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ACCELERATED EDUCATION PROGRAMME

PHYSICS

SYLLABUS

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DEVELOPMENT CENTRE

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Contents

Foreword

Education is a fundamental tool for protection of conflict-and-disaster-affected children and youths from harm and exploitation. This is a crucial part of UNESCO's advocacy messages. Under appropriate conditions of security, provision of education can help protect children and youth from recruitment into fighting forces, forced labour, prostitution, drug abuse and other criminal activities. In post-conflict settings, education contributes to the reintegration into society of former soldiers and other children and youths associated with fighting forces.

The National Curriculum Development Centre (NCDC), in collaboration with War Child Canada, embraced Accelerated Education Programme (AEP) that focuses on providing relevant and appropriate education to learners in refugee camps and the host communities of secondary school age (ages 16-45+) in Adjumani District. The programme will help them to acquire the necessary competencies that will enable them to 'catch-up' and re-join learners of the same (or near) age group in the formal education programme.

AEP subjects were selected based on the Ugandan regulation which states that learners must study the seven core subjects, i.e. Mathematics, English, Physics, Chemistry, Biology, History and Geography. So AEP learners shall take all the core subjects. In addition, learners shall take: Religious Education which will help to address the prevalence of early marriages for the girl-child, cases of indiscipline and moral modelling of the learners; Personal Social and Health Education/Physical Education which will help the learners to develop physically, learn to live together, develop talents and become emotionally balanced; Guidance and Counselling in which teachers will be trained on integration of guidance and counselling services in the delivery of the education curriculum.

This Programme will equip teachers and other stakeholders in schools and the communities with relevant information, values and skills that will enable them to effectively facilitate the teaching and learning processes.

We recommend AEP to you and trust that the materials will be valuable, in your endeavour to meet the educational needs of the refugee learners and other beneficiaries from the host communities.

Hon. Janet Kataaha Museveni
First Lady and Minister of Education and Sports

Acknowledgement

National Curriculum Development Centre (NCDC) would like to express its gratitude to all those who, in one way or another, contributed and worked tirelessly towards the development of this Accelerated Education Programme (AEP) syllabus.

Special thanks go to War child Canada-Uganda for the financial support, their guidance in overseeing and taking timely decisions whenever necessary during the development and production of this AEP Physics Syllabus.

We also express our gratitude to NCDC Subject Specialists and panel members for their professional guidance and technical assistance.

Furthermore, NCDC recognises the work of the editors who worked with the writers throughout the development of this Syllabus.

NCDC takes responsibility for any shortcomings that might be identified in this syllabus and welcomes suggestions for addressing the inadequacies. Such comments and suggestions may be communicated to NCDC through: P.O. Box 7002, Kampala or e-mail admin@ncdc.go.ug.

Grace K. Baguma

Director

National Curriculum Development Centre

Introduction to Accelerated Education Programme

Worldwide, substantial alternative schooling programmes are developed to meet the basic education needs of under-reached children. Of recent, it has been increasingly recognized that the goals of Education for All cannot be achieved unless more attention is paid to educating out-of-school children (UNESCO, Global Monitoring Report, 2008). Indeed, the UNESCO Global Monitoring Report 2010 'Reaching the Marginalized' focused on this issue. In a bid to help developing countries achieve the Millennium Development Goals, there should be initiatives to incorporate elements of accelerated learning to achieve SDG 4.

The Accelerated Education Programme (AEP) in Uganda is a form of curriculum option which combines the stronger features of earlier mainstreaming approaches into the new design to raise the success rates for refugee community learners. The AEP secondary school tier is a bigger stride to address the education gap within refugee communities not only in Uganda but also other neighbouring countries. Benchmarking the Primary AEP programmes, the Secondary Education Programme intends to infer the entire process of education and its cognitive, emotional, and social components.

The Accelerated Learning Programme at Secondary school level focuses on completing learning in a shorter period of time, of two years. The AEP is complementary both in providing an alternative route and in matching its curriculum to the 'official' curriculum, thus allowing learners to return to formal schooling at some stage. The programme intends to promote access to education in an accelerated timeframe for disadvantaged groups, out of school and over-age children, and youths who missed out or had their education interrupted due to poverty, violence, conflict, and crisis. The goal of this programme is to provide learners with competencies equivalent to those in the formal system in an accelerated timeframe, with learners either transitioning back into the mainstream education or exiting with some competencies required for work.

Ideally, teaching AEP calls for a methodology that is interactive and learner-centred, incorporating other aspects of multiple-intelligence learning. Because teaching and learning are accelerated, and the curriculum content is compressed and condensed, the four 'P' elements are at the core of the accelerated learning cycle; processes, psychological, physiological, and physical. These core elements provide the physical and psychological space in which the learner can learn more effectively.

It is intentional to include alternative subjects in this programme e.g. life skills, peace education, environment, HIV and AIDS which are responsive to the context. Learners of AEP need alternative supporting knowledge and life skills to survive in the challenging world. It is equally important to note that this conception of accelerated learning requires an extremely well-resourced classroom and exceptionally well-trained teachers. The expanded learning time from the norm is because the teaching methodology is interactive and learner centred.

