# The New Senior Secondary Curriculum for Sierra Leone

**Subject syllabus for Physics**

Subject Discipline: Sciences and Technologies

This subject syllabus is based on the National Curriculum Framework for Senior Secondary Education. It was prepared by national curriculum specialists and subject experts.

SSSC
Senior Secondary School Curriculum

# Curriculum Elements for Physics – a core subject

## Subject description

Physics is the branch of science concerned with the nature and properties of matter and energy.

## Rationale for Inclusion of Physics in the Senior Secondary School Curriculum

The study of Physics places a strong emphasis on the learners' understanding of the world, both physical and biological. It is one of the most fundamental subjects that facilitates the advancement of sciences and technologies in any nation. Yet, in Sierra Leone, most students, especially females, shy away from the subject at the Senior Secondary level. For a long time, Senior Secondary School Physics has been thought of as an elitist subject only useful for students who are inclined to pursue studies in science and technology-related disciplines such as medicine, engineering, agriculture etc. The primary method of teaching Physics at that level has been didactic (i.e., teacher-centred 'talk and chalk'), which in turn led to the memorisation of facts by the learners. An assessment process that mainly tested the recall of facts completed the vicious teaching-learning cycle. The ultimate result has been the production of school leavers with theoretical know-how but lacking the technical 'know-why'. This type of education will not transform a nation in the direction the Sierra Leone Government aims at. Currently, for most students, the focus of senior secondary education is singularly on passing the West Africa Senior Secondary Certificate Examination (WASSCE) and entering university. The focus for the new Sierra Leone curriculum is not only on passing WASSCE and entering a university, but also equipping learners with broad competencies for a changing employment market, as well as the knowledge and skills to become enlightened citizens of the 21st century. This in turn will propel the nation forward.

## General Learning Outcomes (Broad Goals)

The main aim of this Physics syllabus is to enhance the contribution of education to human capital development (HCD) through the study of the subject. The specific aims are to:

i) Equip learners with the requisite scientific knowledge and skills needed to solve pertinent real-world problems
ii) provide practical and mind-engaging learning experiences which will culminate in well-informed and productive citizens
iii) raise the awareness of the inter-relationships between Physics and Industry, Information and Communication Technology, Agriculture, Health, and other disciplines
iv) imbue students with skills and attitudes that will enable them to practice science effectively and efficiently, and conscious of cost.
v) stimulate and sustain students' interest in Physics as a useful tool for transforming society
vi) recognize the usefulness, utilization, and limitations of scientific methods in all spheres of life.

## Structure of the Senior Secondary School Physics Syllabus

The draft syllabus is divided into two parts:

1. syllabus content shown divided by school year (SSS I, II and III) and by terms.

2. the Instructional Guide, which contains five columns:
   a. topics that constitute the Senior Secondary School Physics syllabus, i.e., the syllabus content.
   b. description of what the students should be able to do after learning the topic (learning outcomes)
   c. the recommended teaching methods. The methods are based on the premise that learners are not passive in the learning process. Instead, they come to class with pre-existing knowledge gathered from various life experiences and they apply that knowledge in confronting and resolving new ideas presented by the instructor. Therefore, the teaching should be interactive in eliciting learners' pre-existing ideas and engaging them in activities that will help them formulate the correct scientific concepts being taught. The role of the teacher is to facilitate learning. The purpose of demonstration by the instructor and practical work by the learners is for the instructor to use the results of these activities to guide students through enquiry-based learning to attain the correct scientific understanding of the concepts. Together with the learners, the instructor/ facilitator would then summarise the salient points or observations of the lesson.
   d. contains resources (equipment and materials etc.) needed to teach the topic effectively. Suggested items for practical work, where necessary, are given.
   e. contains sample items that test whether the expected learning outcomes have been achieved. Emphasis should be placed on the higher levels of Bloom's Taxonomy of educational objectives in setting test items.

## Structure of the syllabus over the three-year Senior Secondary School cycle

| | SSS 1 | SSS 2 | SSS 3 |
|---|---|---|---|
| **Term 1** | **1. Concept of Physics**<br>a) The definition of Physics<br>b) Branches and careers in Physics<br>c) Ways of studying Physics<br>d) Procedures in solving problems in Physics<br>e) Application areas and careers in Physics<br><br>**2. Physical Quantities and Units**<br>a) Definition of physical quantities<br>b) Types of physical quantities<br>c) The three main basic quantities and the different forms of distance<br>d) Definition of unit<br>e) Types of units<br>f) Prefix of SI units<br>g) System of units<br>h) Conversion of units<br>i) Definition of dimensional analysis<br>j) Application and limitation of Dimensional Analysis<br><br>**3. Measurement**<br>a) Definition of measurement<br>b) Importance of measurement<br>c) Types of measurement<br>d) Types of instruments<br>e) Instruments of measurement of some quantities | **1. Machines**<br>a) Definition of machine<br>b) Terms used in machine<br>c) Types of simple machine<br>d) Application of mechanical energy machines: levers, pulleys, inclined plane, wedge, screw, wheel and axle, and gears<br><br>**2. Heat and Temperature**<br>a) Definition, sources, uses and effects of heat on matter, e.g.: (i) rise in temperature (ii) change of phase state (iii) expansion (iv) change of resistance<br>b) Concept of temperature as degree of hotness or coldness of a body<br>c) Construction and graduation of a simple thermometer<br>d) Properties of thermometric liquids. The following thermometers should be treated: constant–volume gas thermometer, resistance thermometer, thermocouple, liquid-in-glass thermometer (including maximum and minimum thermometer and clinical thermometer), pyrometer and radiation thermometers | **1. Electric Fields**<br>a) Electrostatics<br>b) Production of electric charges<br>c) Types of distribution of charges<br>d) Storage of charges<br>e) Electric lines of force<br>f) Electric force between point charges and Coulomb's law<br>g) Concepts of electric field, electric field intensity (potential gradient), and electric potential<br>h) Capacitance: definition, arrangement, and application<br><br>**2. Direct Current electricity**<br>a) Production of electric current from primary and secondary cells<br>b) Potential difference and electric current<br>c) Electric circuit<br>d) Electric conduction through materials<br>e) Electric energy and power<br>f) Shunt and multiplier<br>g) Resistivity and conductivity<br>h) Measurement of electric current, potential difference, resistance, EMF and internal resistance of a cell. |

f) Errors and uncertainties

**4. Concept of Graphs**
a) Definition of a graph
b) Plotting of a graph
c) Parts of a plotted graph
d) Determination of slope
e) Evaluation and deduction from a graph

**5. Scalar and Vector Quantities**
a) Definition of scalar and vector quantities and examples
b) Differences between scalar and vector quantities
c) Addition and subtraction of vector quantities
d) Scalar products

**6. Mass and Weight**
a) Definition of mass and weight
b) Differences between mass and weight
c) Relations connecting mass and weight

**7. Concept of matter**
a) Definition and composition of matter
b) Properties and states of matter
c) Kinetic theory of matter
d) Phenomena explaining molecular theory of matter

e) Celsius and Absolute scales of temperature. Kelvin and degrees Celsius and degrees Fahrenheit as units of temperature
f) Definition, advantages, and disadvantages of expansion
g) Thermal expansion – linear, area and volume expansivity

**3. Measurement of heat energy**
a) Concept of heat capacity
b) Specific heat capacity
c) Specific latent heat of fusion and of vaporization
d) Heat curve
e) Melting point and boiling point
f) Evaporation and boiling
g) Vapour and vapour pressure
h) Humidity, relative humidity, and dew point
i) Humidity and the weather

**4. Transfer of Heat**
a) Conduction, thermal conductivity: solar energy collector and black body
b) Convection
c) Radiation

**5. Gases**
a) Assumptions of kinetic theory of gases,

**3. Simple Alternating Current circuits**
a) Graphical representation of EMF and current in an AC circuit
b) Peak and RMS values
c) Series circuit containing resistor, inductor, and capacitor
d) Reactance and impedance
e) Vector diagrams
f) Resonance in an AC circuit
g) Power in an AC circuit

**4. Magnetic fields**
a) Properties of magnets and magnetic materials
b) Magnetization and demagnetization
c) Concept of magnetic field
d) Magnetic force

