practical examples of each. • Apply the law of conservation to simple examples of interactions such as collisions in one and two dimensions, and explosions.		reaction to a jet of air flowing out of the balloon can move the system.
2.3 TURNING EFFECT OF	**2.31 Moment of a Force. Fixing and**	• Rotation of objects and the equilibrium of	• Stating Newton's laws of motion and the law of	• Moment of a force • Couple and torque due a	• Define the moment of a force about an axis, couple and torque of a couple. • Explain the factors that	Interest in civil engineering Consciousness/	**Visit a civil engineering structure such as a**

FORCES	**removing of nuts eg on car tyre** **Couple and Torque.**	rigid bodies.	conservation of linear momentum • Analysing Newton's laws of motion to bring out their implications • Carrying out experimental work on Newton's second law of motion • Carrying out experimental investigations on the law of conservation of linear momentum • Identifying, explaining and making use of some applications of Newton's laws of motion and of the law of conservation of linear momentum. • Solving problems using Newton's laws of motion	couple. • **The principle of moments** • **Static equilibrium of a system under the action of coplanar forces.** • Conditions for equilibrium • Centre of mass • Centre of gravity	determine the magnitude of the moment. • Make use of a knowledge of the factors affecting the moment of a force in practical situations such as undoing a tight nut, locating hinges on door and window shutters, etc. • Calculate moments of forces and torque of couple. • State and apply the principle of moments. • Distinguish between centre of mass and centre of gravity of a rigid body. • State the conditions for static and dynamic equilibrium of a rigid body and use them in solving simple problems. • Determine the mass of a body by use of moments. • Explain the use of couples and torques in daily life.	awareness of existence of torques in systems and how to avoid unpleasant effects of these, especially where such are undesirable.	**bridge and study its equilibrium** **Construction and calibration of a simple beam balance**

			and the law of conservation of linear momentum such as in collisions and explosions.				
2.4 SIMPLE HARMONIC MOTION OF MECHANICAL SYSTEMS	**2.41 Vibrating and oscillating objects and systems.**	• Simple Harmonic Motion Examples of objects undergoing SHM • Simple harmonic motion in relation to circular motion • The equations of displacement, velocity and acceleration of an object executing SHM • Graphical representation of physical quantities associated with SHM • Definition of free SHM system • Definition of damping in SHM	• Set up an oscillating system e.g simple pendulum, mass/spring, water in a U-tube, etc • Observe, examine and explain the suspension of a car system • Explain the role of springs and shock absorbers in cars	• Definition of SHM. • Derivation of second order differential equation $a = -\omega^2 x$ Where $\omega = 2\pi f$ (pulsatance or angular frequency). The equation should be understood physically, algebraically and graphically. • Experimental study of examples of SHM; -simple pendulum - helical spring /mass • Equations for frequency and period. • Mass on a smooth horizontal surface attached to a spring • Simple harmonic oscillator and energy • Phase differences in the variations of some physical quantities for SHM	• State and describe examples of practical oscillations • Investigate the motion of an oscillator using experimental and graphical methods • Define and use the terms amplitude, period, frequency and phase difference and express the period in terms of both frequency and angular frequency • Use the equation $a = -\omega^2 x$ as the defining equation of SHM • Understand that all systems with the above differential equation have as general solution $x = x_0 \sin(\omega t + \varphi)$ or $x = x_0 \cos(\omega t + \varphi)$ where φ the initial phase can be 0 depending on the initial conditions. • Derive and apply equations of the velocity and acceleration from the general solution i.e. $v = \omega x_0 \cos(\omega t + \varphi)$ and $a = -\omega^2 x_0 \sin(\omega t + \varphi) = -\omega^2 x$ • Recognize and apply the Cartesian equations of velocity and acceleration as $v =$	Diving into a swimming pool from a spring board	-String, stand and clamp, pendulum bob, helical spring, standard masses, or mass and balance Cantilever experiments Glycerine -Heavy-duty machines put on rubber supports to absorb vibrations

					$\pm\omega\ \sqrt{x_0^2 - x^2})\ and\ a = -\omega^2 x$ • Describe with graphical illustrations the changes in displacement, velocity and acceleration during SHM • Describe the interchange between kinetic and potential energy during SHM. • Name the different degrees of damping and understand their effects on a SHM system.		
	2.42 Forced mechanical Oscillations and Resonance	- Definition of forced oscillation in mechanical systems. Definition of resonance in mechanical oscillating systems	• Case of the suspension system of a car. • Observe the pendulum clock.	• Qualitative and experimental discussion of free, damped and forced mechanical oscillators and resonance.	• Give practical examples of forced oscillations and resonance. • Describe graphically how the amplitude of a forced oscillator changes with frequency near f_o and understand qualitatively the factors that determine the frequency response and sharpness of resonance. • Appreciate situations in which resonance is useful and those in which it is a nuisance.	• Explain using a spring board how to dive into a swimming pool.	-String -stand and clamp -pendulum bob -helical spring -stand and masses. or mass and balance -Car springs and shock absorbers.
2.5 CIRCULA R MOTION	**2.51 Movement of an auto-mobile along a bend**	Describing, explaining, analysing, predicting and applying motion in circular paths and trajectories.	• Deriving useful formulae. • Applying relevant formulae in solving problems. • Analysing systems undergoing circular motion.	**Definition of essential concepts** • Angular distance, angular speed, radial and tangential unit vectors, angular displacement, angular velocity, angular acceleration, centripetal acceleration, centripetal force. • (A centripetal force to be	• Define radial and angular unit vectors, angular distance, angular displacement, angular speed, angular velocity, angular acceleration, centripetal acceleration, centripetal force. • State and explain conditions necessary for uniform circular motion to occur. • Derive the equations $\vec{v} = r\omega\hat{\theta}, \vec{a} = -r\omega^2\hat{r} = -\frac{v^2}{r}\hat{r},$	• Explain motion of roller coaster • Orbital motion of planets	

				understood as a requirement to be met for circular motion and not as another example of force. This requirement has to be met by the forces acting depending on the particular circumstance). • Formulae for uniform circular motion: • $\vec{v} = r\omega\hat{\theta}, \vec{a} = -r\omega^2\hat{r} = -\frac{v^2}{r}\hat{r},$ • $\vec{F} = -mr\omega^2\hat{r} = -\frac{mv^2}{r}\hat{r}$ • Equations of motion with uniform angular acceleration • Different areas of life in which circular motion is encountered • **Analysis of examples of circular motion** from different areas of life (satellite motion, charged particles, vehicles on earth's surface, conical pendulum). • **Apparent weightlessness;** Meaning, causes and examples.	• $\vec{F} = -mr\omega^2\hat{r} = -\frac{mv^2}{r}\hat{r}$ • Use formulae above to solve simple problems on circular motion. • Describe qualitatively and quantitatively, motion along a curved path due to a normal force. • Give examples of situations requiring a centripetal force and identify the source of the centripetal force in each case. • Analyse systems undergoing circular motion to derive relevant quantities, by applying relevant equations. • Analyse examples of circular motion from different areas of life (satellite motion, charged particles, vehicles on earth's surface, conical pendulum, bodies whirled on strings, etc). • Explain the effect of the rotation of the earth on gravitational field strength. • Explain the phenomenon of apparent weightlessness and give examples of situations in which it occurs.		

2.6 MECHANICAL WORK, ENERGY AND POWER	**2.61 Mechanical Energy Considerations**	• Work, energy, power and efficiency (Efficient and effective use of energy in moving systems)	• Defining essential concepts • Exploring and explaining types and forms of energy, energy transfers quantitative and qualitative treatment. • Applying the law of conservation of energy to different systems • Applying the work-energy theorem to different situations • Conservative and non-conservative forces • Applying Einstein's mass-energy relation to simple systems • Determining the efficiency of given systems or energy transfer	**Work** • Define~~d~~ as a scalar quantity derived from the scalar (dot) product of force and displacement. • Consider work as energy transfer during a physical process. • The joule (J) as the SI unit of work. **Energy** • Definition of energy • Types of mechanical energy: kinetic energy and potential energy • Potential energy understood as energy associated with position with respect to a reference. • Forms of potential energy (gravitational, elastic, chemical, nuclear, electrostatic) • Change in gravitational potential energy close to the earth's surface given by $\Delta U \approx mg\Delta h$ • Elastic potential energy $E = \frac{1}{2}kx^2 = \frac{1}{2}Fx$ • Forms of kinetic energy: - Translational kinetic energy $(E_{kT} = \frac{1}{2}mv^2)$, for $v \ll c$ - Rotational kinetic energy $(E_{kR} = \frac{1}{2}J\dot{\theta}^2)$,	• Define work, energy and power and give their S. I. units. • Appreciate work as energy transferred by some physical process. • Derive classical mechanics formulae for kinetic energy, gravitational potential energy, elastic potential energy. • State the law of conservation of energy and apply it to different situations involving energy changes. • State the work-energy theorem and apply it in calculations. • Apply the law of conservation energy in solving simple problems. • State and use Einstein's mass-energy relation; $\Delta E = \Delta mc^2$ • Distinguish between average and instantaneous power • Appreciate the efficient use of energy in the home. • Distinguish between conservative and non-conservative forces, giving examples in daily life. • Appreciate efficiency as the ratio of work (or energy or power) output to work (or energy or power) input. • Consider fractional and percentage efficiency • Describe and explain ways of reducing energy or power losses in systems or energy transfer processes at home and in the community.		Construct machines understood as devices on which a force can be applied at one point to overcome other force at a different point. Explain the convenience in using the machine constructed over direct manual work.

			processes • Figuring out/devising ways of minimising energy or power losses in systems.	• The law of conservation of energy • The work-energy equation for mechanical systems • $\vec{F}.\vec{s} = \Delta(\frac{1}{2}mv^2)$ • The work-energy theorem and equation for mechanical systems $\vec{F}.\vec{s} = \Delta W = \Delta E_k$ • Conservative and non-conservative force systems • The principle of conservation of energy obtained from the work-energy theorem • Einstein's mass-energy relation $\Delta E = \Delta mc^2$ • Meaning and applications • **Efficiency** • Definition and significance • Relative efficiency expressed as a fraction and/or percentage. **Power** • Power as a scalar quantity expressed as the scalar (dot) product of force and velocity. • Power as the rate of change of energy transfer or work done, with time • The watt (W) as SI unit of power. • Average and instantaneous power.			

MODULE 3: EVERYDAY USES OF ENERGY

THERMAL ENERGY

CONTEXTUAL FRAMEWORK		COMPETENCIES		RESOURCES			
FAMILIES OF SITUATIONS	**EXAMPLES OF SITUATIONS**	**CATEGORIES OF ACTIONS**	**EXAMPLES OF ACTIONS**	**CONTENT (CORE KNOWLEDGE)**	**OBJECTIVES: APTITUDE (SKILLS)**	**OBJECTIVES: ATTITUDES**	**OTHER RESOURCES/ (projects)**
3.1 TEMPERATURE	**3.11 Thermometers. Thermal equilibrium.**	• Thermal equilibrium and temperature. • Thermometry • Temperature scales.	• Measurement of temperature in different units. • Convert temperature expressed in one unit to another; $\theta = (\frac{T}{K} - 273.15)°C$ $T = (\frac{9}{5}\frac{\theta}{°C} + 32)F$ Calibrate thermometer using fixed points. $\theta = \frac{X_{\theta} - X_0}{X_{100} - X_0} 100\ °C$ Compare thermometers with respect to thermometric properties.	**Thermal equilibrium and Temperature**. • Zeroth law of thermodynamics. • Linear relationship between temperature and thermometric property. • Absolute and thermodynamic temperatures. **Thermometry.** • Temperatures measured in degree Celsius to kelvin and Fahrenheit. • Advantages and disadvantages of resistance thermometers, gas thermometers, mercury in glass thermometers and thermocouples.	• Identify sources of heat and effects of heat absorbed or given out on temperature. • Relate an increase in temperature to an increase of the internal energy of a body. • Express internal energy as the sum of the kinetic and potential energies associated with molecules of the system. • Show an understanding that a physical property which varies as temperature changes may be used for the measurement of temperature and state examples with reasons making them suitable for the purpose. • Show an understanding that regions of equal temperature are in thermal equilibrium. • Use clinical thermometer to measure body temperature.	• Read and interpret variation in thermometric properties due to temperature change. • Appreciate the fact that absolute scale of temperature does not depend on the property of any substance. • Understand thermodynamic temperature as the SI base physical quantity measured in kelvin. • Appreciate different situations for use of different thermometers.	**Resources** Hot and cold objects (dissimilar wires, thermostats, thermometers) **Project 1** Construct and graduate thermometers from objects that expand and contract with temperature variations. **Project 2.** Visit lab, workshop, industry, hospital, and compare thermometers used in terms of precision, size and temperature range.