**5. Electromagnetic fields**
a) Concept of electromagnetic field
b) Electromagnetic induction
c) Faraday's law, Lenz's law, and motor-generator effect
d) Inductance
e) Eddy currents
f) Power transmission and distribution
g) Use of electromagnets
h) The earth's magnetic field
i) Magnetic force on a moving charged particle (a current-carrying conductor placed in a magnetic

| | | | |
|---|---|---|---|
| | | b) Gas laws: Boyle's law, Charles' law, and pressure law<br>c) General gas equation<br><br>**6. Circular motion**<br>a) Distinguish between vertical and horizontal circular motion using appropriate experiments<br>b) Show the difference between angular speed and velocity<br>c) Draw a diagram to illustrate centripetal force<br>d) Banking of roads in reducing sideways friction<br><br>**7. Gravitational field**<br>a) Concept of fields<br>b) Acceleration due to gravity, (g)<br>c) Gravitational force between two masses: Newton's law of gravitation<br>d) Gravitational potential and escape velocity<br>e) Satellites and rockets<br><br>**8. Oscillatory Motion and Simple Harmonic Motion**<br>a) Illustration, explanation, and definition of Oscillatory Motion and Simple Harmonic Motion (SHM)<br>b) Speed and acceleration of SHM<br>c) Period, frequency, and amplitude of a body executing SHM<br>d) Energy in SHM | field and between two parallel current-carrying conductors) |

| | | | |
|---|---|---|---|
| | | e) Damped oscillations<br>f) Forced vibration and resonance | |
| **Term 2** | **8. Fluid at Rest**<br>a) Density, relative density and upthrust<br>b) Law of flotation,<br>c) Archimedes principle<br>d) Pressure in solids and fluids (air and liquid)<br><br>**9. Properties of Material**<br>a) Elasticity of material<br>b) Terms used in elasticity of material<br>c) Graph of strained material<br>d) Hook's law and work done by strained material<br>e) Tensile strain<br>f) Tensile stress<br>g) Young's modulus<br><br>**10. Forces and their effects**<br>a) Type of forces<br>b) Resolution of forces<br>c) Equilibrium of forces<br>d) Turning effect of forces<br>e) Moment of forces<br>f) Frictional force<br><br>**11. Linear motion**<br>a) Definition, type, and forms of motion<br>b) Speed and velocity | **9. Concept of Wave Motion**<br>a) Propagation of mechanical waves<br>b) Energy transmitted with definite speed, frequency, and wavelength.<br>c) Waveforms<br>d) Mathematical relationship connecting frequency (f), wavelength (λ), period (T) and velocity (v)<br>e) Transverse and longitudinal<br>f) Mathematical representation of wave motion.<br>g) General Progressive Wave Equation and its application<br>h) Properties of waves: reflection, refraction, diffraction, Interference, superposition of progressive waves, producing standing and stationary waves.<br><br>**10. Electromagnetic Spectrum**<br>a) Types of radiation in electromagnetic spectrum<br>b) Spectrum: elementary description and uses of various types of radiation: radio, infrared, visible light, ultra-violet, X-rays, gamma rays<br><br>**11. Sound Waves** | **6. Structure of the atom**<br>a) Models of the atom<br>b) Energy quantization<br>c) Photoelectric effect<br>d) Thermionic emission<br>e) X-rays<br><br>**7. Structure of the nucleus**<br>a) Composition of the nucleus<br>b) Radioactivity – natural and artificial<br>c) Nuclear reactions - fusion and fission<br><br>**8. Electronic (Electrical Conduction through Materials)**<br>a) Distinction between conductors, semiconductors, and insulators in term of band theory<br>b) Semiconductor materials (silicon and germanium)<br>c) Meaning of intrinsic semiconductors (example of materials silicon and germanium)<br>d) Charge carriers<br>e) Doping production of p-type and n-type extrinsic semiconductors<br>f) Junction diode – forward and reverse biasing, voltage characteristics<br>g) Uses of diodes |

| | | | |
|---|---|---|---|
| | c) Concept of speed as change of distance with time<br>d) Concept of velocity as change of displacement with time<br>e) Uniform/ non-uniform speed/ velocity<br>f) Distance/ displacement-time graph rectilinear acceleration<br>g) Concept of acceleration/ deceleration as increase/ decrease in velocity with time.<br>h) Uniform/non-uniform acceleration<br>i) Velocity-time graph<br>j) Equations of motion with constant acceleration<br>k) Motion under gravity as a special case<br>l) Projectile motion concept of projectiles as an object thrown/release into space | a) Sources of sound<br>b) Transmission of sound waves<br>c) Speed of sound in solids, liquids, and air<br>d) Echoes and reverberation<br>e) Noise and music<br>f) Characteristics of sound<br>g) Ultra-sound and applications<br><br>**12. Vibration in String and Pipes**<br>a) Vibration in strings<br>b) Vibration in pipes – open and closed pipes<br>c) Harmonies and overtones<br>d) Forced vibration<br>e) Resonance and beat | h) Half and full wave rectification<br><br>**9. Wave-particle paradox**<br>a) Electron diffraction<br>b) Duality of matter<br>c) Heisenberg's Uncertainty Principle |
| **Term 3** | **12. Dynamic motion**<br>a) Newton's laws of motion:<br>i. First Law: inertia of rest and inertia of motion<br>ii. Second Law: force, acceleration, momentum, and impulse<br>iii. Third Law: action and reaction<br>b) Apparent Weightlessness<br>c) Conservation of linear momentum | **13. Light**<br>a) Sources of light<br>b) Rectilinear propagation of light<br>c) Reflection of light at plane surface: plane mirror<br>d) Reflection of light at curved surfaces: concave and convex mirrors<br>e) Refraction of light at plane surfaces: rectangular glass prism (block) and triangular prism. | **Exams** |

d) Collisions
e) Types of collisions

**13. Work, Energy and Power**

a) Concept of work as a measure of energy transfer
b) Concept of energy as capability to do work
c) Work done in a gravitational field
d) Types of mechanical energy (i) Potential energy (PE) (ii) Kinetic energy (KE)
e) Conservation of mechanical energy
f) Concept of power as time rate of doing work

f) Refraction of light at curved surfaces: Converging and diverging lenses
g) Application of lenses in optical instruments.
h) Dispersion of white light by a triangular glass prism
i) Polarization of light
j) Definition, types, and demonstration of interference
k) Definition, types, and demonstration of diffraction

**14. Introduction to Fiber Optics and Lasers**

a) Explanation of concept of fiber optics.
b) Principle of transmission of light through an optical fiber
c) Applications of fiber optics e.g., Local Area Networks (LAN), medicine, sensing devices, carrying laser beams, etc.
d) LASER and it's applications

## Teaching syllabus

| Topic/ Theme/ Unit | Expected learning outcomes – at the end of the topic, learners should be able to: | Recommended teaching methods | Suggested resources | Assessment of learning outcomes |
|---|---|---|---|---|
| **Concept of Physics**<br>• The definition of Physics<br>• Branches and careers in Physics<br>• Ways of studying Physics<br>• Procedures in solving problems in Physics<br>• Application areas and careers in Physics | ➢ Define Physics<br>➢ Explain how Physic is related to other sciences<br>➢ Name examples of branches of Physics, and careers in Physics<br>➢ State examples of applications of Physics in everyday life | ➢ Teacher-students discussion, aimed at eliciting student pre ideas and modifying them.<br>➢ Engage students in activities such as debate, extended written assignments, slide shows to encourage their interest in the topic. | • Recommended textbooks<br>• Chalk/ whiteboard<br>• Projector<br>• Internet | • Learners are asked independently to write a two-page essay on the topic 'The importance of Physics in everyday life' |
| **Physical Quantities and Units**<br>• Definition of physical quantities<br>• Types of physical quantities<br>• The three main basic quantities and the different forms of distance<br>• Definition of unit<br>• Types of units<br>• Prefix of SI units<br>• System of units | ➢ Define physical quantities<br>➢ State the types of physical quantities<br>➢ Differentiate between basic and derived quantities<br>➢ Give examples of basic and derived quantities<br>➢ State the different forms of distance measurement<br>➢ Define the dimensions of a physical quantity<br>➢ Give examples of the uses of dimensional analysis<br>➢ Explain the relevance of units<br>➢ state the types of units and systems of units | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them.<br>➢ Engage students in practical activities using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students' understanding of material covered | • Recommended texts<br>• Chalk/ whiteboard<br>• Projector | • Length L that appears in atomic Physics is given by the formula L = $\frac{h}{m_e C}$, where $m_e$ is the mass of an electron, C is the speed of light, and h is a constant known as Plank's constant. What are the dimensions of h?<br>• The fuel consumption of a car is usually given in liters (L) per 100 km. For example, |

| | | | | |
|---|---|---|---|---|
| • Conversion of units<br>• Definition of dimensional analysis<br>• Application and limitation of Dimensional Analysis | ➢ Determine the unit of derived quantity using basic unit<br>➢ Use the following prefixes and their symbols to indicate decimal submultiples or multiples of both base and derived units: pico (p), nano (n), micro (μ), milli (m), centi (c), deci (d), kilo (k), mega (M), giga (G), tera (T)<br>➢ Carry out conversion of units of measurement | through questioning and setting a mini-project. | | a small Toyota uses 7L/100 km, while the gasoline consumption of a large Mercedes Benz car is stated as 23L/100 km. Convert these consumption units to miles per gallon so that Sierra Leonean car owners can make sense of these figures. [1 mile = 1.609 km; 1 gallon = 4 5 liters). |
| **Measurement**<br>• Definition of measurement<br>• Importance of measurement<br>• Types of measurement<br>• Types of instruments<br>• Instruments of measurement of some quantities<br>• Errors and uncertainties | ➢ State the instruments used for measuring mass, length, and time (traditional instruments included)<br>➢ Use appropriate instruments, both analogue and digital where possible, to measure correctly:<br>○ lengths using rulers, Vernier calipers and micrometers<br>○ weight and hence mass using balances<br>○ an angle using a protractor<br>○ time intervals using clocks and stopwatches<br>○ temperature using a thermometer<br>○ current and voltage using ammeters and voltmeters respectively<br>○ calibration curves<br>➢ Errors and uncertainties: | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them.<br>➢ Engage students in practical activities using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning and setting a mini-project. | • Chalk or white board.<br>• Standard textbook<br>• Video clips<br>• Internet<br>• Equipment for practical work: metre rule, Vernier calipers, micrometers, beam balance, protractor, ticking clock, stopwatch, thermometer, spherometer, | • Explain how you could determine the number of grains of rice that can fill a commercial measuring cup.<br>• Why is ''light-years'' the most convenient unit to measure distance in astronomy? |

<table>
<tr>
<td></td>
<td>
<ul>
<li>explain the effects of systematic errors (including zero errors) and random errors in measurements</li>
<li>discuss precision and accuracy in measurement</li>
<li>asses the uncertainty in a derived quantity by simple addition of absolute, fractional or percentage uncertainties (a rigorous statistical treatment is not required).</li>
</ul>
</td>
<td></td>
<td>voltmeter, and ammeter</td>
<td></td>
</tr>
<tr>
<td>Concept of Graphs<br>• Definition of a graph<br>• Plotting of a graph<br>• Parts of a plotted graph<br>• Determination of slope<br>• Evaluation and deduction from a graph</td>
<td>➢ Define graph<br>➢ Distinguish between sketching and plotting of a graph<br>➢ Identify the part of a plotted graph (axes, scale, plotted point, and line of best fit/ smooth curve)<br>➢ Choose appropriate scales in plotting graphs.<br>➢ Determine and explain slope and intercept of graph<br>➢ Interpolate/ extrapolate information from the graph<br><br>[Table for Assessment exercise (see Column 5, right)
<table>
<tr><td>P</td><td>0.50</td><td>1.50</td><td>2.50</td><td>3.49</td><td>4.29</td></tr>
<tr><td>R/Ω</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
</table>
]</td>
<td>➢ Student-teacher activity based.<br>➢ Students collect data and are guided to represent the data graphically.<br>➢ Teacher guides the students to analyse the graph.<br>➢ Assignment.</td>
<td>• Recommended textbook<br>• Chalk or white board<br>• Standard graph paper<br>• Mathematical set</td>
<td>• From the table in Column 2 (left):<br>○ Plot a graph with P on the vertical axis and R on the horizontal axis.<br>○ Using the graph determine the slope S and the intercept I on the vertical.<br>○ Evaluate 4s-1<br>○ Determine the value of P when R = 1.7Ω</td>
</tr>
<tr>
<td>Scalar and Vector Quantities</td>
<td>➢ Distinguish between scalar and vector quantities<br>➢ Give examples of scalar and vector quantities<br>➢ Represent vectors diagrammatically</td>
<td>➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the</td>
<td>• Chalk or white board<br>• Textbook<br>• Powerpoint</td>
<td>• A man rides a motorcycle 12km due east and later 5km</td>
</tr>
</table>

| | | | | |
|---|---|---|---|---|
| • Definition of scalar and vector quantities and examples<br>• Differences between scalar and vector quantities<br>• Addition and subtraction of vector quantities<br>• Scalar products | ➢ Add and subtract coplanar vectors (vectors in the same plane) by graphical and resolution methods | correct scientific concept.<br>➢ Engage students in practical activities using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Video clips<br>• Internet<br>• Equipment for practical work: force board, pulleys, metre rule, string or thread, and masses. | due north. Calculate the:<br>○ total distance<br>○ displacement of the man<br><br>• Can the magnitude of a vector ever be equal to one of its components? Explain your answer.<br>• Two ropes are attached to a heavy box to pull it along a smooth floor. One rope applies a force of 2 KN in the direction due east; the other rope applies a force of 1.5 KN due south-east. Calculate the magnitude and direction of the force that would be applied by a single rope to have the same effect as the two forces put together. |
| **Mass and Weight**<br>• Definition of mass and weight | ➢ Differentiate between mass and weight<br>➢ Demonstrate mastering of use of a beam balance to measure the mass and spring | ➢ Teacher-students guided discussion to elicit students' ideas and modify and | • Recommended textbook.<br>• Chalk or white board. | |

| | | | | |
|---|---|---|---|---|
| • Differences between mass and weight<br>• Relations connecting mass and weight | balance to measure the weight of a substance<br>➢ Use the relationship between mass and weight to find one variable when the other is given | correct them to the correct scientific concept.<br>➢ Engage students in practical activities using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning and setting mini projects. | • Powerpoint.<br>• Equipment for practical work: beam balance, spring balance | |
| **Concept of matter**<br>• Definition and composition of matter<br>• Properties and states of matter<br>• Kinetic theory of matter<br>• Phenomena explaining molecular theory of matter | ➢ Define matter and state its composition<br>➢ List the general properties of matter<br>➢ Use the kinetic theory to explain the state of matter<br>➢ Explain the terms surface tension, diffusion, capillarity, angle of contact, viscosity, and the factors affecting them | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Engage students in practical activities using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Ask questions to check students | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Equipment for practical work: stone, water, spray, ink, flame, mercury, capillary tube, metal blade. | • State three properties of matter which are common to all substances. |

| | | | | |
|---|---|---|---|---|
| | | understanding of the concept. | | |
| **Fluid at Rest**<br>• Density, relative density and upthrust<br>• Law of flotation,<br>• Archimedes principle<br>• Pressure in solids and fluids (air and liquid) | ➢ Define the following terms:<br>○ density and relative density<br>○ upthrust and pressure<br>➢ State the law of flotation<br>➢ State Archimedes principle<br>➢ Use the definitions of pressure and density, to show that $\Delta p = \rho g \Delta h$ | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Engage students in practical activities using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning and setting mini projects. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Video clips<br>• Internet<br>• Equipment for practical work: beam balance, spring balance, beaker, measuring cylinder, meter rule, retort stand, and relative density bottle. | • Mercury has a relative density of 13.6. Calculate the density of mercury, given that the density of water is 1000 kg/m3. |
| **Properties of Material**<br>• Elasticity of material<br>• Terms used in elasticity of material<br>• Graph of strained material<br>• Hook's law and work done by strained material | ➢ Distinguish between elastic and plastic deformation of a material<br>➢ Define the terms load, extension, and compression<br>➢ Recall and demonstrate Hook's law<br>➢ From Hook's law, experiment plot and interpret the force-extension graph<br>➢ Determine the work done by the spring or energy in the spring recall and use | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Engage students in practical activities using different | • Recommended textbook.<br>• Chalk or white board.<br>• Video clips<br>• Internet<br>• Equipment for practical work: spring balance, meter rule, | • When is a material said to be elastic?<br>• A wire is gradually stretched by loading it until it snaps. Sketch a load-extension graph for the wire and on the graph indicate the:<br>○ elastic limit<br>○ yield point |

| | | | | |
|---|---|---|---|---|
| • Tensile strain<br>• Tensile stress<br>• Young's modulus | E = $\frac{1}{2}$ $Fe$ = $\frac{1}{2}$ $Ke^2$ for a material deformed within its limit of proportionality<br>➢ Define the terms stress, strain, and Young's modulus<br>➢ Express the mathematical relationship between stress, strain, and Young's modulus<br>➢ Perform an experiment to determine the Young's modulus of a metal in the form of a wire | instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning and setting mini projects.<br>➢ Field trip | retort stand, masses, and graph paper. | ○ maximum load<br>○ breaking point<br>• The upward acceleration of a lift of total mass 2500kg is 0.5ms$^{-2}$. The lift is supported by a steel cable which has a maximum soft working stress of 1.0 x 10$^{8}$Nm$^{-2}$. Determine the cross-sectional area of the cable. (g=10ms$^{-2}$). |
| **Forces and their effects**<br>• Type of forces<br>• Resolution of forces<br>• Equilibrium of forces<br>• Turning effect of forces<br>• Moment of forces<br>• Frictional force | ➢ Describe the meaning of contact force and non-contact force<br>➢ Explain the meaning of upthrust acting on a body in a fluid<br>➢ Discuss frictional forces and viscous forces<br>➢ Define centre of gravity<br>➢ Define moment of a force<br>➢ Give examples of the concept of principle of moment in everyday examples such as crowbar, wheelbarrow, pliers, scissors, tweezers, or tongs<br>➢ Explain what is meant by couple and torque<br>➢ State the principle of moments<br>➢ Explain when a body is said to be in equilibrium<br>➢ Draw graphical representation of three coplanar forces in equilibrium | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Engage students in practical activities using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Video clips<br>• Internet<br>• Equipment for practical work: incline plane, protractor, knife edge, metre rule, string or thread, and masses | • A body of mass 58g is suspended at the 20cm mark of a uniform metre rule. The metre rule is adjusted on a pivot until it settles horizontally at the 40cm mark. Determine the mass of the metre rule.<br>• A box of mass m rests on an inclined plane which makes an angle θ with the horizontal. There is friction between the box and the surface, and the box is in equilibrium. |