3.2 ENERGY TRANSFER	**3.21 GENERALITIES ON ENERGY TRANSFER.**	• Forms of energy. • Energy transfer and conversion • Law of conservation of energy. • Internal energy	• Convert energy from one form to another. • Identify energy in various forms • Apply principle of conservation of energy in simple examples. • Illustrate the implication of practical losses of energy in devices. • Demonstrate energy transfer by (a)mechanical process $\Delta W = \vec{F} \cdot \vec{d}$ (b) thermal process $\Delta Q = mc\Delta T$ (c) electrical process $\Delta W = IV\Delta t$	• **Forms of energy.** • **Energy transfer and conservation.** • **Law of conservation of energy.** • **Understanding of internal energy as determined by the state of a system and which can be expressed as the sum of the random distributions of the kinetic and potential energies associated with the molecules or particles which constitute the system.**	• Identify forms of energy in the environment. • Identify day to day situations of energy transfer. • Define and calculate efficiency for energy transfer processes.	• Give advice on the efficiency of devices in terms of energy conversion. • Appreciate the functioning of house hold electrical (ENEO)meters • Use energy efficiently. • Appreciate consumption by electrical devices.	**Project 1**. Identify energy transducers at home. **Project 2.** Visit an industry in locality and identify energy transfer processes. Visit a thermal power plant, a brewery etc.
	3.22 GENERATION AND TRANSFER OF THERMAL ENERGY	• Heat capacity, latent heat and specific latent heat; • Measurements of specific heat capacities of solids and liquids and specific latent heats of fusion of solids (ice)	• Use of calorimeter to determine specific heat capacity of water • Determination of the latent heat of fusion using melting ice (method of mixtures)	**Heat capacity and latent heat** • Using a simple kinetic model for matter explain why (i) melting and boiling take place without a change in temperature (ii) the specific latent heat of vaporization is higher than the specific latent heat of fusion for the same substance (iii) a cooling effect accompanies evaporation • Experiments to determine specific heat capacity by electrical	• Explain using a simple kinetic model for matter why (i) melting and boiling take place without a change in temperature (ii) the specific latent heat of vaporization is higher than the specific latent heat of fusion for the same substance (iii) a cooling effect	• Appreciate why water is used in electrical thermal plants and nuclear power systems • Appreciate why water is a very good coolant and used in car radiators and steam burns very	**Resources:** Aluminium, clay silver pots, methylated spirit, rubber bucket and calabash **Project 1** Compare the cooking rates in a clay pot, silver pot, iron

		and vaporization of liquid (water)		method. • Experiment to determine the specific latent heat of fusion of ice and the specific latent heat of vaporisation of water.	accompanies evaporation • Define and use the concept of specific heat capacity and identify the main principles of its determination by any electrical method	seriously. • Appreciate why evaporation leads to cooling • Using the lid of a pot during cooking to minimize energy loss	pot and aluminium pots and explain their differences in terms of specific heat capacities -Use methylated spirit to experience the cooling effect of evaporation.
	3.23 Thermal Energy Transfer	• Thermal energy transfer processes (conduction, convection, radiation and evaporation). • Thermal conductivity • Good and poor conductors.	• Identify and explain everyday applications and consequences of energy transfer processes. • Identify infra-red radiation as part of the electromagnetic spectrum. • Solve problems with numerical examples using $\frac{dQ}{dt} = -\lambda A \frac{d\Theta}{dx}$ $\frac{Q}{t} = \lambda A \frac{\theta_2 - \theta_1}{x}$ • Identify and use different types of conductors in different situations in	**Heat transfer processes**. • Mechanisms of heat transfer processes. • Experiments to illustrate conduction, convection, and radiation. • Convection in fluids and density changes. • Application and consequences of conduction, convection and radiation. **Thermal conductivity**. • Compare thermal and electrical conduction. • Simple numerical examples in one dimension only. • Simple molecular account of heat transfer in solids. **Good and bad conductors** • Experiments to demonstrate the properties of good and bad conductors of heat.	• Identify and appreciate position of heating element in water. • Identify and use poor and good conductors in different situations. • Develop ways of preventing heat losses from objects and persons. • Describe experiments to illustrate conduction, convection, and radiation. • Relate convection in fluids to density changes. • Explain everyday application and consequences.	• Appreciate importance and use of wooden carpets on floors, silver coated bulb of thermometer. • Avoid burns by using insulators to handle heat conductors. • Appreciate heat transfer processes taking place in electric kettle. • Appreciate precautions to be taken by humans during hot and cold weather to prevent the body from too much cold or heat. • Reducing heat losses in different	**Resources**. Aluminium foil, dark surfaces, cartons, scissors, glue, Leslie cubes. **Project 1**. Design and construct functional devices to illustrate thermal energy generation transfer and thermal energy insulation in solar heaters.

			everyday life.	• Experiments to demonstrate the properties of good and bad emitters, absorbers of radiant energy.		situations.	
3.3 ELECTRICAL ENERGY TRANSMISSION AND DISTRIBUTION	**3.31 Current Electricity**	• Electric current and potential difference. • Resistance and resistivity. • Electric circuits and networks. • Potential divider.	• Measuring p.d, current and resistance using a voltmeter, ammeters or multimeter • Measuring the internal resistance of a cell. • Building up simple series and parallel circuits • Apply $\sum I=0$; $\sum E=IR$ in solving problems. • Use the formulae in $I= dQ/dt$ $V = IR$ $V = W/Q$ $P = VI = I^2R$ • Electric circuit calculations	**Electric current and potential difference (p.d**) • p.d as energy transfer/charge or $V = W/Q$ • P.d and e.m.f • Graphs of current versus potential difference for ohmic and non-ohmic conductors (metal wires, wire filament, semiconductor diode, thermistor). • The use of ammeters with resistance and voltmeters with non-infinite resistance in place of ideal ammeters and voltmeters. • Extension of the range of electrical meters (multimeters) **Resistance, resistivity and conductivity**. • Experiment to determine the resistivity of a material. • Mention of superconductivity • Internal resistance of a cell. **Ohm's law** • Resistors in series and parallel rheostats • Temperature dependence of resistance. • The potential divider; The potentiometer as a potential divider. The use of balanced potentials using a calibrated potential divider (slide wire potentiometer) • The potentiometer as an ideal	• Read e.m.fs of sources of electrical energy. Determine electrical energy consumption of a household from the meter installed by electricity board. • Understand why some appliances consume electrical energy than others. • Explain why someone can be electrocuted. • Explain why an electric distributor can be used to power several appliances at once. • Manipulate and use multimeters. • Distinguish between p.d and e.m.f • Sketch I-V graphs for ohmic and non-ohmic conductors (metal wires, wire filament, semiconductor diode, thermistor).	• Appreciate that bulbs in our houses are connected in parallel • Observe safety rules when dealing with electricity. • Read and interpret labels on electrical appliances.	**Resources** Ammeter, Voltmeter, Multimeter, resistor, dry cell battery, fuses, switch, socket, plugs etc. **Project 1** Design simple circuits. Construct switches, Sockets and electrical power distributors into which various devices can be socketed for use. Project 2: Visit a major building site and observe how wiring is done. Project3: Do simulations for the wiring

				voltmeter (null deflection at balance point). **Kirchhoff's laws** • Solve circuit problems using Kirchhoff's laws. • Relate Kirchhoff's laws with the principles of conservation of charge and energy.			of a home such that rooms and different points can be supplied from a single meter.

MODULE 4: MATTER, EFFECTS OF ENERGY AND APPLICATIONS.

MATTER

CONTEXTUAL FRAMEWORK		COMPETENCIES		RESOURCES			
FAMILIES OF SITUATIONS	**EXAMPLES OF SITUATIONS**	**CATEGORIES OF ACTIONS**	**EXAMPLES OF ACTIONS**	**CONTENT (CORE KNOWLEDGE**	**OBJECTIVES**		**OTHER RESOURCES/ (projects)**
					APTITUDE (SKILLS)	**ATTITUDES**	
4.10 SOLIDS ,LIQUIDS AND GASES	**4.11 Macroscopic and microscopic differences between solids, liquids and gases.**	• Quantitative molecular account of the difference between solids, liquids and gases. • Pressure • Crystalline, glassy, amorphous and polymeric solids and force-extension	• Quantitative molecular account of the difference between solids, liquids and gases. • Pressure • Crystalline, glassy, amorphous and polymeric solids and force-extension characteristics.	• Properties of matter in terms of molecular behaviour. • Simple kinetic model for solids, liquids and gases. • Structures and densities of solids, liquids and gases to simple ideas of the spacing, ordering and motion of molecules. • Direct measurement of densities. • Structure of crystalline and non-crystalline solids with particular reference to metals, polymers	• Appreciate why particles in liquids have higher average kinetic energies than in solids under the same conditions and why liquids can flow. • Define density and describe an experiment to determine density. • Appreciate the different structures of solids. • Derivation and application of the expression for pressure in fluids.	• Appreciate why liquids and solids have different mechanical applications (e.g. hammer, hydraulics) • Distinguish between brittle, elastic and non-elastic materials as well as	• **Project1** ○ At home and in school, test the mechanical properties of different materials and collect statistics, from which basic calculations can be done.

		characteristics. • Stress, strain and the Young's modulus. • Energy stored in a stretched spring, cord of wire; • Force separation and potential energy separation curve for two atoms in crystalline solids.	• Stress, strain and the Young's modulus. • Energy stored in a stretched spring, cord of wire. • Force separation and potential energy separation curves for two atoms in crystalline solids.	and amorphous materials. • Hooke's law and behaviour of springs in terms of load, extension, elastic limit. • Young's modulus • Elastic and plastic deformation of materials. • Use of the equation p = $h\rho g$ • Pressure difference across a spherical/curved interface. • Surface tension of water and its variation with temperature.	• Appreciate that deformation is caused by a force and that in one direction, it can be tensile or compressive. • Understand that the extension is proportional to the force applied, when the elastic limit is not exceeded. • List practical examples of plastic deformation (creep), yield point (fatigue). • Basic calculations of stress, strain and the Young's modulus for a material • Interpret relevant graphs e.g. Force-separation and potential energy separation for molecules, force-extension and stress-strain for solids. • Ability to carry out the experiment and collect the necessary data to evaluate. • Calculate the pressure difference across a spherical/curved interface. • Determine the surface tension of water and its variation with temperature.	strong, flexible and stiff materials. • Appreciate that materials deform or break when stretched beyond certain limits • Appreciate the different applications of rubber with a large or small hysteresis loop • Relate fatigue to some accidents (bridges, planes) • Understand the effects of heating and adding detergents to water in laundry. • Understand that surface tension is responsible for a number of physical phenomena. • Appreciate that the angle of contact is measured through the liquid.	○ Visit a construction site in your locality or a carpentry workshop: 1) Identify the materials used there and 2) Relate the properties of these materials to their uses.

4.20 THERMODYNAMICS	**4.21 Gas Laws and Kinetic Theory of gases.**	• Ideal gas and real gases. • Pressure, volume and temperature as parameters to measure in thermodynamics. • Gas laws • Ideal gas equations (equations of state). • Distribution of molecular speeds.	• State laws of gases and express their equations. • Ideal gas equation in relation to the gas laws. • Solve problems using equations of state of an ideal gas. • State the basic assumptions of the kinetic theory of gases • Explain how molecular movements cause pressure exerted by gases.	• **Brownian motion in gases.** • **Ideal and real gases** • The behaviour of ideal and real gases. • Gas laws and their equations • Basic assumptions of the kinetic theory. • Use the kinetic theory to explain pressure exerted by gases • the ideal gas equation in the form $PV = nRT = \frac{m}{M}RT = \frac{N}{N_A}RT = NkT$ • Graphs to illustrate gas laws (Boyle's law, Charles' law, pressure law) • Derive expressions $P = \frac{1}{3}\rho\overline{c^2}$ and $\frac{1}{2}m\overline{c^2} = \frac{3}{2}kT$ and hence deduce and use the relation average translational KE of ideal gas molecules **α** T. • Distribution of molecular speeds. • Graham's law of diffusion.	• Predict the effects of variation of pressure, temperature, and volume on gases. • Compare real gases and ideal gases • Presentation of information graphically. • Predict the effect of heat on gases. • state the basic assumptions of the kinetic theory • Interpret graphs for molecular speed distribution. • Infer evidence for molecular motion from Brownian motion. • Use Graham's law to explain the spread of odours from sprays at a point or location in a room.	• Appreciate changes in the environmental conditions due to changes in pressure and temperature. • Appreciate the functioning of instruments which function using gases (barometers, pressure gauges)	**Project 1.** -Visit a weather forecasting station around and study barometer and other weather forecasting equipment. **Project 2.** Identify household equipment which function based on pressure, temperature and volume variations (pressure cookers, water heaters, etc)
	4.22 Laws of Thermodynamics	• First law of thermodynamics. • Isobaric, Isochoric, Adiabatic and isothermal changes and processes. • Second law of thermodynamics • Entropy	• -State and apply first law of thermodynamics in solving problems. • Interpret Isobaric, Isochoric, Adiabatic and isothermal changes and give their equations • Relate these changes with ideal gas laws	**First law of thermodynamics**. • First law of thermodynamics and relation to the law of conservation of energy $\Delta Q = \Delta U + \Delta W$. ΔQ = Heat supplied or given out. ΔU =change of internal energy of a system ΔW =work done on a system or by a system. **Thermodynamic processes** • Isobaric, Isochoric, Adiabatic and isothermal processes. • Thermodynamic processes and	• State the first law of thermodynamics and relate it to the law of conservation of energy. • Identify Isobaric, Isochoric adiabatic and isothermal processes. • Apply conservation laws in systems (heat pumps and heat engines).	• Identify dependent and independent variables in graphs • Perform simple repairs based on understanding of how devices function. • Efficient and proper use of devices. Give technical	**Project 1.** Visit a refrigerator repairer and study the components of a refrigerator and air conditioners and their functioning.

			• Identify adiabatic and isothermal processes in the environment. • Apply second law of thermodynamics to explain how simple systems like refrigerator, air conditioners, internal and external combustion engines work.	first law of thermodynamics Isothermal process $T = const. PV = const$ $\Delta U = 0, \quad \Delta Q = \Delta W$ Isochoric process $V = const, \quad \frac{P}{T} = K$ $\Delta Q = \Delta U$ Isobaric process $P = const, \frac{V}{T} = \text{K}$ $\Delta Q = \Delta U + \Delta W$ adiabatic process $PV^{\gamma} = const,$ $\Delta Q = 0, \quad \Delta U = \Delta W$ **Second law of thermodynamics**. Second law of thermodynamics. Reversible and irreversible processes. • The basic functioning of heat engines, Carnot engines and heat pumps (refrigerators and air conditioners). • Coefficient of performance **Entropy.** • Entropy, $\Delta S = \frac{\Delta Q}{T}$ for a reversible process and $\Delta S \geq 0$ for a closed system.	• Explain the working principles of air conditioners and refrigerators. • Solve simple problems using the expression for the efficiency of a heat engine. $\eta = 1 - \frac{Q_1}{Q_2}$ • Solve simple problems using the expression for coefficient of performance. $\beta = \frac{Q_2}{Q_1 - Q_2} = \frac{T_2}{T_1 - T_2}$ • Draw and interpret graphs involving adiabatic and isothermal processes, reversible and irreversible processes.	advice on how to handle devices.	**Project2**. Visit a motor mechanics garage to observe the • Internal mechanisms of an internal combustion engine. Heat transfer mechanisms involved between the engine, radiator and working substance.

4.30 ATOMIC AND NUCLEAR PHYSICS

CONTEXTUAL FRAMEWORK		**COMPETENCIES**		**RESOURCES**			
FAMILIES OF SITUATIONS	**EXAMPLES OF SITUATIONS**	**CATEGORIES OF ACTIONS**	**EXAMPLES OF ACTIONS**	**CONTENT (CORE KNOWLEDGE)**	**OBJECTIVES**		**OTHER RESOURCES/ (projects)**
					APTITUDE (SKILLS)	**ATTITUDES**	
4.31 ATOMIC AND NUCLEAR PHYSICS	**4.311 The Atomic Nucleus**	• α-particle scattering experiment • Simple model of the atom • Subatomic particles • Isotopes • Atomic and nuclear sizes • Conservation of mass and energy in nuclear reactions • Nuclear reactions (fusion and fission).	• Describing α-particle scattering experiment. • Naming and giving the properties of subatomic particles. • Stating the sizes of the nucleus and the atom • Calculate energy as a result of mass difference during fission and fusion from $E = \Delta mc^2$	• Evidence for the existence of atomic nucleus and atomic model from the alpha-particle scattering experiment. • Relative atomic mass, nucleon number, atomic number, isotopes. • Nuclear reactions (fusion, fission)	• Draw and describe the nuclear model of an atom. • Infer from the α-particle scattering experiment the existence, size and composition of the atomic nucleus. • Nucleon number and proton number (atomic number) • Show an understanding that an element can exist in various isotopic forms each with a different number of neutrons. • Distinguish between nuclear fusion and nuclear fission. • Write balanced nuclear equations in which nucleon number, proton number and energy are all conserved.	• Appreciate the nature of the nucleus and the atom • Understand that an element can exist in more than one isotopic forms • Energy from nuclear fission and fusion which can be converted to electrical energy.	
	4.312 Radioactivity	• Factors affecting the stability of a nucleus • Background radiation • Balanced nuclear equations for radioactive decay.	• Calculate binding energy per nucleon and neutron – proton ratio and relate them to nuclear stability • Define background	• Nuclear stability • Natural and artificial (induced) radioactivity • Properties and uses of α, β and γ and associated decay processes. • Radioactivity as a random process.	• Sketch and interpret graphs of Binding Energy per nucleon (B.E/A) versus **A.** • Calculate binding energy from mass difference. • Explain the relevance of BE/A for nuclear fission, fusion and radioactivity. • Give evidences for the	• Take care when handling radioactive substances given their harmful effects • Understand and propose safe methods	Standardized samples of radioactive materials such as uranium-238, radium, polonium. GM tube for counter, cloud chamber, etc.

		• Effects of radiation on people and the environment. • Carbon dating, detection of flaws in metals, medical uses, etc.	radiation and give sources. • Calculating corrected count rates • Writing balanced nuclear equations for α,β and γ decays • $\frac{dN}{dt} = -\lambda N$ • $N = N_0 e^{-(\lambda t)}$ • $T_{\frac{1}{2}} = (ln2)/\lambda$	• The exponential decay law and decay constant. • Half-life • Energy of radioactive transformations. • Detectors of radiations • Practical applications of radioisotopes. • $\frac{dN}{dt} = -\lambda N$ • $N = N_0 e^{-(\lambda t)}$ • $T_{\frac{1}{2}} = (ln2)/\lambda$	random and spontaneous nature of radioactivity • Explain natural radioactivity and give examples of nuclides that undergo this process • Describe the nature and properties of α,β and γ radiations • Write and make use of nuclear decay equations • Define the terms; activity and decay constant and solve problems using the equation $A = \|-\lambda N\|$ • Infer and sketch the exponential nature of radioactive decay and solve problems using the radioactive decay equation • Define half- life and explain how it can be obtained from a data of activity and time. • Solve problems using the equations $\lambda t_{1/2} = ln2$	of disposing nuclear waste. • Understand that the occurrence of radioactive decay is spontaneous and unpredictable • Realize that energy can be obtained from radioactive decay processes • Appreciate the effect of exposure to radiations on humans and environment.	Design and construct a detector of radiation.

4.40 BASIC ELECTRONICS

CONTEXTUAL FRAMEWORK		**COMPETENCIES**		**RESOURCES**			
FAMILIES OF SITUATIONS	**EXAMPLES OF SITUATIONS**	**CATEGORIES OF ACTIONS**	**EXAMPLES OF ACTIONS**	**CONTENT (CORE KNOWLEDGE)**	**OBJECTIVES**		**OTHER RESOURCES/ (projects)**
					APTITUDE (SKILLS)	**ATTITUDES**	
4.41 BASIC ELECTRONICS	**4.411 Charge flow in Metals, Semiconductors and Conduction Mechanisms.**	• The relation $I = nAve$ • Insulators, Semiconductors and conductors • Temperature coefficient of resistance. • Hall effect • Semiconductors	• Derivation of $I = nAve$. • Temperature coefficient of resistance and its sign for insulators, Semiconductors and conductors. • Hall Effect and demonstrating the Hall voltage. • Conduction mechanism in semiconductors. • Doping of pure semiconductors. • Description of the p-n junction diode.	• Conduction in semiconductors is due to free electrons and holes. • Electric current is due to the flow of charge. • Hall effect, how a Hall voltage is set up in a material placed in an external magnetic field. • The current flowing through a conductor is given by $I = nAve$. • Temperature coefficient of resistance (negative for insulators and semiconductors and positive for metals). • Doping an intrinsic semiconductor with a few trivalent /pentavalent atoms produces a p-type/n-type semiconductor respectively. • Electrical neutrality of both intrinsic and extrinsic semiconductors. • The band theory in the explanation of electrical conduction. • Experiment to determine	• Derive $I = nAve$ and use it in solving problems. • State that conduction in semiconductors is due to free electrons and holes. • Distinguish between conductors, semiconductors and insulators using the band theory of conduction. • Define temperature coefficient of resistance. • Calculate temperature coefficient of resistance from formulae and graphs. • Explain doping in semiconductors leading to n-type and p-type semiconductors (majority and minority charge carriers). • Electrical neutrality of intrinsic, n-type and p-type semiconductors. • Explain why insulators and semiconductors have negative temperature coefficients of resistance. • State the difference between intrinsic and extrinsic semiconductors and for p-type	• Demonstrate an awareness of the fact that the conductivity of semiconductors can be influenced through the process of doping to various desired levels while the conductivity of metals cannot be influenced by doping.	• Simple experiments with thermistors of positive and negative temperature coefficients of resistance.

				temperature coefficient of resistance.	and n-type semiconductors		
	4.412 Electronic Devices	• The p-n junction (semiconductor diode) and LED. • Zener diode • The bipolar transistor. • Common emitter amplifiers. • The transistor as a switch. • Integrated circuits • Logic gates. • Input sensors	• Formation of a p-n junction. • Forward and reverse bias states of a diode. • Use of the semiconductor diodes in rectification of a.c. signals to d.c. signals. • Using the LED as a low energy output sensor in replacement of bulbs of higher power ratings. • Using the Zener diode in voltage regulation. • Production of a bipolar junction transistor • Production of n-p-n and p-n-p transistors. • Biasing a transistor • Various modes of biasing a transistor, the common emitter mode • Using a transistor as a current or	• Formation of a p-n junction • Functions of a junction diode • Majority and minority charge carriers • Biasing a p-n junction, I-V curves for forward and reverse bias modes • The depletion layer • Barrier potential for a diode • The LED • Applications of LEDs in daily life. • Advantage of LED over ordinary light bulbs • Breakdown voltage for a diode • Avalanche and Zener breakdown. • The Zener diode and voltage regulation. • The bipolar junction transistor(BJT) • Transistor action • The BJT as an electronic switch • The BJT in switching circuits with different sensors (e.g. light, heat, mechanical) • The BJT as an amplifier • Logic gates (AND, OR, NAND, NOR and NOT gates.	• State the functions of a junction diode. • State the functions of a LED • Define the depletion layer and barrier potential. • State that the size of the depletion layer reduces in forward bias mode and increases in reverse bias mode for a diode. • Describe the action of a diode in rectification. • Identify the terminals of a diode. • Draw current voltage curves for a diode for forward and reverse bias modes. • Describe Zener and avalanche breakdown. • Describe the action of a Zener diode in voltage regulation • Recognize and draw circuit symbols for a semiconductor diode, Zener diode, LED,BJT, the logic gates AND, OR, NAND, NOR and NOT. • Construct simple circuits that behave like the logic gates above • State in words and in truth table form the action of the logic gates AND, OR, NAND, NOR and NOT. • Recognise the various semiconductor devices. • Use a multimeter to identify the base, collector and emitter of a transistor.	• Prefer LED-lighting to filament and fluorescent ones. • Pick out relevant components from scrap circuit boards to build simple desired rectifiers instead of always being ready to buy new items.	• Soldering iron, lead, connecting cable, circuit boards, LDRs, Diodes. • Build a half wave rectifier and a full wave (bridge rectifier) using diodes (IN4148). • Build a light operated switch that can be used to control street lights automatically using a BJT and a light sensor.

			voltage amplifier • Using a transistor as a switch. • Modelling the various logic gates	• Truth tables for logic gates.	• Use a multimeter to identify whether a transistor is n-p-n or p-n-p • Draw a circuit diagram for the biasing of an n-p-n transistor in the common emitter mode and explain the functions of the various components in the circuit • Include various input sensors (thermistors, LDRs, photodiodes, phototransistors etc) in circuits with the BJT to act as electronic switches in specific cases. • State the advantage of integrated circuits to TTL (Transistor-Transistor Logic)		
4.42 THE ELECTRON, THERMIONIC EMISSION	**4.421 Electron Motion in Fields**	• Thermionic emission • Electron (charge) motion in electric and magnetic fields • Properties of cathode rays. • The cathode ray oscilloscope (CRO)/ Electronic Oscilloscope.	• Do simple calculations • Sketch electron paths in these fields • Emission of electrons by hot metal filaments, production of cathode rays. • Basic structure, functioning and uses of the cathode ray oscilloscope/EO	• Thermionic emission • Electron motion in electric and magnetic fields. • Need for a gas at a very low pressure to enable a continuous flow of electrons from the cathode to the anode of an electron gun. • The electron gun • Conservation of energy in the electron gun (electrical energy to k.e. of electron) • Measurement of voltage, frequency, time intervals, etc, using a CRO.	• Explain the emission of electrons by hot metal filaments. • Define work function, specific charge. • Explain thermionic emission and electron paths in fields. • State the properties of cathode rays. • Explain the emission of electrons by hot metal filaments • Draw and label the electron gun stating the function of each part. • State the relation between the accelerating p.d. in an electron gun and the k.e. of the accelerated electrons.		