| | | | | |
|---|---|---|---|---|
| | | | | ○ Sketch the free-body diagram showing the forces acting on the box.<br>○ If the value of θ is slowly changed so that at some critical angle $\theta_c$ the box starts to slide, determine the value of $\theta_c$ in terms of $\mu_s$, the coefficient of static friction. |
| **Linear motion**<br>• Definition, type, and forms of motion<br>• Speed and velocity<br>• Concept of speed as change of distance with time<br>• Concept of velocity as change of displacement with time<br>• Uniform/ non-uniform speed/ velocity<br>• Distance/ displacement-time graph rectilinear acceleration | ➢ Define motion and state the types of motion<br>➢ Define distance, displacement, speed, velocity, and acceleration and state their SI unit<br>➢ Plot and interpret distance-time, displacement-time and velocity-time graphs for linear motion<br>➢ Recall and appropriately apply equations of uniformly accelerated motion<br>v = u + at; a = $\frac{v-u}{t}$, $v^2 = u^2 + 2as$ and s s = ut + ½ a$t^2$<br>➢ Describe an experiment to determine the acceleration of free fall using an incline plane<br>➢ Define projectile and the terms used in projectile motion | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Engage students in practical activities using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Video clips<br>• Internet<br>• Equipment for practical work: incline plane, metre rule, stopwatch, and spherical bob | • A racing car starts from rest and accelerates uniformly for 16s. During this time it covers a total distance of 512m. The car then brakes with uniform deceleration and covers a further 256m. Find<br>○ the maximum velocity reached,<br>○ the time taken for the complete journey.<br>• A rifle at a height H above the ground fires |

| | | | | |
|---|---|---|---|---|
| • Concept of acceleration/ deceleration as increase/ decrease in velocity with time.<br>• Uniform/non-uniform acceleration<br>• Velocity-time graph<br>• Equations of motion with constant acceleration<br>• Motion under gravity as a special case<br>• Projectile motion concept of projectiles as an object thrown/release into space | ➢ Derive and apply equations used in projectile motion in solving numerical problems | | | a bullet horizontally. At the same instant and at the same height, a second bullet is dropped from rest. Neglecting air resistance, which bullet will strike the ground first? Explain your answer. |
| **Dynamics of motion**<br>• Newton's laws of motion:<br>○ First Law: inertia of rest and inertia of motion<br>○ Second Law: force, acceleration, momentum, and impulse<br>○ Third Law: action and reaction | ➢ Explain what is meant by the dynamics of motion<br>➢ State that mass is the property of a body that resists change in motion<br>➢ Recall the relationship F = ma and solve problems using it, remembering that acceleration and resultant force are always in the same direction<br>➢ Define and use linear momentum as the product of mass and velocity (recall p = mv)<br>➢ Define and use force as the rate of change of momentum | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Engage students in practical activities using different instruments as required by the topic. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Video clips<br>• Internet<br>• Equipment for practical work: linear momentum apparatus, pulley, thread, | • A rocket travelling at constant velocity explodes in midair. What effects does the explosion have on:<br>○ its momentum;<br>○ its total kinetic energy?<br>• A rocket of mass 5000kg carrying 4000kg of fuel is to be launched vertically. The fuel is consumed |

| | | | | |
|---|---|---|---|---|
| • Apparent Weightlessness<br>• Conservation of linear momentum<br>• Collisions<br>• Types of collisions | ➢ State and apply each of Newton's laws of motion<br>➢ Describe and explain qualitatively the motion of bodies falling in a uniform gravitational field with air resistance (including reference to terminal velocity)<br>➢ Define impulse and relate it to change in momentum<br>➢ Use the relationship between impulse and change in momentum to calculate the force exerted, time for which the force is applied, and change in momentum for a variety of situations involving the motion of an object in one dimension<br>➢ Explain the application of impulse to safety considerations in everyday life, e.g., airbags, seatbelts, jumping down from a height, and arrestor beds<br>➢ State the principle of conservation of momentum<br>➢ State and apply the principle of conservation of momentum to solve simple problems, including elastic and inelastic interactions between bodies in both one and two dimensions (knowledge of the concept of coefficient of restitution is not required)<br>➢ Differentiate between elastic collision and inelastic collision<br>➢ Explain apparent weightlessness | ➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | scale pan, masses | at a steady rate of 50kgs$^{-1}$. Calculate the least velocity of the exhaust gases if the rocket will just lift off the launching pad immediately after firing [take g=10ms$^{-2}$]<br>• Imagine a person of mass *m* standing on a scale inside an elevator. Describe what the scale reads:<br>○ If the elevator moves downward with acceleration *a.*<br>○ When the lift is stationary, or when it is moving at constant speed.<br>○ When the elevator moves upward with acceleration *a.* |
| **Work, Energy and Power** | ➢ Explain the concept of work and state its SI unit | ➢ Teacher-students guided discussion to elicit students' ideas | • Recommended textbook. | • Work can be positive, negative or zero. Explain the |

| | | | | |
|---|---|---|---|---|
| • Concept of work as a measure of energy transfer<br>• Concept of energy as capability to do work<br>• Work done in a gravitational field<br>• Types of mechanical energy (i) Potential energy (PE) (ii) Kinetic energy (KE)<br>• Conservation of mechanical energy<br>• Concept of power as time rate of doing work | ➢ State that work done is equal to change in kinetic energy of the body<br>➢ Calculate the work done in different situations, e.g., carrying a suitcase horizontally, in an expanding gas, and movement of an object on an inclined plane<br>➢ Define energy<br>➢ State with examples, the sources and forms of energy in the earth's system (emphasis on renewable and non-renewable energy)<br>➢ State the principles of energy conservation and explain its application in a case of a simple swinging pendulum<br>➢ Derive and apply the formula for the following relationships<br>$E$k = $\frac{1}{2}mv^2$ Ep = mgh where symbols have their usual meanings<br>➢ Distinguish between gravitational potential energy and elastic potential energy<br>➢ Energy losses in practical devices – heat dissipation.<br>➢ Define power and states its SI unit<br>➢ Derive the power of a moving object as the product of force and v | and modify and correct them to the correct scientific concept.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning.<br>➢ Field trip to a dam, solar plant, thermal energy plant, etc., to extend their understanding of the subject | • Chalk or white board.<br>• Powerpoint.<br>• Video clips<br>• Internet | circumference leading to each of the scenario.<br>• A horizontal force of 2000 N is applied to a vehicle of mass 4000kg which is initially at rest on a horizontal surface. If the total force opposing motion is 800N, Calculate<br>○ the acceleration of the vehicle,<br>○ the KE of the vehicle 5.0s after the force is first applied<br>○ the total power developed 5.0s after the force is first applied. |
| **Machines**<br>• Definition of machine<br>• Terms used in machine<br>• Types of simple machine | ➢ Define machine<br>➢ Explain the following terms as they relate to machines: load, effort, mechanical advantage, velocity ratio, and efficiency of a machine<br>➢ Recall and apply the equations for mechanical advantage, velocity ratio, and | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Video clips<br>• Internet | • Explain the statement 'the velocity ratio of a machine is 5'<br>• A car engine has an efficiency of 20% and produces an average of 25kJ of useful work |

| | | | | |
|---|---|---|---|---|
| • Application of mechanical energy machines: levers, pulleys, inclined plane, wedge, screw, wheel and axle, and gears | efficiency of a machine to solve simple problems<br>➢ Name and describe types of simple machines and explain how the velocity ratio and mechanical advantage can be determined in each case. | ➢ Engage students in practical activities using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Equipment for practical work: knife edge, meter rule, movable and fixed pulley, inclined plane, protractor, wheel and axle | per second. How much energy is converted to heat per second? |
| **Heat and Temperature**<br>• Definition, sources, uses and effects of heat on matter, e.g.: (i) rise in temperature (ii) change of phase state (iii) expansion (iv) change of resistance<br>• Concept of temperature as degree of hotness or coldness of a body<br>• Construction and graduation of a simple thermometer<br>• Properties of thermometric liquids. The following | ➢ Explain the terms: heat; temperature<br>➢ Outline the steps and principles involved in the measurement of temperature<br>➢ Define the fixed points used in establishing the temperature scale<br>➢ Describe the features and uses of different types of thermometers<br>➢ Calculate the temperature reading using both graduated and ungraduated thermometers<br>➢ Analyse the effect of temperature change on the dimensions of substances - leading to linear, superficial, and cubical expansivity | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Engage students in practical activities using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Video clips<br>• Internet<br>• Equipment for practical work: calibrated and non-calibrated thermometers, bimetallic strip, brass rod, copper rod, source of heat, and calorimeter | • In taking the temperature of a sick child, a nurse sometimes puts the thermometer under the tongue of the child for some time before reading the scale. Explain why it is necessary to leave the thermometer under the tongue for some time.<br>• The resistance in the element of a platinum resistance thermometer is 6.75Ω at 0$^{o}$C, 7.75Ω at 100$^{o}$C and 6.900Ω at room temperature. Determine the room |

| | | | | |
|---|---|---|---|---|
| thermometers should be treated: constant–volume gas thermometer, resistance thermometer, thermocouple, liquid-in-glass thermometer (including maximum and minimum thermometer and clinical thermometer), pyrometer and radiation thermometers<br>• Celsius and Absolute scales of temperature. Kelvin and degrees Celsius and degrees Fahrenheit as units of temperature<br>• Definition, advantages, and disadvantages of expansion<br>• Thermal expansion – linear, area and volume expansivity | | | | temperature on the scale of the resistance thermometer. |

| | | | | |
|---|---|---|---|---|
| **Measurement of heat energy**<br>• Concept of heat capacity<br>• Specific heat capacity<br>• Specific latent heat of fusion and of vaporization<br>• Heat curve<br>• Melting point and boiling point<br>• Evaporation and boiling<br>• Vapour and vapour pressure<br>• Humidity, relative humidity, and dew point<br>• Humidity and the weather | ➢ Explain heat capacity and specific heat capacity<br>➢ Describe the methods for measuring heat capacity and specific heat capacity<br>➢ Explain the concepts of latent heat and specific latent heat of fusion and vaporization<br>➢ Explain heat curves and their uses to determine specific heat capacity and latent heat<br>➢ Explain the concept of melting<br>➢ Distinguish between boiling and evaporation<br>➢ State the factors that affect boiling | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Engage students in practical activities using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Video clips<br>• Internet<br>• Equipment for practical work: lagging calorimeter, thermometer, heating coil, electronic balance, joule meter, power supply, heat source, retort stand, steam trapped, conical flask with stopper, delivery tube, stopwatch, hygrometer, and impurities such as salt, sugar, kerosene, etc. | • Explain what is meant by the specific heat capacity of iron is 400Jkg k-1.<br>• Calculate the mass of water that must evaporate from the surface of a 75kg human body to cool it by 20C. The specific heat capacity of the human body is assumed to be the same as that for water. |
| **Transfer of Heat**<br>• Conduction, thermal conductivity: solar | ➢ Explain the different modes of heat transfer: conduction, convection, and radiation<br>➢ Conduct an experiment to illustrate: | ➢ Teacher-students guided discussion to elicit students' ideas and modify and | • Recommended textbook.<br>• Chalk or white board. | • The pendulum shaft of a clock is 1.0 m long and made of aluminum. The clock |

| | | | | |
|---|---|---|---|---|
| energy collector and black body<br>• Convection<br>• Radiation | ○ conduction of heat in a metal rod<br>○ convection current in a fluid<br>○ radiation or absorption of radiant energy<br>➢ Describe the parts and functions of a thermos flask<br>➢ Explain thermal conductivity<br>➢ Describe a black body<br>➢ State Stefan – Boltzmann's law and use it to do simple calculations | correct them to the correct scientific concept.<br>➢ Engage students in practical activities using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Powerpoint.<br>• Video clips<br>• Internet<br>• Equipment for practical work: metal rods of different materials, wax, source of heat, thermos flask, gauze, test tube, and ice | reads correctly for 12 hours during the day when the average temperature is 21$^{o}$C, will the clock gain or lose reading during the night when the average temperature is 9$^{o}$C? Explain your answer<br>• A black body radiates maximum energy when its surface temperature T and the corresponding wavelength λmax are related by the equation λmax T = constant. Given the value of the constant and surface temperature as 2.9 x 10$^{-3}$mK and 57$^{o}$C respectively, calculate the frequency of the maximum energy in the spectrum. |
| **Gases**<br>• Assumptions of kinetic theory of gases, | ➢ State the assumptions of the kinetic theory of gases<br>➢ State the gas laws (Boyle's, Charles's, and Pressure law) in mathematical form | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Video clips | • Air is in a container at 0$^{o}$C. If the pressure is doubled, to what temperature must it be raised for the volume to remain the same? |

| | | | | |
|---|---|---|---|---|
| • Gas laws: Boyle's law, Charles' law, and pressure law<br>• General gas equation | ➢ Use the three gas laws in to derive the general gas equation PV = NRT and use it to solve numerical problems<br>➢ Apply the equations from the gas laws to solve problem | correct scientific concept.<br>➢ Engage students in practical activities using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Internet<br>• Equipment for practical work: meter rule, syringe, masses, u-tube, manometer, gas thermometer, Boyle's law apparatus, pressure gauge, stopcock, syringe, extenders, beaker, thermometer, graduated cylinder, and water bath | • An ideal gas of volume 20cm3 and pressure 0.5Pa is compressed at constant temperature to 2.5 Pa. Calculate the final volume. |
| **Circular motion**<br>• Distinguish between vertical and horizontal circular motion using appropriate experiments<br>• Show the difference between angular speed and velocity<br>• Draw a diagram to illustrate centripetal force | ➢ Define circular motion<br>➢ Explain terms used to describe circular motion: angular displacement, angular velocity, frequency, period, angular acceleration etc.<br>➢ Derive and apply the relationship between linear velocity and angular velocity<br>➢ Explain centripetal force<br>➢ Derive and apply the expression for centripetal acceleration and relate it to centripetal force | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Engage students in practical activities using different instruments as required by the topic. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Video clips<br>• Internet<br>• Equipment for practical work: pulley, string, mass of object (stone), cross bar, fixed rod, | • On an analog wrist watch, calculate the angular speed of:<br>○ the second hand,<br>○ the minute hand,<br>○ the hour hand.<br>• Is it possible for Alie to drive his car at constant velocity of 80km/h around the curve? Explain your answer |

| | | | | |
|---|---|---|---|---|
| • Banking of roads in reducing sideways friction | ➢ Describe the applications of circular motion to: banking of roads, centrifuge, conical pendulum, and negotiating a bend | ➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | pointer, spiral spring, stopwatch, meter rule, and beam balance | |
| **Gravitational field**<br>• Concept of fields<br>• Acceleration due to gravity, (g)<br>• Gravitational force between two masses: Newton's law of gravitation<br>• Gravitational potential and escape velocity<br>• Satellites and rockets | ➢ Define fields<br>➢ State the type of fields<br>➢ State the properties of a force field<br>➢ Describe gravitational field<br>➢ Describe planetary motion<br>➢ State Kepler's laws of planetary motion<br>➢ State Newton's universal law of gravitation<br>➢ Discus the relationship between acceleration due to gravity and universal gravitational constant<br>➢ Explain gravitational field strength<br>➢ Explain gravitational potential and escape velocity<br>➢ Describe satellite<br>➢ Distinguish between artificial and natural satellites<br>➢ Explain uses of satellites<br>➢ Explain geostationary and parking orbit<br>➢ Determine the period of revolution of a satellite | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Video clips<br>• Internet | • The magnitude of the force of attraction between two particles of masses M and m separated by a distance d is $f_1$. When the distance of separation is d/2 the magnitude of the force is $f_2$. Given that the universal gravitational constant is G, obtain expression for<br>○ f1<br>○ the ratio of $\frac{f_2}{f_1}$<br>• It is desired to launch a geostationary satellite in to orbit above the earth. Calculate<br>○ the minimum speed with which the satellite should be projected |

| | | | | |
|---|---|---|---|---|
| | | | | ○ the height the satellite would be above the ground |
| **Oscillatory Motion and Simple Harmonic Motion**<br>• Illustration, explanation, and definition of Oscillatory Motion and Simple Harmonic Motion (SHM)<br>• Speed and acceleration of SHM<br>• Period, frequency, and amplitude of a body executing SHM<br>• Energy in SHM<br>• Damped oscillations<br>• Forced vibration and resonance | ➢ Define oscillatory motion and give examples<br>➢ Describe simple harmonic motion (SHM) using diagrams<br>➢ Use the diagram of a simple harmonic motion to show the following<br>○ amplitude<br>○ period<br>➢ Determine the acceleration due to gravity using a simple pendulum and Helical spring experiment<br>➢ State the effect of the following on the period of oscillation:<br>○ length of a simple pendulum,<br>○ mass of a loaded spring,<br>○ mass of a loaded cantilever<br>○ length of a bifilar suspension<br>➢ Describe the variation of the velocity, acceleration, and energy of a body exhibiting simple harmonic motion | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Engage students in practical activities using different instruments as required by the topic to illustrate energy transformation involving a simple pendulum and helical spring, and students' activities to determine the acceleration due to gravity.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Video clips<br>• Internet<br>• Equipment for practical work: retort stand, thread, pendulum bob, stopwatch, standard masses, helical or spiral spring, cantilever, and set of meter rules | • A mass m attached to a light spiral spring is caused to perform simple harmonic motion of frequency $f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$ where k is the force constant of the spring.<br>○ explain the physical significance of k/m<br>○ if m = 0.3kg, k = $30Nm^{-1}$ , and the maximum displacement of the mass from the equilibrium position is 0.015m, calculate the maximum velocity. |

| | | | | |
|---|---|---|---|---|
| **Concept of Wave Motion**<br>• Propagation of mechanical waves<br>• Energy transmitted with definite speed, frequency, and wavelength.<br>• Waveforms<br>• Mathematical relationship connecting frequency (f), wavelength (λ), period (T) and velocity (v)<br>• Transverse and longitudinal<br>• Mathematical representation of wave motion.<br>• General Progressive Wave Equation and its application | ➢ Describe a wave motion and classify wave as transverse, longitudinal, progressive, electromagnetic, and mechanical<br>➢ State the properties of wave<br>➢ Explain the measuring properties of a wave: displacement, amplitude, frequency, phase, wavelength, velocity, phase difference, and period<br>➢ From the definitions of speed, frequency and wavelength derive the wave equation v = fλ<br>➢ Illustrate the graphical representations of transverse and longitudinal waves<br>➢ Explain that energy is transferred by a progressive wave<br>➢ Demonstrate familiarity with general progressive wave equation:<br>y = A$\sin(\omega t + \frac{2\pi x}{\lambda})$<br>➢ Use a given general progressive wave equation to determine parameters of a wave such as amplitude, frequency, wavelength, and speed | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Engage students in practical activities using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Video clips<br>• Internet<br>• Equipment for practical work: tuning fork, retort stand, cork, electric motor, power source, ripple tank, beaker and water | • A wave is represented by the equation:<br>y = 0.2 sin 0.4π (x-60t), where all distances are measured in cm and time in s. Determine:<br>○ wavelength<br>○ frequency<br>○ speed of wave |
| • Properties of waves: reflection, refraction, **interference**, **diffraction**, superposition of progressive waves, producing standing | ➢ Define the terms interference and coherence<br>➢ Describe experiments that demonstrate two-source interference using water ripples, light (monochromatic light source, e.g., laser) and microwaves | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Video clips<br>• Internet | • When two waves interfere, is there a loss of energy in the system? Explain your answer.<br>• With the aid of a diagram explain the |