MODULE 5: FIELD PHENOMENA

CONTEXTUAL FRAMEWORK		COMPETENCIES		RESOURCES			
FAMILIES OF SITUATIONS	EXAMPLES OF SITUATIONS	CATEGORIES OF ACTIONS	EXAMPLES OF ACTIONS	CONTENT (CORE KNOWLEDGE)	OBJECTIVES		OTHER RESOURCES/ (projects)
					APTITUDE (SKILLS)	ATTITUDES	
5.1 FIELDS	**5.11 Gravitational Fields**	• Vector nature of gravitational field. • Lines of force and equipotential • Gravitational potential difference • Escape velocity • Mass of the earth • Circular motion of planets and satellites. • Equipotentials and field lines of the earth.	• Understanding direction and magnitude of gravitational field strength. • Measurement of gravitational field strength. • Determining immeasurable masses, velocities and distances (radii) eg mass of the earth, moon, velocity of satellite, • Calculating escape velocity • Graphs of g versus distance, V versus distance, etc.	• Newton's law of universal gravitation. • Gravitational field strength • Qualitative description of the earth's gravitational field. • Inverse square law for force between masses and gravitational field strength from a point mass. • Variation of g inside and outside the earth. • Gravitational potential and gravitational potential energy. • Kepler's laws, orbital speed and geostationary satellites. Orbital speed and movement of satellites with geostationary orbits as example. • Escape velocity • Equipotentials and field lines.	• State Newton's law of universal gravitation • Apply Newton's law to solving problems using $\vec{f} = -G\frac{m_1 m_2}{r^2}\hat{r}$ • Define gravitational field strength, g. • Derive g from force of gravity for uniform field • Draw and interpret graphs showing variation of g with distance from the centre of the earth. • Draw equipotentials and field lines of the earth. • Apply potential and potential energy to planetary and satellite motions. • Define potential energy and derive $\mathbf{V = -G\frac{m}{r}}$ • Sketch graphs showing variation of V with distance from centre of mass • Relate small changes in G.P.E to mgΔh and state its validity • State Kepler's laws and apply them to the motion of	• Gravitational field cannot be shielded • Understand that satellites and other planets are kept in space by gravitational attraction • Know that satellites are transported by rockets into geostationary orbits.	Launching of artificial satellites

					the moon and the movement of planets • Calculate the parameters of satellites (average velocity, average centripetal acceleration)		
	5.12 Projectiles motion	• Horizontal projection from the top of a cliff or table top • Vertical projection • Projection at an angle to the vertical	• Vector equation for projectile in a plane • Vertical and horizontal components of vector equation • Angle of projection, trajectory, and time of flight. • Drawing the trajectory	• Expression of vector equation for a projectile along a plane. • Resolution of the motion of an object into two dimensions. • Find the range of movement of a projectile • Calculate the maximum height, and maximum displacement of projectile. • Appreciate the significance of the angle of projection.	• Resolve motion of a body into two dimensions. • Find the range of movement of a projectile. • Calculate the maximum height and maximum displacement of a projectile. • Calculate time to reach maximum height and total time in flight.	• Appreciate both vertical and horizontal projectiles. • Constancy of horizontal component of velocity and its explanation.	Stone, two tennis balls, stopwatch, catapult, meter rule, high table
5.2 FIELDS	**5.21 Electric Fields**	• Electrostatic phenomena and electric charge. • Electric flux and Gauss' law. • Good and bad electrical conductors.	• Acquisition of net charge by rubbing cork on dry hair or cloth. • Measurement of charge (approximate methods e.g. measuring currents produced by discharging bodies. • Testing for the sign of charge.	• Types of charge. • Good and bad conductors of electricity. • Charging by friction, contact and by induction; (know that polythene, ebonite become negatively charged when rubbed with dry woollen cloth while perspex, glass become positively charged when rubbed with dry woollen cloth). • Distribution of charge on plane, curved and spherical conductors • Electrostatic induction. • Measurement of charge. • Point action and the lightning conductor. • Use of the leave electroscope • Potential and field across a	• Describe charging by contact, friction and induction. • Represent electric fields by means of field lines. • Interpret field lines. • Define electric field strength as force per unit positive charge acting on a stationary point charge. • Identify the presence of charge on a body using the (gold) leaf electroscope. • Quantity of charge. Use $Q = It$ to solve simple problems. • Sketch variation of potential and electric field curves for various	• Appreciate that electric fields can be shielded and be able to use this to explain how a Faraday's cage works. • Demonstrate that a charged body transfers all its charge to the outside of a hollow metallic conductor once touched inside the conductor or enclosed by it (Using	• Polythene and glass rods, the plastic pen, other (plastic) materials suitable for demonstrations • Make a jet of water from a plastic bottle and bring a charged plastic ruler close to it and observe what

				spherical conductor • Electric field strength and electric potential. • Conservative and non-conservative force fields. • Electric flux. Gauss's law. • Electric current as a time rate of flow of charge.	conductors and regions. • Building a lightning conductor for a house.	Gauss's law)	happens. • Construct a lightning conductor and explain how it works.
	5.22 Electric Fields	• Coulomb's law. • Electric potential. • Electric field dipole and torque.	• Dependence of the force between two point charges on factors. • Energy needed to take a positive test charge from one point to another at a higher potential in an electric field and analogy between electrical and gravitational potential. • Apply $E = \frac{V}{d}$ in calculating the field strength of the uniform field between charged parallel plates where V is p.d. between plates and d is the separation of the plates.	• From Coulomb's law the force between two point charges in free space or air is $\vec{F} = K\frac{Q_1 Q_2}{r^2}\dot{r}$ where $K = \frac{1}{4\pi\varepsilon_o}$. • The field strength due to a point charge Q at a point distant r from it in free space or air is $\vec{E} = \frac{Q}{4\pi\varepsilon_o r^2}\hat{r}$ • The effect of a uniform electric field on the motion of charged particles. • Force on a charged particle in an electric field. • Definition of electric potential • The need for a reference for measuring potential at infinity; the difference between the potential at a point in a field and the p.d. between two points in the field. • Equipotentials and field lines. • The electrostatic field is a	• State coulomb's law. • Appreciate that coulomb's law is an inverse square law. Solve problems using $\vec{F} = K\frac{Q_1 Q_2}{r^2}\dot{r}$. • Define and use $\varepsilon_{0.}$ • Compare E-fields and G-fields. • Use Gauss's law to explain why there can be no net charge inside a solid or hollow conducting material (a sphere is often used). • Define electric potential and p.d. and use these definitions to show that the work done in moving a point charge round a closed path in and electric field is zero (a conservative field) • Define equipotentials • Apply the equation $V = \frac{Q}{4\pi\varepsilon_o r}$ for the potential at a point in the field of a point charge.	• Avoid taking shelter under tall trees and opening umbrellas in a thunder storm (safest place to be is in a metallic enclosure like a car which is the equivalence of a Faraday's cage). • Avoid constructing close to high tension cables. • Ability to choose different materials for use in daily life depending on their ability to conduct electricity.	• Investigate the practical uses /import ance of electrostatic s in your society (spraying vehicles, smoke precipitators , prevention of sparks and likely consequenc es if not prevented)

				conservative field.	• Show how the electric potential gradient is related to electric field strength and apply $E = \frac{V}{d}$ in the case of uniform fields to calculate field strength.		
CAPACITORS	**5.23 Capacitors, charge stored and energy stored.**	• Identification of capacitors and circuit symbols. • Measurement of capacitance. • Investigation of the factors that affect the capacitance of a parallel plate capacitor. • Capacitor combinations. • Exponential variation of charge stored in a capacitor in series with a resistor with time. • Time constant • Energy stored in a charged capacitor	• Identify different types of capacitors, read and interpret the information on them. • Describe experiments to measure the capacitance of a parallel plate capacitor • Describe experiments to investigate the factors on which the capacitance of a parallel plate capacitor depends. • Effective capacitance of capacitors connected in series and in parallel. • Derive expressions for the variation of	• The principle of the vibrating reed switch and how it is used in experiments with capacitors. • Various types - electrolytic, ceramic, variable, polar, non-polar capacitors. • Factors that affect the capacitance of a capacitor. • Definition of capacitive time constant. • The time constant of a circuit consisting of a capacitor and a resistor in series is RC and meaning. • Capacitors in series and parallel. • The energy stored in a charged capacitor in terms of charge and voltage, capacitance and voltage and charge and capacitance.	• State factors affecting the rate of charging and discharging of a capacitor in series with a resistor. • Define capacitance and state its units. • State and explain the factors that affect the capacitance of a parallel plate capacitor. • Distinguish between relative permittivity and the absolute permittivity of a medium. • Name and identify different types of capacitors and the situations where each type is most appropriate for use. • Explain the action of a dielectric between the plates of a capacitor when it is isolated and when connected to a battery. • State the factors that affect the charging and discharging of a capacitor in series with a resistor. • Sketch graphs of growth and decay of charge in a capacitor in series with a resistor.	• Given a set of capacitors students can derive various combinations to obtain a value of capacitance that is not found on the market or available at the moment. • Design circuits with capacitors to prevent sparks and rapid changes in circuits during switching operations. • Use capacitors to produce prototype backup systems.	• Soldering iron, lead, multimeters (analogue and digital), capacitors and resistors of different values, bread boards. • Build a simple circuit with capacitors and resistors and adjust the time constant to fall within a given range of values.

			charge in a capacitor in series with a resistor with time and deduce from these expressions the corresponding curves for current and other related electrical quantities with time.		• Derive the expression for the energy stored in a capacitor from the area between a V-Q graph and the Q-axis. • Explain energy losses in the charging, discharging and connecting of charged capacitors. • Solve circuit problems involving capacitors.		
5.3 FIELDS	**5.31 Magnetic Fields**	• Origin of the magnetic field • Force on a current-carrying conductor in a magnetic field • Force on a charged particle moving through a magnetic field • Deflection of particles using fields. • The cyclotron	• Tracing the magnetic field around a bar magnet and that of the earth • Direction of earth's magnetic field. • Determining the force on a current-carrying conductor in a magnetic field. • Determining the specific charge (e/m_o)	• The magnetic field and examples. • Magnetic flux density and its units (the tesla). • Field patterns of current-carrying conductors (straight wire, plane circular coil, solenoid). • Force on a current-carrying conductor in a uniform magnetic field • The direction of the force from Fleming's left hand rule • Forces on objects in cross-fields • Torque on a rectangular coil within a uniform magnetic field **($T = NAIB$)** • Biot-Savart law • Ampere's law • Magnetic flux density within a long solenoid, long straight wire, and plane circular coil (**$B = \mu_o nI$, $B = \mu_o I/2\pi r$, $B = \mu_o I/2r$**). • Force between two current-carrying conductors. • Relation between **μ_o**, ε_0 and c.	• Define magnetic flux density and magnetic field. • Explain the factors that affect the magnitude of force on a current-carrying conductor in a magnetic field. • Describe how a current balance can be designed to standardize other current measuring meters • Define the ampere • Describe how an equipment can be shielded from the effects of a magnetic field • Ability to state Biot-Savart law • Understand the use of dc motors/ generators. • Understand the use of electromagnets in - relays - electric bells - the lifting of heavy objects such as shipment	• Appreciate the importance of magnetic fields in navigation • Keeping of magnets • Standardisation of current measuring devices • Verification of the purity of copper wires	Bar magnet Iron filings Sheet of paper Magnetic compass Conducting wire Battery **Projects:** 1. Detect the presence of a magnetic field around a current-carrying wire. 2. Production of an electromagnet 3. Trace field lines using iron filings 4. Measure the angle of dip at different attitudes

				• Force on a moving charge in uniform magnetic field. • Measurement of specific charge (e/m_o) • The Hall effect • dia, para- and ferro-magnetic materials • Magnetic Shielding • The Lorentz force	containers. • Solve numerical problems related to **B**-fields • Ability to explain the Lorentz force as the force on charged particles moving in electric and magnetic fields.		5. Visit to a sea port and identification of some of these uses.
	5.32 Electromagnetic Induction	• Magnetic flux (ϕ) and flux linkage • Induced e.m.f is proportional to rate of change of flux linkage • Mutual inductance (M)	• Demonstration of Faraday's law and that a change of flux induces an e.m.f in a circuit • Investigating Lenz's law • Generating electricity by use of bicycle dynamo. • Construction of Step up and step down transformers	• Faraday's and Lenz's laws of electromagnetic induction. • Induced e.m.f. across a conductor moving with velocity v, through uniform magnetic field. • Simple DC generator • Meaning of self-inductance and mutual inductance • the L-R DC circuit (the growth and decay of current) • Energy stored in an inductor • Coefficient M and L should be understood to be defined as the constants in the equations: • $N\phi = LI$ • $N\phi_2 = MI_1$ and $N\phi_1 = MI_2$ • Theory of transformers • Knowledge, understanding but not derivation of • $\frac{V_p}{V_s} = \frac{N_p}{N_s} = \frac{I_s}{I_p}$ for ideal transformers • Sources of power losses for practical transformers and how each is minimized.	• Define magnetic flux and the weber. • Analyse the effect of inserting a core in a current carrying solenoid. • Solve problems using $\Phi = \vec{B}.\vec{A}$ • Appreciate the fact that a changing magnetic flux can induce an e.m.f in a circuit. • State and explain the laws of electromagnetic induction • Derive and apply $\varepsilon = -N\frac{d\varphi}{dt}$ • Appreciate the fact that Lenz's law is a statement of the conservation of energy. • Describe the design of a simple DC moto/generator. • Define self-inductance and mutual inductance. • Show an understanding of the principle of operation of a simple iron-cored transformer and solve	• Generating electrical energy • The use of transformers in the transmission of electrical energy at higher voltage than current to minimise power losses • Using dc generators for the charging of batteries and for lighting.	• Insulated copper wires • Ferrous magnetic material • Multi-meters • Cells • Bar magnets • **Projects** • Generation of electricity using a strong Bar magnet and coil of about 1000 turns to cause a low voltage lamp(LED) to produce a flash of light • Construction of a transformer

					problems involving al transformer. • Appreciate the use of ac generators in the production of electrical energy.		
ALTERNATING CURRENT	**5.33 Root-Mean-Square values** **5.34 Impedance** **5.35**	• Sinusoidal representation of alternating currents and voltages • Capacitive Reactance • Inductive reactance • Impedance for C-R circuit. • Impedance for L-R circuit • Impedance for R-C-L circuit • Resonant frequency $f_0 = \frac{1}{2\pi\sqrt{LC}}$	• Meaning of r.m.s. and peak values and their relationship for sinusoidal currents and d.c. • Using phase relationships to determine capacitive reactance (X_c) and Inductive Reactance (X_L) • Construction of simple circuit to show half-wave rectification	• Graphs of various periodic functions such as sinusoidal, square and saw tooth signals. • Deduce from the above graphs definitions and values of period. • Meaning of r.m.s. and peak values and their relationship for sinusoidal currents and d.c • Phasor diagrams to determine the impedance of R-C, R-L, and R-C-L circuits. • Electrical Resonance for series and parallel R-C-L circuits. • Graphs of energy-time and power-time for resistive loads. • The use of a single diode for half-wave rectification. • The use of four diodes in the construction of the bridge	Be able to: • Define and calculate root-mean-square values of alternating currents and voltages. • Interpret the equations $I = I_0 Sin\ 2\pi ft$ and $V = V_0 sin 2\pi ft$ • Define and calculate the reactance of inductive and capacitive components • Show an understanding of and the use of phasor diagrams • Define and calculate impedance for series R-C-L and parallel R-C-L circuits • Calculate the resonant frequency in R-C-L series connection only. • Calculate the Quality-factor of an R-C-L circuit. • Sketch, draw and interpret graphs of impedance versus frequency. • Interpret graphs of energy-	• Understand the fact that alternating current and voltage values as read from measuring instruments are root-mean-square values • Understand that current leads voltage by 90^0 in a purely capacitive circuit and voltage leads current by 90^0 in a purely inductive circuit • Appreciate the significance of resonance in tuned circuits	• Step down transformers • Multimeters • Connecting leads • CRO • Diodes • **Projects** • Investigate the functioning of appliances that use a.c and d.c. such as motors in corn mills, , etc electric fans in homes. • Half and full wave rectification of alternating current.

	Power in a.c. Circuits **5.36 Rectification and Smoothing**	• Mean power = $\frac{I_0 V_0}{2}$	• Construction of the bridge rectifier for full-wave-rectification.	rectifier. • The effect of a single capacitor in smoothing.	time and power-time for resistive loads • Solve problems related to mean power for resistive loads. • Appreciate real and apparent power loss. • Explain the use of a single diode for half-wave rectification. • Explain the use of four diodes for full-wave-rectification. • Analyse the effect of the value of capacitance in relation to load resistance.	• Deduce that the mean power in a resistive load is equal to half the maximum power for a sinusoidal alternating current • Appreciate the everyday use of a.c in homes and industries.	

MODULE 6: WAVES AROUND US

WAVE PHENOMENA

CONTEXTUAL FRAMEWORK		COMPETENCIES		RESOURCES			
FAMILIES OF SITUATIONS	EXAMPLES OF SITUATIONS	CATEGORIES OF ACTIONS	EXAMPLES OF ACTIONS	CONTENT (CORE KNOWLEDGE)	OBJECTIVES		OTHER RESOURCES/ (projects)
					APTITUDE (SKILLS)	ATTITUDES	
6.1 WAVE PHENOMENA	**6.11 Mechanical Waves**	• Types of mechanical waves. • Generation and propagation of mechanical waves. • Energy transmission Linked to oscillations in the propagating medium. • All points on a wave- front are in phase • speed of sound in free air by measuring frequency and wave length using a progressive wave system	• Understanding that a wave is propagated in space and time. • Demonstration of longitudinal and transverse waves in slinky springs/ shallow trays • Use of long string to produce transverse progressive waves • Definition of amplitude, speed, wavelength, frequency and phase from wave equation.	• Mechanical waves need media like water, strings/ springs and in air for propagation. • Sinusoidal equation for the propagation of progressive mechanical waves: $y = Y_0 Sin\ (\omega t - kx)$ or $y = Y_0 Sin\ (2\pi f t - \frac{2\pi}{\lambda} x)$ • Progressive waves characteristics; amplitude, speed, wavelength, frequency and phase interpreted from equation and graphically. • Longitudinal and transverse waves as modes of propagation and not types of waves. • Reflection and refraction of water waves in a shallow tray, wavefront. • The factors affecting the speed of transverse waves on taut strings and wires.	• Distinguish between longitudinal and transverse waves giving examples of each mode of wave propagation. • Draw displacement-time and displacement-distance graphs to represent waves and use them to establish definitions for period, amplitude, wavelength and frequency. • Define and describe a wavefront • Associate progressive waves with energy transfer • Describe an experiment for measuring the speed of sound in free air. • Know the expressions for the speed of mechanical waves in various media: air, water, string, rods etc. • Use the formulae $c = f\lambda$; $c = \sqrt{(T/\mu)}$, in solving problems	Appreciate the everyday use of sound as a type of mechanical wave Appreciate that vibrations in various materials are forms of mechanical waves	-Ripple tank, slinky spring -Tuning forks -Taut wires For experimental work. -Resonance tube experiment -Production of ripples in standing pools of water and estimating speed from wavelength and frequency - production of sound from traditional musical instruments

	6.12 Doppler Effect in Sound	• Qualitative treatment of the Doppler Effect as a result of relative motion along the line of source and observer.	• The use of Doppler shift to estimate the speed of blood flow.	• Quantitative treatment for a stationary medium along the line of source and observer. - For a moving detector and a moving source.	• Define Doppler Effect. • Derive the associated equations and use them in solving problems.		The change in frequency of sound observed when a source is moving.
	6.13 Superposition of Mechanical Waves	• Superposition of waves: Beats, stationary waves, interference and diffraction • Stationary waves on a taut wire with vibrator at one end and the other end fixed. • Formation of nodes and antinodes attributed to the superposition of a progressive and regressive wave in phase or antiphase • Diffraction of waves Single slit diffraction:(water waves through a single narrow opening) Diffraction grating (water waves many narrow openings) • Interference of waves (sound and	• Understanding the principle of superposition: beats, stationary waves, interference and diffraction • Set up a ripple tank k for demonstration of stationary waves, diffraction and interference • Use two loudspeakers connected to the same source to produce	• Definition of superposition, beats, stationary wave, interference and diffraction. • Diffraction of waves in water. • The **principle** of superposition illustrated by the overlapping of two sets of circular waves on water and two loudspeakers connected to the same source of sound waves. • Stationary waves on a taut wire or long stretched spring. • Stationary waves in closed and open pipes • Notion of harmonics for frequency variation • Phase difference and path difference for stationary waves and interference of waves. • Measurement of speed of sound in free air.	• State and use the principle of superposition of waves • Distinguish between stationary and progressive waves • Appreciate that stationary waves can be longitudinal or transverse. • Indicate that the distance between successive nodes or antinodes = $\lambda/2$ • Establish the relationship between phase difference and path difference. • Describe an experiment using stationary waves to determine the speed of sound in free air. • Show an understanding of the experiment that demonstrates stationary waves using microwaves, stretched string and air columns. • Explain the formation of stationary waves using a graphical method and identify nodes and antinodes. • Define diffraction • Demonstrate the diffraction of water waves through a wide gap and narrow gap. • Explain the term interference and relate it to the notion	• waves transmit energy • Sound clearer at night than during the day. • Sound instruments in which stationary waves are produced (string instruments: guitar, piano etc., pipe instruments: flute, trumpet, drums etc.) • Reflection diffraction grating from grooved lines on CD, DVD plates. • Interference of sound waves from two loudspeakers	-CRO -loud speaker -Ripple tank -Slinky spring -String -Clamp and stand -Mains electricity **Project: 1** Production and graduation of musical instruments such as guitars, flutes, harps, simple drums etc. **Project 2:** Demonstrate the diffraction of water waves in a ripple tank.