| | | | | |
|---|---|---|---|---|
| and stationary waves. | ➢ Describe the conditions required if two-source interference fringes are to be observed<br>➢ Explain the meaning of diffraction<br>➢ Describe an experiment that demonstrates diffraction, including the qualitative effect of the gap width relative to the wavelength of the wave, e.g., diffraction of water waves in a ripple tank | ➢ Engage students in practical activities using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Equipment for practical work: power source, shallow tank of water, oscillating paddle, viewing screen, retort stand, source of light, electric motor, optical rail with cm mark, multiple slit pattern, laser diode source, screen, paper and single slit pattern | two types of diffraction of a waves |
| **Electromagnetic Spectrum**<br>• Types of radiation in electromagnetic spectrum<br>• Spectrum: elementary description and uses of various types of radiation: radio, infrared, visible light, ultra-violet, X-rays, gamma rays | ➢ Define electromagnetic spectrum<br>➢ State that all electromagnetic waves are transverse waves that travel with the same speed in free space<br>➢ Recall the orders of magnitude of the wavelengths of the principal regions of the electromagnetic spectrum from radio waves to gamma rays | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Video clips<br>• Internet | • Investigate and write a report on how a radio station operates |

| | | | | |
|---|---|---|---|---|
| | | ➢ Field trips to local radio station | | |
| **Sound Waves**<br>• Sources of sound<br>• Transmission of sound waves<br>• Speed of sound in solids, liquids, and air<br>• Echoes and reverberation<br>• Noise and music<br>• Characteristics of sound<br>• Ultra-sound and applications | ➢ Define a sound wave and outline its characteristics<br>➢ Distinguish between musical notes and noise<br>➢ Describe how a sound wave is propagated<br>➢ Distinguish between echo and reverberation<br>➢ Describe the use of sound in measuring distance<br>➢ Calculate the velocity of sound using the principle of echo.<br>➢ Understand ultrasound and its applications in medicine and navigation. | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning.<br>➢ Field trips to studios | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Video clips<br>• Internet<br>• Equipment for practical work: jar glass, electric bell, stopwatch, vacuum pump and clamps. | • Explain how radio stations avoid echo and reverberation?<br>• Car B moves towards a stationary Car A. Car B produces an ultrasonic sound at a point and it takes 5.6 x $10^{-3}$s for a beep to be heard in Car A. Calculate the distance between the two cars at that instant (speed of sound in air = 340ms$^{-1}$) |
| **Vibration in String and Pipes**<br>• Vibration in strings<br>• Vibration in pipes – open and closed pipes<br>• Harmonies and overtones<br>• Forced vibration<br>• Resonance and beat | ➢ Define vibration.<br>➢ Carry out activities involving vibrations in strings<br>➢ State the principle of superposition of waves<br>➢ Use graphical method to illustrate the formation of a stationary wave showing nodes and antinodes<br>➢ Demonstrate the relationship between the frequency and length of string<br>➢ Outline the factors that affect the vibration of string instruments<br>➢ Demonstrate the modes of vibration in pipes | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Engage students in practical activities using different instruments as required by the topic.<br>➢ Give summary notes. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Video clips<br>• Internet<br>• Equipment for practical work: masses, string, pulley, G clamp, wooden bridge, meter rule, beam balance, retort stand, | • A sonometer wire has a frequency of 259Hz. It is sounded alongside a tuning fork of frequency 256Hz. Calculate the beat frequency.<br>• Why does a tuning fork sound louder when its stem is pressed against a tabletop? |

| | | | | |
|---|---|---|---|---|
| | ➢ Demonstrate the relationship between the frequency and length of the air column in pipes<br>➢ Determine the wavelength of sound using stationary waves (e.g., use of sonometer, resonance tubes, tuning forks)<br>➢ Explain end correction and resonance<br>➢ Describe beat and state its applications in real life, e.g., in tuning guitar strings<br>➢ Explain Doppler's effect | ➢ Evaluate students understanding of material covered through questioning. | sonometer, string vibrator, stopwatch, resonant tube, and tuning fork | |
| **Light**<br>• Sources of light<br>• Rectilinear propagation of light<br>• Reflection of light at plane surface: plane mirror<br>• Reflection of light at curved surfaces: concave and convex mirrors<br>• Refraction of light at plane surfaces: rectangular glass prism (block) and triangular prism.<br>• Refraction of light at curved surfaces: Converging and diverging lenses<br>• Dispersion of white light by a triangular glass prism | ➢ Describe reflection of light from plane surfaces<br>➢ State the laws of reflection<br>➢ Describe experiment to demonstrate the laws of reflection<br>➢ Locate and observe the image formed in a plane mirror and describe its characteristics<br>➢ Determine the number of images formed by two plane mirrors that are<br>○ Parallel<br>○ inclined to each other at an angle<br>➢ Distinguish between converging (concave) and diverging (convex) mirrors<br>➢ Describe the terms used in curved mirrors:<br>○ pole<br>○ radius of curvature<br>○ focal length<br>○ principal axis<br>○ center of curvature<br>○ principal focus | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Engage students in practical activities and demonstrations using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning.<br>➢ Extend learning by engaging students in mini project or | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Video clips<br>• Internet.<br>• Equipment for practical work: optical pins, plane mirror, protractor, drawing board light source, and screen | • Two plane mirrors are inclined to each other such that they produce 9 images of a lamp placed between them. Calculate the angle between the reflecting surfaces.<br>• A concave mirror of radius of curvature 30cm produces an inverted image, which is 4 times the size of the object. Determine:<br>○ the position of the image<br>○ the position of the object<br>• Does the focal length of a crown-glass diverging lens change when the lens is |

| | | | | |
|---|---|---|---|---|
| | ➢ Trace light rays to locate the position of the images formed by spherical mirrors and describe their nature<br>➢ Carry out an experiment to determine the focal length of a converging mirror<br>➢ Explain the uses of spherical mirrors<br>➢ Use of mirror formula $\frac{1}{f}=\frac{1}{v}+\frac{1}{u}$ to calculate the unknown variables<br>➢ Define refraction of light<br>➢ State the laws of refraction<br>➢ Describe qualitatively the concept of total internal reflection and Critical angle<br>➢ Define a lens and state the types of lenses<br>➢ Explain focal length and the power of lenses<br>➢ Trace light rays to locate the position of the images formed by lenses and describe their nature<br>➢ Carry out an experiment to determine the focal length of a lens<br>➢ Explain the uses of a lens<br>➢ Use of lens formula $\frac{1}{f}=\frac{1}{u}+\frac{1}{v}$ to calculate the unknown variable<br>➢ Define real depth, apparent depth, and lateral displacement<br>➢ Draw a ray diagram to show the path of light ray as it travels<br>○ from air to water<br>○ from air to glass<br>➢ Determine the refractive index in each case above | extended essay writing | | immersed in water? Justify your answer<br>• Explain why we see the sun before it actually rises above the horizon in the morning<br>• Why is a diamond more brilliant than a glass imitation cut the same way?<br>• A ray of light is incident at 45º on one face of a 60º prism of refractive index 1.5. Calculate the total deviation of the ray |

| | | | | |
|---|---|---|---|---|
| | ➢ Define angle of prism and the emergence angle<br>➢ Sketch a diagram to illustrate refraction of light as it passes through a prism<br>➢ Carry out an experiment to determine the refractive index of a glass prism<br>➢ Define minimum deviation<br>➢ Use Snell's law to determine the minimum deviation<br>➢ State the applications of a prism (dispersion of light and composition of colour) | | | |
| • Polarization of light<br>• Application of lenses in optical instruments.<br>• Definition, types, and demonstration of interference<br>• Definition, types, and demonstration of diffraction | ➢ Define polarization of light<br>➢ State the methods of polarizing an unopolarised light<br>➢ State Brewster's law<br>➢ Name examples of optical instruments<br>➢ Explain the structure and operation of optical instruments (human eye, microscope, camera, and telescope)<br>➢ Describe eye defects and their corrections<br>➢ Explain the adjustments in optical instrument<br>➢ Explain visual angle and angular angle<br>➢ Describe the composition of a compound microscope and telescope<br>➢ Explain magnification in a simple microscope, a compound microscope, and a telescope in both normal adjustment and non-normal adjustment | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Engage students in practical activities and demonstrations using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Video clips<br>• Internet.<br>• Equipment for practical work as available. | • How could you determine whether a beam of light is plane polarized or unpolarized?<br>• The refractive index of diamond for sodium light is 2.417. Find the angle of incidence for which the reflected ray of the diamond is completely polarized.<br>• A woman wishes to study a photograph in fine detail by using a lens as a simple magnifying glass in such a way that she sees an image magnified ten times and at a distance of |