		water waves). • Measurement of frequency and wavelength of a stationary wave. • Stationary waves and resonance	interference of sound waves		coherence. • Describe an experiment to demonstrate two coherent – source interference pattern using water waves. • State and explain the conditions necessary for two coherent sources interference fringes to be observed.		
	6.14 Electromagnetic Waves	• Knowledge of and use of electromagnetic waves as a combination of electric and magnetic fields • Classes of electromagnetic waves • Generation and propagation of electromagnetic waves • Energy transmission by em-waves. • Notion of wave-fronts • Speed of electromagnetic waves in free air or in a vacuum as speed of light. • Qualitative understanding of dispersion by prisms • Divisions of EM	• Name and explain classes of electromagnetic waves • Understanding that a wave is propagated in space and time • Understanding that these waves do not necessarily need a material medium for propagation and that they are always transverse and can be plane-polarized. • Definition of amplitude, speed, wavelength, frequency	• Electromagnetic waves and their characteristics. • Electromagnetic waves do not necessarily need a material medium for propagation. • Sinusoidal equation for the propagation of electromagnetic waves: $E_x = E_0 Sin\,(\omega t - kx)$ and $B_y = B_0 Sin\,(\omega t - kx)$ • Speed of electromagnetic wave as: $c = 1/\sqrt{\mu_0 \varepsilon_0}$ and $c = E_0/B_0$ • EM-spectrum and uses. • Methods of production and properties of the EM Spectrum. • Meaning and application of plane polarization. • X-rays	• State the order of magnitude of the wavelength of the principal radiations from radio waves to gamma rays. • Define a wavefront and construct new wavefronts (Huygens' Construction) • Draw combined electric or magnetic field vibration-propagation time and electric or magnetic field vibration – propagation distance graphs to represent waves and use them to establish definitions for period, amplitude, wavelength and frequency. • Describe the method of production of X-rays • Recall the application of X-rays in medical diagnosis. • Recall precautions on handling X-rays and the dangers of exposure to X-rays. • Use polarization to distinguish between transverse and longitudinal waves.	• Appreciate the everyday use of electromagnetic waves in telecommunication. • Appreciate that all tuned circuits emit and/or receive electromagnetic waves	Visit a radio broadcasting station and observe how electromagnetic waves are produced and emitted / received. Interpret the structure of a parabolic aerial in relation to the transmission and reception of radio signals

		spectrum from radio to gamma and approximate wavelengths. • Use of polaroid to demonstrate polarization by reflection. • Methods of production and properties of the main divisions of EM waves • Relation between property and photon energy.	and phase from wave equation. • Visit a hospital to know how X-rays are produced • Compare optical fibres and copper cables as communication channels. • Read about radio conferencing				
	6.15 Superposition of Electromagnetic Waves	• Coherent sources of light • Use of wavefronts in interference and diffraction • Relationship between phase difference and path difference • Comparing the spectrum of white light produced by a prism to that produced by a diffraction grating	• Images of objects seen in the sun do not have sharp edges due to diffraction	• Fraunhofer diffraction at a single slit and a circular aperture. • Two – source interference patterns • Young's double slit experiment and the measurement of wavelength. Approximate dimension of the apparatus used needed. • Light sources • Optical transmission grating with normal incidence. • Multiple slit diffraction	• Describe Fraunhoffer diffraction pattern at a single slit and aperture (Circular /rectangular). • State the conditions necessary for two light sources to produce an observable interference pattern. • Use the equation $y = \lambda D/a$ in solving problems. • Explain coherence and the conditions necessary for its occurrence. • Determine the wavelength of light/microwaves by the method of Young's double slit experiment. • Derive the diffraction grating equation $dsin\theta = n\lambda$ and use it to solve problems. • Explain the effect of a	• Use polaroid sun glasses to reduce glare	Identify light sources in your laboratory and classify them as monochromatic or polychromatic Burning candles and LASERS

					diffraction grating on white light(Spectrum production). • Describe the method of production of light by a gas discharge lamp and by a LASER • Give the advantages of the LASER over a gas discharge tube (He-Ne LASER) • Use the diffraction grating to determine the wavelength of light (the structure and use of the spectrometer are not included). • Define excitation and ionization energies and relate to the application in solving problems.		
6.2 GEOMETRICAL OPTICS	**6.21 Use of rays to explain the propagation of light, reflection, refraction and image formation.**	• Reflection and refraction using rays. • Construction of ray diagrams. • Similarities between a microscope and astronomical telescope • Unit of measurement • Formulae	• Estimate the focal length of a lens.	• Reflection and refraction at plane interfaces • Laws of refraction • Refractive index • Dispersion. • Total internal reflection and critical angle. • Lenses, principal focus, focal length. Familiarity with practical situations in which a single converging lens produces a magnified or diminished image, the dioptre • Prisms, optical instruments eg microscopes and astronomical telescopes	• State the laws of reflection and the laws of refraction. • Define relative refractive index in terms of speed, wavelength and angles • Distinguish between relative and absolute refractive indices • Derive $n_1 sin\theta_1 = n_2 sin\theta_2$ • Appreciate the principle of total internal reflection and its application. • Draw ray diagrams to show image formation in lenses, stating a practical application of each case. • Compare the microscope with an astronomical telescope. • Calculate the power of a lens in dioptres. • Use the lens formula in basic calculations involving lenses.		Plane mirror, lenses, optical pins, clamp and stand, metre rule, optical bench, microscope, hand lens, etc. Use of these for imaging near, far and small objects.

6.30 QUANTUM EFFECTS AND INTERACTIONS BETWEEN EM RADIATIONS AND MATTER.

CONTEXTUAL FRAMEWORK		COMPETENCIES		RESOURCES			
FAMILIES OF SITUATIONS	**EXAMPLES OF SITUATIONS**	**CATEGORIES OF ACTIONS**	**EXAMPLES OF ACTIONS**	**CONTENT (CORE KNOWLEDGE**	**OBJECTIVES**		**OTHER RESOURCES/ (projects)**
					APTITUDE (SKILLS)	**ATTITUDES**	
6.31 QUANTUM PHYSICS	**6.311 Photons and Planck Constant**	• Quantization of energy • Stopping potential • Work function • Threshold frequency /wavelength • Einstein's photoelectric equation. • De Broglie's relation	• Explaining the concept of the photon • Calculating energy of EM radiations. • Using the concept of photons to explain photoelectric emission • Defining and measuring stopping potentials • Stating applications of photoelectric effects • Sketching and interpreting graphs of stopping potential versus frequency	• Conservation of energy for waves in free space from a point source • inverse square law • Photoelectric effect and experimental investigations. • The photons, Plank constant and its measurement. • Einstein's photoelectric equation • Wave-particle duality	• Understand the particle nature of electromagnetic radiation and use E = hf in solving simple problems. • Explain that photoelectric effect provides evidence for the particle nature of EM radiation while phenomena such as interference and diffraction provide evidence for the wave nature. • Understand and state the significance of the threshold frequency. • Explain photoelectric phenomena in terms of photon energy and work function energy • Explain the observations of the photoelectric experiment. • Use and explain the significance of the terms in Einstein's photoelectric equation $hf = \phi + KE_{max}$ • Compare observations of photoelectric effect with classical physics expectations. • Describe and interpret	• Appreciate the particulate nature of EM radiation • Identify and use photoelectric cells like photo emissive cells, photovoltaic, etc	Clean zinc plate, source of UV light, ammeter, voltmeter, colour filter, connecting cables, gold leaf electroscope, polythene rod **Project**: Build a simple photoelectric cell.

					qualitatively the evidence provided by electron diffraction for the wave nature of particles. • Use the relation for the de Broglie wavelength $\lambda = h/P$		
	6.312 Atomic Spectra and Energy Levels	• Atomic excitations • Spectral lines • Electron transitions and energy	• Explaining the various ways of atomic excitations • Explaining application of spectra • Using the equation $hf = E_2 - E_1$ to solve problems	• Line spectra • Emission and absorption spectra • Energy levels • The electron volt • Use of equation $E = hf = E_2 - E_1$ • The Schrodinger model of the hydrogen atom. • The Heisenberg's uncertainty principle(position-momentum and time-energy)	• Show an understanding of the existence of discrete electron energy levels in isolated atoms e.g hydrogen atom and deduce how this leads to spectral lines. • Distinguish between line emission and line absorption spectra. • Solve problems using the relation $hf = E_2 - E_1$ • State and apply the Heisenberg's uncertainty principle. • Describe how absorption spectra can be produced.	• Appreciate the beauty of colours of radiations by excited atoms • Identify different elements from the colours of their atomic spectra	Hydrogen gas, neon gas, carbon dioxide gas at low pressure, electrical power supply, spectrometer, diffraction grating, metallic crystals.

OPTION 1: ENERGY RESOURCES AND ENVIRONMENTAL PHYSICS

CONTEXTUAL FRAMEWORK		**COMPETENCIES**		**RESOURCES**			
FAMILIES OF SITUATIONS	**EXAMPLES OF SITUATIONS**	**CATEGORIES OF ACTIONS**	**EXAMPLES OF ACTIONS**	**CONTENT (CORE KNOWLEDGE**	**OBJECTIVES**		**OTHER RESOURCES/ (projects)**
					APTITUDE (SKILLS)	**ATTITUDES**	
OP 1.0 ENERGY RESOURCES AND ENERGY CONVERSIONS	**OP 1.1 Energy, sources, energy resources** and plausible exploitation.	• Identification and classification of energy resources. • Description of energy consumption patterns in Cameroon • Calculations/estimations on energy resources.	• Defining basic concepts on energy resources. • Classifying energy sources. • Describing energy consumption patterns Cameroon. • Applications of the solar constant • Carrying out calculations on energy resources. • Describing energy transformation processes using block diagrams • Describing the production of	• **Energy sources and resources** • Distinction • Primary and secondary energy sources. • Finite and renewable energy sources. • Direct and indirect energy sources • Energy consumption patterns in Cameroon • Non-uniform distribution of energy sources worldwide • The solar constant and its geographical, seasonal and altitude variations • Simple calculations on kinetic energy of wind, potential energy of stored water. • Description of deep water waves • Problem of storage of electrical energy. • **Energy reserves and their sources.** • Estimates of fossil fuels • Uranium resources • Solar power	• Distinguish between: • Energy source and energy resource. • Primary and secondary energy sources, with examples. • Renewable and non-renewable energy sources, with examples • Define and give uses of fossil fuels, fossil materials and biofuels as stores of energy • Identify and describe alternative energy sources, giving locations in Cameroon • Distinguish between direct energy sources and indirect (convertible) energy sources. • Express all energy contributions in a common unit. • Appreciate the non-uniform distribution of energy resources worldwide. • Define the solar constant	Curiosity Interest in energy issues in the community Problem solving disposition Objectivity Critical thinking Creativity In harnessing local resources to solve local problems relating to energy needs and challenges. Interest in electrical power	**Carry out a survey of the energy sources and resources in a local community** **Describe patterns of energy consumption in the chosen locality and their energy challenges** Visit the divisional/regional delegation of the ministry of water and energy and get relevant statistics on energy resources and consumption patterns for a

	OP 1.12 Energy conversions	• Conversion of chemical/fuel energy • Hydroelectric power plants • Nuclear fission plants • Alternative sources of electrical energy.	electrical energy in a hydroelectric power plant/ nuclear fission plant, etc. • Calculating the efficiency of energy transfer processes and systems.	• Energy of winds • Wave energy • Energy of tides • Chemical/fuel energy (a regrouping of atoms) • Comparison of advantages and cost of using natural gas, gasoil and HFO (Heavy Fuel Oil) for electrical energy generation and car consumption. • Hydroelectric power generation and transmission (emphasis on mechanical energies involved). • Efficiency of power stations • Fission reactor as a boiler • **Alternative sources of energy** • Solar cells • Solar power stations • Wind turbines or aero generators • Wave systems • Tidal systems • Nuclear fusion reactor • Efficiency of energy transformation processes • Storage of electrical energy • Energy crisis and the degradation of energy	and use it in simple direct calculations. • Carry out simple calculations on kinetic energy of the wind, gravitational potential energy of stored water. • Identify energy resources in Cameroon. • Describe qualitatively and quantitatively the energy consumption patterns in Cameroon. • Describe the processes by which electrical energy is produced in a thermal power station. • Draw a schematic diagram of a hydroelectric power plant and describe the generation of electrical energy in such a power station. • Draw a schematic diagram of a nuclear fission production plant and describe the generation of electrical energy in such a plant. • Draw a block diagram to describe the structure and energy transformations in thermal, hydroelectric and nuclear power stations • Identify the advantages and problems associated with electrical power production	production engineering; interest in solving energy problems of the community.	given locality/area of interest and explore this information **Consequences of depending heavily on fossil fuels** **Visit a power station (thermal, hydroelectric, solar, etc)** Describe the energy transformations and processes that occur in the station; identify the problems associated with the plant; identify the effects of the activities in the plant on the environment Listen to explanations and illustrations / demonstrations from an

					plants. • Explain what is meant by the energy crisis and explain the need for alternative energy sources • Describe the production of electrical energy from alternative sources of energy such as wind, waves, tides, solar power plants, geothermal sources and relate to efficiency and sustainability. • Carry out calculations involving energy conversions in different power stations		electrical power production engineer **Design and construct a simple solar panel and test it. Determine its power output and efficiency.**
OP 1.2 ENVIRONMENTAL PHYSICS	**OP 1.21 Impact of physical environment on human life.**	• Climate change. • Radiation hazards • Global warming	• Define climate change. • Identify natural and artificial causes of climate change. • Explain the various types of radiation hazards • Identify methods of mitigating the hazards.	• Climate change • Radiation hazard and its consequences on human health and the environment. • Geophysical hazards and their consequences on human health and environment. • Global warming, greenhouse effect	• Explain the radiation hazard between humans and their natural environment. • Describe the destruction of the ionosphere and its consequences. • Appreciate the energy waste in the destruction of the forest. • Appreciate and advice on detection and prevention of destruction caused by seismic waves (tsunami and volcanoes).	• Sense of environmental care /protection/conservation. • Effects of planting trees. • Burning of matter and effects on climate change.	Posters, Meteorological stations /equipment

	OP 1.22 Space Weather	• Air movements • Humidity • Other weather parameters	• Explain the causes of air movements • Identify hydrometer as an instrument to measure humidity • List parameters that determine weather and explain their effect on the environment	• Effect of air on navigation. • Satellite and power plan • Information on collection of satellite data. • Ground armature means of tracking data from different satellite. • Weather forecast	• Appreciate the movements of air over the earth surface due to temperature variations. • Detection of air movements by satellite • Describe simple methods of weather forecast • Describe the variation and the consequences in rain fall in Cameroon. • Appreciate the use of satellite in collecting weather parameters.	• Make simple weather forecasts. • Develop an awareness of man's activities on the environment.	Posters Meteorological stations /equipment Rain gauge, Geostationary and polar satellites, TV as source of information.

OPTION2: COMMUNICATION

CONTEXTUAL FRAMEWORK		**COMPETENCIES**		**RESOURCES**			
FAMILIES OF SITUATIONS	**EXAMPLES OF SITUATIONS**	**CATEGORIES OF ACTIONS**	**EXAMPLES OF ACTIONS**	**CONTENT (CORE KNOWLEDGE)**	**APTITUDES (SKILLS)**	**ATTITUDES**	**OTHER RESOURCES**
OP 2.1 COMMUNICATION	2.11 Radio Systems	- Signals.	- Analogue - Digital	• Explain digital and analogue methods of information packaging for transmission.	• Distinguish between analogue and digital signals • Stating the relative advantages of each over the other. • Explain the functioning of ADCs and DACs	• Understand and explain that the digital transmission of speech or music involves analogue –to- digital conversion (ADC) on transmission and digital –to-analogue	• Diode • Antenna • Coil • Earphone • Capacitor • **Projects:** **1**.Design a

CONTEXTUAL FRAMEWORK		COMPETENCIES		RESOURCES			
FAMILIES OF SITUATION S	**EXAMPLES OF SITUATIONS**	**CATEGORIES OF ACTIONS**	**EXAMPLES OF ACTIONS**	**CONTENT (CORE KNOWLEDGE)**	**APTITUDES (SKILLS)**	**ATTITUDES**	**OTHER RESOURCES**
2.2 The Mobile Phone	The Mobile Phone – Main parts. Communication Channels.	- Transmission and Reception of Signals - Bandwidth and Sidebands - Transmission through air/ space, metal wires, and optical fibres. - Use of satellites for communicati on.	- Modulation and demodulation - Analysis of the mobile phone as a two way radio system - Tuning circuits	• Analogue to Digital converters. • Digital to Analogue converters. • Block diagrams of a simple radio transmitter and receiver. • Multiplexing and demultiplexing (definitions only). • Super-heterodyne system • Causes of signal attenuation • Relative advantages and disadvantages of channels of communication in terms of available bandwidth, noise, cross-linking,	• Explain the meaning of modulation. • Define modulation • Explain the major differences between amplitude and frequency modulations. • Explain the advantages of FM transmission over AM transmission. • Define the terms: bandwidth and sideband. • Appreciate the fact multiple signals can be handled at the same time in transmission. • Appreciate the fact that a complex signal can be broken down into a separate signal after transmission. • Describe a super-heterodyne system • Explain the meaning of intermediate frequencies.	conversion (DAC) on reception • Understand the fact that a signal undergoes attenuation during transmission and reception • Appreciate the use of amplifiers and regenerators	simple AM radio receiver using diode, antenna, coil and earphone **2.**Visit to a radio station/TV station **3.** Tune a radio receiver to pick signals from an FM microphone

CONTEXTUAL FRAMEWORK		COMPETENCIES		RESOURCES			
FAMILIES OF SITUATION S	**EXAMPLES OF SITUATIONS**	**CATEGORIES OF ACTIONS**	**EXAMPLES OF ACTIONS**	**CONTENT (CORE KNOWLEDGE)**	**APTITUDES (SKILLS)**	**ATTITUDES**	**OTHER RESOURCES**
				security, repeaters and regeneration. Cost and convenience. • Parallel –tuned L-C circuits • Series tuned L-C circuits • Resonant frequency dependence on the product LC. • Surface or ground waves • Sky waves • Space waves • Use of copper wires and optical fibres • Low earth orbits (LEO), • Medium earth orbits (MEO) and • Geostationary (GEO) satellites	• Use the tuned circuit to explain the principle of operation of a radio receiver or television.	• Understand the dangers of using mobile phones in certain situations like during thunder storms, in a gas kitchen, answering calls at fuelling stations, under high tension cables etc.	
		- Base stations		• Factors that determine	• Understand the fact that waves can travel	• Appreciate the importance of each	

CONTEXTUAL FRAMEWORK		COMPETENCIES		RESOURCES			
FAMILIES OF SITUATIONS	**EXAMPLES OF SITUATIONS**	**CATEGORIES OF ACTIONS**	**EXAMPLES OF ACTIONS**	**CONTENT (CORE KNOWLEDGE)**	**APTITUDES (SKILLS)**	**ATTITUDES**	**OTHER RESOURCES**
		and their role		the location of a base station. • Link between the base stations (via cellular exchange) and the public switch telephone network (PSTN) in a mobile phone system. • Cells and Base stations. • Block diagram of a mobile phone handset • Give the full meanings of abbreviations like; SIM, SMS, MMS, GSM, CDMA, SERVICE PROVIDER.	through and along the earth's surface, atmosphere or space. • Give the advantages of optical fibres over copper wires in the transmission of signals. • Describe the various types of communication satellites. • List the factors that determine the location of a base station. • Explain the link between base stations (via cellular exchange) and the public switch telephone network (PSTN) in a mobile phone system • Explain the importance of cells. • Explain the role of the base station and the cellular exchange during the making of a call from a mobile handset. • Draw a simplified block diagram of a mobile phone handset and give the function of each block.	channel of transmission • Appreciate the importance of a base station • Impact of mobile phone on the society • Safety Rules	• Mobile phone SIM CARD Examples of base station sites

OPTION 3: ELECTRONICS

CONTEXTUAL FRAMEWORK		COMPETENCIES		RESOURCES			
FAMILIES OF SITUATIONS	**EXAMPLES OF SITUATIONS**	**CATEGORIES OF ACTIONS**	**EXAMPLES OF ACTIONS**	**CONTENT (CORE KNOWLEDGE**	**OBJECTIVES**		**OTHER RESOURCES/ (projects)**
					APTITUDE (SKILLS)	**ATTITUDES**	
OP 3.1 ELECTRONICS	**OP 3.11 Basic Aspects of Electronics**	• Action and use of circuit components • Resistor colour code • CR and LR circuits • LCR series circuits • Transformers • Centre tapped transformer in rectification.	• The functioning of an electron gun. • Functioning of a cathode ray oscilloscope • Identification of various electronic components. • Analysing CR and LR circuits and using the results to design circuits to accomplish defined tasks. • Colour code for resistors • Use of Thevenin's law • Choosing components for circuits depending on the suitability of their power ratings • Use capacitors with suitable values in charging and discharging circuits to produce the desired time constant. • Use of capacitors and inductors as filters • Using capacitors to	• Electronics deals with small currents and electrotechnics with large currents. • Need for a gas at a very low pressure to enable a continuous flow of electron from cathode to anode of electron-gun. • The electron-gun • Conservation of energy in the electron-gun (electrical energy to k.e. of electron). • Advantage of CRO over ammeters and voltmeters in measuring electrical signals. • Resistor colour code • Component identification • Capacitive and inductive time constants • Significance of the time constant of a CR circuit to how rapidly or slowly it charges or discharges and when practically a capacitor is considered to be completely charged or	• Draw and label the electron gun stating the function of each part. • State the relation between the accelerating p.d. in an electron-gun and the k.e. of the accelerated electrons • Identify the components in an electronic circuit • Draw and recognise circuit symbols for electrical components • Interpret CRO traces, define the voltage sensitivity and time base with respect to a CRO • Read the nominal value of resistors using the colour code • Determine the actual values of resistors with multimeters and compare with the nominal values to sort out faulty resistors. • Define the time constant of a circuit. • Calculate the reactance of capacitors and resistors and impedance of LCR circuits to a.c. signals	• Ability to sort out different electronic components from a collection of many electronic components and to know the role each component plays in a circuit.	Use of a CRO to view the waveforms of different signals from a signal generator and from circuits constructed by the learners.

			couple different parts of a circuit • Drawing and interpreting Phasor diagrams. • Calculation of the reactance, and impedance for LCR series circuits. • Use of transformers in stepping up and stepping down electrical voltages and subsequent rectification (Half and full wave rectification).	discharged • Thevenin's law • Thevenin equivalent circuits for electrical circuits and their importance. • Coupling capacitors in electronic circuits • The capacitor as a high pass filter. • The inductor as a low pass filter. • Phasor diagrams • Importance of phasor diagrams • Impedance of reactive circuits. • Transformers in rectification circuits.	• Calculate Thevenin voltage and resistance. • Draw Thevenin equivalent circuits for electrical circuit. • State the relevance of Thevenin's law in circuit analysis. • State the function of transformers in electronic circuits.		
ELECTRONICS	**OP 3.12 Heat and Light Sensors. Relays and Switches**	• Thermistor and LDR Relay • The reed switch	• Action of the LDR and heat sensors • Use of the reed switch in experiments with a.c. • Description of the action of magnetic Relays in electronic circuits • Using small currents to switch larger ones with a relay.	• The circuit symbol for an LDR • Variation of resistance of LDR with light intensity. • The thermistor and thermostat as heat sensors. • The use of a Magnetic Relay. • The use of a reed switch.	• Draw circuit symbol for an LDR • State how the resistance of an LDR/ thermistor varies with light intensity or temperature. • State that a thermistor can have a positive or a negative temperature coefficient of resistance. • State that a thermostat is used mostly for temperature regulation (in electric irons, refrigerators, etc). • Explain how an LDR can be used in switching circuits to achieve a predefined goal • Explain why coupling with C or L is necessary.	• Choose from a range of light and heat sensors (LDR, Photodiode, Phototransistor , thermistor, thermostat etc) the one most suitable for a given task.	• Design a switching circuit using a light sensor, BJT and Magnetic Relay. • Design a switching circuit using a reed switch for charging and discharging a

							capacitor
ELECTRONICS	**OP 3.13 Semiconductor Devices and the P-N Junction**	• Semiconductors Pure SC materials Extrinsic SC materials • P-N junction and Zener diode • Characteristics of a P-N junction • LED • Photodiode • Band theory • The Hall effect	• Conduction in intrinsic and extrinsic semiconductors. • Explanation of the band theory of conduction for metals, semiconductors and insulators. • Doping intrinsic semiconductors to produce n-type, p-type extrinsic semiconductors. • Production of a p-n junction diode. • The formation of a depletion layer and barrier potential. • Use of Zener diodes in voltage regulation. • Use of diodes (IN4148) in half wave and full wave rectification of a.c signals. • Use of the photodiode and LED as input light sensors • Production of a Hall voltage.	• Semiconductor material mostly used are germanium and silicon with silicon being more popular. • The band theory of conduction for solids. • Forbidden gap for silicon is larger than for germanium and implications on magnitude of the leakage current for the two materials. • Holes and free electrons as charge carriers in semiconductors. • Doping • Minority and majority charge carriers in extrinsic semiconductors • The semiconductor diode, p-n junction. • Biasing a diode • The Zener diode • The photodiode and the LED. • The Hall effect • Application of the Halleffect in the Hall probe and in determining the sign of the charge carriers in a semiconductor.	• Define a semiconductor • State the differences between extrinsic and intrinsic semiconductors. • Bring out the difference in the conduction mechanism in metals and semiconductors. • Draw diagrams to show the energy bands for metals, semiconductors, and insulators with emphasis on the forbidden gaps and level of occupancy of the various bands, position of donor and acceptor levels in extrinsic semiconductors. • Explain why silicon is overtaking germanium on the semiconductor market. • Describe the formation of a p-n junction. • Describe how a junction diode functions. • State that a Zener diode functions in reverse bias mode beyond the breakdown voltage in voltage regulation. • Define the depletion layer and barrier potential. • State that all semiconductors, intrinsic or extrinsic, are electrically neutral. • Use the Hall Effect in determining the sign of the charge on a particle.	• Appreciate the fact that the conductivity of semiconductors can be influenced to desired levels in the process of doping. • Develop a habit of picking out components from scrap circuits to build new circuits for demonstration purposes or buying cheap components for building and testing circuits. More expensive components bought only when sure of the model.	• Design and build simple circuits to study the characteristics of a diode in forward and reverse bias; • Pick out components from scrap circuit boards
ELECTRONICS	**OP 3.14 Transistors, Analogue**	• Transistor as a current amplifier. • Voltage	• Production of n-p-n and p-n-p transistors • Biasing a transistor,	• n-p-n and p-n-p transistors. • Transistor action.	• State the relative sizes and degrees of doping in the collector, base and emitter of a	• Recognise the transistor as a three terminal	• Construct a circuit and use it