| | | | | |
|---|---|---|---|---|
| | | | | 250mm from the lens. What focal length lens should she use and how far from the photograph should it be held? (D = 25cm) |
| **Introduction to Fiber Optics and Lasers**<br>• Explanation of concept of fiber optics.<br>• Principle of transmission of light through an optical fiber<br>• Applications of fiber optics e.g., Local Area Networks (LAN), medicine, sensing devices, carrying laser beams, etc.<br>• LASER and it's applications | ➢ Explain what is meant by fiber optic<br>➢ Describe the principle of operation of optical fibers<br>➢ Describe the applications of optical fibers in ever day life<br>➢ Explain what is meant by laser<br>➢ Describe the principle involved in the production of laser<br>➢ Describe types of lasers<br>➢ Outline the uses of lasers<br>➢ Describe laser safety | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Video clips<br>• Internet. | |
| **Electric Fields**<br>• Electrostatics<br>• Production of electric charges<br>• Types of distribution of charges<br>• Storage of charges<br>• Electric lines of force | ➢ Classify material as conductors, semiconductors, and insulators<br>➢ Outline the methods of charging material<br>➢ Describe the distribution of charges on a pear shaped and spherical conductor<br>➢ Explain the concept of an electric field intensity | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Internet.<br>• Equipment for practical work: | • The magnitude of the electrostatics force between two point charges is given by the equation $F = k\frac{q_1 q_2}{r^2}$ |

| | | | | |
|---|---|---|---|---|
| • Electric force between point charges and Coulomb's law<br>• Concepts of electric field, electric field intensity (potential gradient), and electric potential<br>• Capacitance: definition, arrangement, and application | ➢ Map out an electric field by means of field lines<br>➢ Explain Coulomb's law for point charges and be able to apply its mathematical formula to solve numerical problems<br>➢ Explain electric potential, potential difference, and electric potential energy<br>➢ Deduce the relationship between the potential gradient and the electric field intensity<br>➢ Describe the structure and operation of capacitors<br>➢ Explain capacitance<br>➢ Describe the charging and discharging processes of a capacitor<br>➢ State the factors that affect the capacitance of a capacitor<br>➢ Derive the formulae for the capacitance of the series and parallel arrangements of capacitors and be able to apply it to solve numerical problems<br>➢ Derive the expressions for energy stored in a charged capacitor and be able to apply it to solve numerical problems<br>➢ State examples of applications of capacitors | ➢ Engage students in practical activities and demonstrations using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | perspex, ebonite rod, fur, silk, gold leaf, electroscope, different types of capacitors, connecting wire, voltmeter, multimeter, switch, and battery | ○ Identify each of the other symbols in the equation.<br>○ State the unit of each symbol<br>• A series arrangement of three capacitors of values 8μF, 12μF and 24μF is connected in series with a 90V battery.<br>○ Draw an open circuit diagram for this arrangement<br>○ Calculate the effective capacitance in the circuit<br>○ On closing a circuit, calculate the charge on each capacitor when fully charged.<br>○ Determine the potential difference across 8μF capacitor. |
| **Direct Current electricity** | ➢ Describe the sources of current electricity<br>➢ Explain that electric current is a flow of charge carriers | ➢ Teacher-students guided discussion to elicit students' ideas and modify and | • Recommended textbook.<br>• Chalk or white board. | • A current of 5.0A flows through a typical filament bulb when a potential difference of |

| | | | | |
|---|---|---|---|---|
| • Production of electric current from primary and secondary cells<br>• Potential difference and electric current<br>• Electric circuit<br>• Electric conduction through materials<br>• Shunt and multiplier<br>• Resistivity and conductivity<br>• Measurement of electric current, potential difference, resistance, EMF and internal resistance of a cell.<br>• Electric energy and power | ➢ Recall that the charge on charge carriers is quantized<br>➢ Recall and use Q = It<br>➢ Define Coulomb as the SI unit of electric charge<br>➢ Represent circuit components by symbols<br>➢ Recall and use appropriate circuit symbols.<br>➢ Distinguish between closed and open circuits<br>➢ Describe the effect of short circuiting<br>➢ Explain the principle of operation and use of an ammeter and a voltmeter<br>➢ Distinguish between series and parallel connections<br>➢ Draw circuit diagrams containing sources, switches, resistors, ammeters, voltmeters, and/ or any other type of electrical component<br>➢ Explain the conversion of a galvanometer into an ammeter and a voltmeter (shunt and multiplier)<br><br>➢ Define resistance of a conductor and state its SI unit<br>➢ State Ohm's law and recall its mathematical relation V = IR<br>➢ Sketch and discus the I, V, characteristics of a metallic conductor at constant temperature in<br>○ semiconductor<br>○ filament | correct them to the correct scientific concept.<br>➢ Engage students in practical activities and demonstrations using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Powerpoint.<br>• Internet.<br>• Equipment for practical work: dry and wet cell, voltmeter, ammeter, connecting wire, key/ switch, bulb, resistance box, rheostat, and resistors of different magnitude<br><br>crocodile clips, different wire, meter rule, galvanometer, micrometer screw gauge, meter bridge, bulb, dry / wet cell, voltmeter, ammeter, connecting wire, key/ switch, bulb, resistance box potentiometer, and rheostat | 240V is applied across it. Calculate the resistance of the bulb filament.<br>• Two resistors R1 and R2 are connected, a) in series and, b) in parallel across a filament bulb.<br>○ Sketch the diagram showing each of the arrangements.<br>○ In which of the arrangements will the bulb be brighter? Explain why.<br><br>• Two wires, A and B, are made of the same material. A has twice the length of B and twice its diameter. What is the ratio of the resistance of A to that of B?<br>• Draw a diagram to show how you could connect together four 560Ω resistors so that their combined resistance is 560Ω |

| | | | | |
|---|---|---|---|---|
| | ➢ Arrange resistors in series and parallel and in each case determine their effective resistance<br>➢ Explain the factors that affect the resistance of a conductor<br>➢ Define resistivity of a material and show that $\rho = \frac{RA}{L}$ where R is the resistance, ρ is the resistivity of the material, L is the length of the conductor, and A is the cross-sectional area<br>➢ Describe a metre bridge and state its uses<br>➢ Perform an experiment to demonstrate the uses of a potentiometer<br><br>➢ Distinguish between electromotive force (e.m.f.) and potential difference<br>➢ State the sources of electromotive force<br>➢ Discus the effect of internal resistance of a source of e.m.f. on potential difference<br>➢ Recall and use the equation V = E – Ir, where V is the voltage, E is the electromotive force, (e.m.f), I is the current and r is the internal resistance<br><br>➢ Define electric work and show that W = QV where W = electrical work, Q = charge, and V is the voltage<br>➢ Define electric power and derive its mathematical relation P = VI where P = electric power, V = voltage, and I = current<br>➢ Determine the heat generated and power lost in a resistor | | three phase connecting wire, three pin plug, tester and circuit breaker | • The resistance of a wire is 4Ω and a cell supplies a current of 0.8A through it. If the resistance of the wire is increased to 17Ω, the current supplied by the cell is 0.2A. Find the e.m.f. and internal resistance of the cell.<br>• An electric motor takes 15A at 110V. Determine:<br>○ the power input<br>○ the cost of operating the motor for 8 hours at Le10 per kilowatt-hour |

| | | | | |
|---|---|---|---|---|
| | ➢ Explain application of simple electrical installations such as a three pin plug and a circuit breaker | | | |
| **Simple Alternating Current circuits**<br>• Graphical representation of EMF and current in an AC circuit<br>• Peak and RMS values<br>• Series circuit containing resistor, inductor, and capacitor<br>• Reactance and impedance<br>• Vector diagrams<br>• Resonance in an AC circuit<br>• Power in an AC circuit | ➢ Explain the characteristics of an alternating current (AC)<br>➢ Sketch a graph showing the variation of voltage/ current against time<br>➢ Describe the terms used in alternating current<br>○ peak current (I0)<br>○ peak voltage (V0)<br>○ root mean square value of alternating current (Irms)<br>○ root mean square value of alternating voltage (Vrms)<br>➢ Explain the terms reactance capacitance and inductance<br>➢ explain the alternating current series circuit of:<br>○ R-C<br>○ R-L<br>○ R-L-C<br>➢ Explain the terms impedance<br>➢ Discus the conditions for resonance and show that f = $\frac{1}{2\pi\sqrt{LC}}$<br>➢ Discus the application of resonance in selecting a particular frequency in radio reception and transmission<br>➢ Discuss power factor | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Engage students in practical activities and demonstrations using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Internet. | • A resistor of resistance 50Ω, a capacitor of capacitance 01μF, and an inductor of inductance 0.1H are connected in series to a 1.50 Vrms alternating voltage supply.<br>○ draw the circuit diagram<br>○ calculate the resonant frequency<br>• Explain the statement: the power supply voltage of a source is 230V. |
| **Magnetic fields**<br>• Properties of magnets and magnetic materials | ➢ Identify a magnet, magnetic, and nonmagnetic materials<br>➢ State the properties of a magnetic field<br>➢ Explain the concept of magnetic domains | ➢ Teacher-students guided discussion to elicit students' ideas and modify and | • Recommended textbook.<br>• Chalk or white board. | • Sketch a diagram to illustrate magnetic lines of force for a bar magnet placed in a |

| | | | | |
|---|---|---|---|---|
| • Magnetization and demagnetization<br>• Concept of magnetic field<br>• Magnetic force | ➢ Outline the processes involved in magnetization and demagnetization<br>➢ Describe an experiment to determine the factors that affect the strength of a magnet produced by electrical method<br>➢ Describe the uses of magnets and ferromagnetic materials | correct them to the correct scientific concept.<br>➢ Engage students in practical activities and demonstrations using different instruments as required by the topic.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Powerpoint.<br>• Internet.<br>• Equipment for practical work: battery, key, magnetic wire, iron nail, pins, ammeter, retort stand, insulated copper wire, soft iron rod, magnetic compass, connecting wire, power source, copper wire of three thicknesses, metre rule, and crocodile clips | uniform earth's magnetic field with its north pole pointing north. Indicate the neutral points.<br>• A sailor observes that his mariners' compass reads N100 W at a place where the angle of declination is N150 W. Calculate the true bearing of the place. |
| **Electromagnetic fields**<br>• Concept of electromagnetic field<br>• Electromagnetic induction<br>• Faraday's law, Lenz's law, and motor-generator effect<br>• Inductance<br>• Eddy currents | ➢ Explain the meaning of electromagnetic field<br>➢ List the factors that affect the magnetic force on a current-carrying conductor in a uniform magnetic field<br>➢ Explain the forces set up between parallel current-carrying conductors in a uniform magnetic field<br>➢ Describe the torque produced by a current-carrying rectangular coil in a uniform magnetic field | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Engage students in practical activities and demonstrations using different instruments as required by the topic. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Internet.<br>• Equipment for practical work: battery, key, magnetic wire, iron nail, pins, ammeter, retort stand, insulated | • A current of 5A passes through a straight wire in a uniform magnetic field of flux density 2.0 x 10-3T. Calculate the force per unit length exerted on the wire when it is inclined at 300 to the field.<br>• A 95% efficient transformer is used to operate a lamp rated 60W, 220V from a |

| | | | | |
|---|---|---|---|---|
| • Power transmission and distribution<br>• Use of electromagnets<br>• The earth's magnetic field<br>• Magnetic force on a moving charged particle (a current-carrying conductor placed in a magnetic field and between two parallel current-carrying conductors) | ➢ Describe the structure and action of an electric motor and a moving coil galvanometer<br>➢ Describe the force exerted on a charged particle moving in electric and magnetic fields, and their applications<br>➢ Describe an electromagnetic switch<br>➢ Describe the use of a relay to switch on a motor or fan or light<br><br>➢ Explain the meaning of electromagnetic induction<br>➢ State the laws of electromagnetic induction<br>➢ Describe the factors that affect the magnitude of the induced e.m.f.<br>➢ Describe the principles of the operation of a dynamo and a generator<br>➢ Explain ways of ensuring constant bicycle dynamo output at both low and high speed<br>➢ Describe the structure of an inductor and explain its behavior in DC and AC circuits<br>➢ Derive and apply the equation for calculating the energy in an inductor<br>➢ Describe eddy current<br>➢ Describe the structure, uses and principle of a transformer<br>➢ Establish the relationship between<br>○ e.m.f and the numbers of turns in a transformer<br>○ e.m.f and the current in a transformer<br>➢ Derive and apply the equation for calculating the efficiency of a transformer | ➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | copper wire, soft iron rod, magnetic compass, connecting wire, power source, copper wire of three different thicknesses, metre rule, and crocodile clips | 4400V AC supply. Calculate:<br>○ the ratio of the number of turns in the primary coil to the number of turns in the secondary coil of the transformer.<br>○ the current taken from the mains circuit. |

| | | | | |
|---|---|---|---|---|
| **Structure of the atom**<br>• Models of the atom<br>• Energy quantization<br>• Photoelectric effect<br>• Thermionic emission<br>• X-rays | ➢ Describe the models of the atom as proposed by:<br>○ Thompson<br>○ Rutherford<br>○ Bohr<br>○ Wave mechanics<br>➢ Explain the existence of quantized energy level in an atom<br>➢ Describe the types of spectra and their uses<br><br>➢ Explain photoelectric effect<br>➢ Outline Einstein's quantum theory explanation of photoelectric effect<br>➢ State and explain the laws of photoelectric effect<br>➢ State the equation of photoelectric effect and explain the terms used<br>➢ Describe the application of photoelectric effect<br><br>➢ Explain thermionic emission and its application<br>➢ Describe the nature, production, and uses of cathode rays<br>➢ State the application of photoelectric emission on devices such as a photocell, a cathode ray tube, and a photometer<br>➢ Explain the mode of operation of photocell, cathode ray tube, electron gun and fluorescent tube | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Internet. | • State three conclusions that can be drawn from Rutherford's experiment on the scattering of alpha particles by a thin metal foil in relation to the structure of the atom.<br>• State Einstein's equation of photoelectric effect<br>• A photon has a frequency of 5.02 x 1014 Hz. Calculate the energy of the photon in:<br>○ joules<br>○ electron volts<br>[h = 6.6 x $10^{-34}$Js; 1ev = 1.6 x$10^{-19}$]<br>• State three uses of X-ray other than those in Medicine. |

| | | | | |
|---|---|---|---|---|
| | ➢ State the uses of photocell, cathode ray tube, electron gun, and fluorescent tube<br><br>a) Describe the nature and production of X-rays<br>b) Outline the properties, types, and characteristics of X-rays<br>c) Explain the uses and hazards of X-rays<br>d) State the relationship between kinetic energy and linear momentum (Ek = $\frac{p^2}{2m}$) in an X-ray | | | |
| **Structure of the nucleus**<br>• Composition of the nucleus<br>• Radioactivity – natural and artificial<br>• Nuclear reactions - fusion and fission | ➢ Describe the structure of the nucleus<br>➢ Explain the following terms:<br>○ Nuclide<br>○ Nucleon<br>○ Atomic Number<br>○ Neutron number<br>○ Mass number<br>➢ Establish the relationship between Atomic mass and Mass number<br><br>➢ Explain the meaning of radioactivity<br>➢ Distinguish between natural and artificial radioactivity<br>➢ Discuss the methods of detecting radiation<br>➢ Explain nuclear instability<br>➢ State decay law<br>➢ Determine the half-life, decay constant, and average life using the appropriate mathematical formula<br><br>➢ Define mass defect and binding energy | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning.<br>➢ Field trip to the hospital | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Internet. | • A nuclide AZX emits β-particles to form a daughter nuclide Y. Write a nuclear equation to illustrate the charge conservation.<br>• Tabulate the properties of alpha (ά), beta (β), and gamma (γ) radiations under the following headings: nature, penetration ability, ionization, and charge.<br>• The radioactive nuclei $^{210}_{84}$ PO emits a particle α to produce $^{206}_{82}$ Pb. Calculate the energy, in MeV, released in each |

| | | | | |
|---|---|---|---|---|
| | ➢ Explain the relationship between mass and binding energy<br>➢ Discuss the terms binding energy and binding energy per nucleon<br>➢ Apply nuclear equation<br>➢ State the relationship between Joule, electron volts, and Mega electron volts (Mev)<br>➢ Determine the nuclear energy in Joules and Mega electron volts from nuclear equation<br>➢ State a qualitative explanation of nuclear power generation | | | disintegration. (Take the masses of<br>○ 21084Po= 209.936730u<br>○ 21082 Pb= 205.929421u<br>○ 42He =4.001504u<br>and that<br>○ 1u = 931 MeV.) |
| **Electronic (Electrical Conduction through Materials)**<br>• Distinction between conductors, semiconductors, and insulators in term of band theory<br>• Semiconductor materials (silicon and germanium)<br>• Meaning of intrinsic semiconductors (example of materials silicon and germanium)<br>• Charge carriers<br>• Doping production of p-type and n-type | ➢ Define electronics<br>➢ Define conductor, semi -conductor, and insulator<br>➢ Explain the energy band and the terms used in it<br>➢ Use the energy band to distinguish between conductor, semiconductor, and an insulator<br>➢ Distinguish between intrinsic and extrinsic semiconductors and explain how they are produced<br>➢ Describe the formation and operation of P – N junction diodes<br>➢ Describe the types of P – N junction diodes and their uses<br>➢ Describe the half wave and full wave rectification of an alternating current<br>➢ Explain the smooth or filter capacitor action | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Internet. | • Using the energy band theory, distinguish between conductor, insulator, and semiconductor |

| | | | | |
|---|---|---|---|---|
| extrinsic semiconductors<br>• Junction diode – forward and reverse biasing, voltage characteristics<br>• Uses of diodes<br>• Half and full wave rectification | ➢ Describe voltage regulation, voltage multiplier and DC voltage stabilization | | | |
| **Wave-particle paradox**<br>• Electron diffraction<br>• Duality of matter<br>• Heisenberg's Uncertainty Principle | ➢ Explain the wave-particle duality of matter<br>➢ State Louis de Broglie's postulate<br>➢ Discuss the de Broglie equation<br>➢ State Heisenberg's Uncertainty Principle<br>➢ Discuss the equation of Heisenberg's Uncertainty Principle<br>➢ Explain electron diffraction | ➢ Teacher-students guided discussion to elicit students' ideas and modify and correct them to the correct scientific concept.<br>➢ Give summary notes.<br>➢ Evaluate students understanding of material covered through questioning. | • Recommended textbook.<br>• Chalk or white board.<br>• Powerpoint.<br>• Internet. | • By equating the photo energy E = h$f$ to the Einstein mass-energy relation, derive an expression for de Broglie's wavelength of a particle. |