	and Digital Electronics	amplification by a transistor • Logic gates	the common emitter mode • Investigating transistor action • Investigating transistor characteristics • Use of the transistor in the active region • Use of a transistor in cut-off and saturation modes • Construction of load lines for transistors connected in the common emitter mode • Choosing the d.c. operating point for a transistor in the common emitter mode using the load line. • Coupling capacitors in transistor circuits. • Designing simple electrical circuits to act as the; AND, OR, NAND, NOR and NOT gates. • Drawing and recognising the circuit symbols for the logic gates. • Identification of the terminals of a BJT	• The transistor in common emitter mode. • Transistor characteristics (input, output and transfer). • Transistor as an amplifier • Saturation and cut- off The transistor as a switch • Alarm circuits • Current gain for a transistor. • The common emitter amplifier. • The load line • Choice of a d.c. operating point for a CE amplifier. • Thermal runaway and limiting thermal runaway. • Coupling and decoupling capacitors. • The logic gates; AND, OR, NAND, NOR, and NOT. • Truth tables for logic gates and literal description of action of logic gates. • Symbols for logic gates (ANSI symbols will be used). • Transistor-transistor logic (TTL) and complementary metal oxide semiconductors (CMOS).	BJT • Describe the action of a transistor. • Draw the transistor characteristics and interpret them to get the relevant information. • Define cut-off and saturation for a transistor and use these to explain the switching action of a transistor. • Construct a load line for a transistor circuit acting as an amplifier in the common emitter mode and use it to locate a suitable operation point for the amplifier. • State why coupling capacitors are necessary in a circuit. • Draw and recognise circuit symbols for the logic gates. • State in word and in truth table form the action of the logic gates AND, OR, NAND, NOR and NOT; • Combinational logic i.e Construct and interpret the function performed by a simple circuit produced by a combination of the logic gates in terms of one of the state of the inputs. • State the main difference between TTL and CMOS circuits	device and use a multimeter to identify the terminals. • Appreciate the fact that the transistor is the basic block at the heart of modern electronic circuits and ICs have thousands of them on a small chip.	to obtain the transistor characteri stics.
ELECTRONI CS	**OP 3.15 The**	• Bistable and astable circuits	• Using negative feedback to control the	• Input and output impedances of an Op.	• State that the input impedance of an ideal Op. amp is infinite	• The use of negative	• Build an astable

	Operational amplifier (Op . amp)		infinite gain of Op. amps. • Introduction to sequential logic using astables and bistables ; • Action of the bistable multivibrator (flip-flop) ; • Action of the astable multivibrator ; • Action of the monostable multivibrator;	amp. • Negative feedback • The bistable circuit • The astable circuit • The monostable circuit; • Dependence of frequency of an astable multivibrator on the capacitive and resistive components. • Bistable circuits and astable circuits as examples of sequential logic. • Use of a bistable and astable circuits.	while its output impedance is zero; • State why negative feedback is important in an Op. amp ; • Explain and solve simple problems on transfer characteristics; • State that bistale circuits exhibit the property of memory; • State that the astable circuit is used as a pulse generator or clock or warning signal generator; • State how the frequency or period of an astable circuit is related to the values of the resistive and capacitive components.	feedback to stabilise the gain of Op. amps. • Have an understanding of how twinkling lights (oscillators) function.	and use it to control two light bulbs through a Magnetic Relay.

OPTION 4: MEDICAL PHYSICS

CONTEXTUAL FRAMEWORK		COMPETENCIES		RESOURCES			
FAMILIES OF SITUATIONS	**EXAMPLES OF SITUATIONS**	**CATEGORIES OF ACTIONS**	**EXAMPLES OF ACTIONS**	**CONTENT (CORE KNOWLEDGE**	**OBJECTIVES**		**OTHER RESOURCES/ (projects)**
					APTITUDE (SKILLS)	**ATTITUDES**	
OP 4.1 PHYSICS OF THE EYE	**OP 4.21 The physics of vision and defects**	• Review of image formation in diverging and converging lenses • Structure of the eye • Image formation by the eye • Functions of the retina, rods and cones • Persistence of vision • Eye defects and their correction • Lens formula	• Identify important parts of a simple lens camera and compare with those of the eye.	• Physics of vision • Sensitivity of the eye • Spatial Resolution • Persistence of vision • Lenses • Ray diagrams • Eye defects • Correction of eye defects using lenses.	• Draw a simple structure of the eye. • Show an understanding of the eye as an optical refracting system including ray diagrams of image formation. • Explain spectral response as photo detector in terms of the behaviour of rods and cones • Show an understanding of what is meant by persistence of vision. • Explain the properties of converging and diverging lenses and power. **Image formation** • Explain how myopia, hypermetropia, and astigmatism affect the eye. • Draw ray diagrams • Do calculations of power (in dioptres) of correcting lenses for myopia and hypermetropia • Show an understanding of the format of prescription for astigmatism.	Correction lenses must be prescribed by qualified personnel	Use a simple converging lens to focus the image of a distant object. Visit an optician's workshop

OP 4.3 PHYSICS OF THE EAR	**OP 4.31 Hearing and defects**	• Basic structure of the ear showing the outer, the middle and the inner ear • Basic functions of the main parts of the ear which have to do with sound detection and transmission. • Sound intensity levels and its measurement. • Audible range of frequencies and ultrasounds.	• Use of tuning fork to produce i) High and low pitch sounds ii) high intensity and low intensity sounds. • Use of ultrasounds by some animals e.g bats, dogs, cats. • Use of hearing aids	• The ear as a sound detection system • Sensitivity and frequency response • Relative intensity levels of sound. • Defects of hearing • Various types of hearing aids and their advantages.	• Draw and describe the simple structure of the ear and transmission processes. • Display an understanding of human perception of relative intensity level and the need for a logarithmic scale to reflect the physics of the ear. • Measure the sound intensity levels and the use of dB, and dBA scales • Define intensity • Describe the threshold of hearing and its values. • Explain the effect on equal loudness curves and the changes experienced in terms of hearing loss of: injury resulting from exposure to excessive noise; deterioration with ages. • State and describe the types of hearing losses. Conductive and sensorineural losses. • State the types of hearing aids.	• Avoid very loud sounds.	Visit radio broadcasting stations and sound recording studios to see how echoes are avoided -Visit large buildings to see how architects design them to minimize echoes. - See how noise is confined in dance halls ICT modules -Noise control in cinema halls
OP 4.4 BIOLOGICAL MEASUREMENT	**OP 4.4 Biological Measurements for the heart**	• Structure of the heart • Action potential • ECG waves and machines • Blood pressure	• Drawing the diagram of the heart. • Identifying the components of the cardiac conduction system. • Explaining how the sino-arterial node (pacemaker) generates impulses	• Basic structure of the heart. • Biological generation and conduction of electrical signals. • Electrical signals and their detection. • Simple ECG machines and the normal ECG waveform.	• Describe the heart as a double pump with identified valves. • Show an understanding of the generation and conduction of electrical signals; action potential of a nerve cell, methods of detection of electrical signals at the skin surface. • Explain the principles of operation for obtaining the	• Appreciate the role played by the heart in sustaining life through its pumping action. • Some care to maintain a normal blood pressure.	ICT model of a human heart ECG machines Project: visiting a hospital unit that has ECG machines.

			• Explaining what action potentials are. • Applying the knowledge of action potential to explain electrical signal transmission in the heart.	• Action potential of a nerve cell. • Blood pressure measurements.	ECG waveform; explain the characteristic shape of a normal ECG waveform. • Recognize a blood pressure measuring instrument. • Use a sphygmomanometer to measure blood pressure. • Distinguish between systolic and diastolic pressure. • Detect low and high blood pressure.	• Be conscious of high and low blood pressure and their effects. • General care of the ear. • Appreciate the use of MR in detecting ear problems.	Stopwatch for counting of heart pulses, sphygmomanometer. Visit a health provider
OP 4.5 NON IONISING IMAGING	**OP 4.51 Ultrasound Imaging**	• Production of ultrasounds. • Use of coupling medium to minimize reflection • Why non-ionizing radiation is -less energetic -less penetrating.	• Use of ultrasounds to produce images of a foetus.	• Non-ionising imaging I. Ultrasound imaging II. Piezo-electric devices. III. A-scan, B-scan	• Explain reflection and transmission characteristics of sound waves at tissue boundaries, acoustic impedance and attenuation. • State the advantages and disadvantages of ultrasound imaging in comparison with other imaging techniques. • Explain the principle of generation and detection of ultrasound pulses. • Give examples of applications.	• Problems with internal soft body organs are easily diagnosed. • Improved prenatal care of the foetus.	Visit medical imagery Centre and echography Centre in hospitals
	OP 4.52 Fibre Optics and Endoscopy	• Light confined in fibre by total internal reflection. • Calculation of maximum angle of incidence in fibre for which total internal reflection will occur.	• Use to illuminate spots/ areas for which ordinary access is difficult. • Perform key-hole surgery with the aid of lasers.	• Properties of fibre optics and application in medical physics.	• State the properties of fibre optics. • Show the application of fibre optics in medical physics. • Recall the total internal reflection at the core cladding interface and flexibility of fibres.		Visit the hospital and see how an endoscopy is done.

	OP 4.53 Magnetic Resonance	• Use of magnetic resonance in medical diagnosis	• Explaining the principle of the MR scanner. • Explaining how images are obtained from the MR scanner for proper medical diagnosis.	• The main principles of an MR scanner.	• Explain how the MR scanner works. • Draw a cross section of a patient scanned using magnetic field resonance. • Explain the behaviour of hydrogen nuclei during the scanning (i.e understand that they are excited during the scan and emit radio frequencies, RF signals as they de-excite; RF signals detected and processed by a computer to produce a visual image.	• Develop a positive attitude towards MR scanner as it is non-ionizing • Consult using MR scanners as often as necessary since its non-ionizing and less hazardous and gives 3-D images.	MR Scanner, Visit to medical centre equipped with MR scanner
	OP 4.54 X-ray Imaging	• How X-rays are produced. • Tissue absorption of X-rays. • Use of X-rays and X-ray machines for diagnosis.	• Explaining how x-rays are produced. • Explaining how different tissues absorb X-rays and implication on the use of X-rays in diagnosis.	• X-rays • Physical principles of the production of X-rays. • Differential tissue absorption of X-rays. • Radiographic image detection.	• Explain the physics of diagnostic X-rays. • Show an understanding of the rotating anode X-ray tube; method of controlling the beam intensity, the photon energy, the image sharpness. • Qualitative description of the absorption process. • Photographic detection with intensifying screen and fluoroscopic images.	• Signs and danger limitations of X-rays.	X-ray machine; visit to health unit where x-ray images are done.
	OP 4.55 Computer Tomography and Positron Emission Tomography (PET)	• Principle of CT scanner.	• Explaining the principle of CT scanner. • Basic principle of PET.	• Basic principle of the CT scanner.	• Elaborate the basic principle of the CT scanners. • Compare ultrasound, CT and MR scans, advantages, disadvantages and limitations in image resolutions, cost and safety concerns.	• Appreciate the non-ionizing action of CT Scanner.	Visit health unit with CT scanner.

<u>Article 2</u>: This syllabus shall go into operation following the time schedule below:

Academic year 2019 – 2020 LSS

2020 – 2021 USS

<u>Article 3</u>: This syllabus replaces all existing syllabuses for the teaching of Physics in the LSS & USS Forms of Secondary General Education.

<u>Article 4</u>: The Secretary General, the Inspector General of Education, the Inspector Coordinator General in Charge of Science Education, the Registrar of the Cameroon General Certificate of Education Board, the Director of Secondary General Education, the Director of Private Education, Regional Delegates for Secondary Education, Divisional Delegates for Secondary Education, Education Secretaries of various Lay and Confessional Education Agencies, Principals and Teachers of public and private schools, each in their sphere of competence, are responsible for the strict implementation of this order which shall be registered and published in the Official Gazette in English and French.

Done in Yaoundé, on the

The Minister of Secondary Education

CC:

-PRC;
-PM;
-MINESEC/CAB/IGE/Directorates;
-Ministry of Higher Education;
-Regional Delegations of MINESEC;
-National Representatives of Organizations of Private Education;
-Offices of Education Secretaries of Lay and Confessional Education Agencies;
-Schools/Institutions concerned;
-Archives;
-Chrono.