It is our hope that AEP will register considerable success in meeting the educational needs of these underserved populations, not only in terms of access and equity but also in being able to return to school and completion, and most importantly in getting measurable learning outcomes.

The aim of this AEP Physics syllabus

This syllabus is aimed at providing the teacher with the required guidance to teach Physics to learners who will not have gone through the normal four years of Ordinary level classes. It is meant to cover the most critical aspects of Physics without affecting its standards. It will adequately prepare learners for Uganda Certificate of Education (UCE). However, the creativity of the classroom teacher is important in this case.

Rationale for Teaching Physics

The aims of teaching Physics are to:

i) provide, through well-designed studies of experimental and practical science, a worthwhile educational experience for all learners, and to enable them to acquire sufficient scientific knowledge and understanding that prepares them for the challenges of the 21st century.
ii) enable learners become confident citizens in a technological world, able to take or develop an informed interest in scientific matters.

iii) enable learners to recognize the usefulness and limitations of Physics, and to appreciate its applicability in other disciplines and in everyday life.
iv) enable learners to be suitably prepared for studies beyond the Ordinary level.
v) encourage efficient and safety practices both during experimental work and in society.
vi) develop attitudes relevant to science in general and Physics in particular such as concern for accuracy and precision, objectivity, integrity, enquiry, inventiveness and innovativeness.
vii) promote awareness that the study and practice of Physics are co-operative and cumulative activities, that are subject to social, economic, technological, ethical and cultural influences, justifications and limitations.
viii) stimulate interest in and care for the environment and proper utilisation of resources with respect to Uganda.

Content Structure

The Accelerated Education Programme (AEP) for Physics is divided into Seven topics which will be taught in two levels. The topics and the respective sub-topics for the two levels are indicated in the table below.

<table>
<tr><th>Level 1</th><th>Level 2</th></tr>
<tr><td>Introduction to Physics
Topic 1: Measurement
Physical Quantities, Units and Measurement
Topic 2: Forces and their Effects
1. Types of forces
2. Turning effects of forces
3. Energy, work and power
4. Motion
5. Pressure
Topic 3: Light
Behaviour of light</td><td>Topic 5: Thermal Physics
1. Kinetic Model of Matter
2. Temperature
3. Transfer of heat energy
4. Expansion of solids, liquids and gases
5. Heat quantities
Topic 6: Electricity and Magnetism
1. Static electricity
2. Current electricity
3. Practical electricity
4. Magnets and their properties
5. Electromagnets and their</td></tr>
</table>

Level 1	Level 2
Topic 4: Waves 1. General wave properties 2. Sound	applications 6. Electromagnetic Induction **Topic 7: Modern Physics** 1. Atomic structure 2. Cathode rays and X-rays 3. Radioactivity

NOTE:

Throughout this Physics syllabus, emphasis must be put on:

a) Knowledge:

i) Knowledge of terminology
ii) Knowledge of specific facts
iii) Knowledge of **conventions and units** used in Physics
iv) Familiarity with experiments suggested in the syllabus
v) Knowledge of common laws/principles and generalization identified in the syllabus

b) Comprehension or understanding:

Ability to:

i) explain standard phenomena from laws/principles and models and to describe standard experiments met with before.
ii) translate various forms of information presentation.
iii) use standard methods to solve familiar and unfamiliar numerical types of problems.
iv) draw conclusions from experimental procedures.
v) synthesise ideas from presented data or otherwise.
vi) apply laws and generalizations already learnt to everyday life and new situations.

c) Application to higher abilities and practical skills

Acquisition of the following abilities:

i) Application of knowledge/theory to practical situations
ii) Stating appropriate experimental title or heading
iii) Manipulation of the apparatus and performing experiments
iv) Making and recording observations accurately in column tables, with proper units
v) Presentation of data in an appropriate form especially graphical, with properly labelled axes and using suitable scales

vi) Determining gradient or slope, intercept or any other required points on the graph
vii) Drawing conclusions from observations made
viii) Assessing suitability of procedure, experiment and observations made in support of the conclusion
ix) Devising projects in which the products employ Physics principles

1.4 Features of this AEP Syllabus

This AEP Physics Syllabus has the following features:

a) Competency

This is a general statement of what a learner can exhibit or do as a result of learning all the concepts within each sub-topic. It is stated at the top of the table for each sub-topic in the detailed syllabus. It shows how the content will be applied in different situations.

b) Learning outcomes

These are the expected behaviour which a learner will exhibit after the study of the sub-topic. ***The teacher must ensure that all the outcomes are achieved***. They have been provided to help the teacher clarify content and scope. Where a higher outcome is stated, lower outcomes are implied. The teacher should use learning outcomes to plan his/her teaching strategies. Learning outcomes also guide in evaluation at the end of the learning process.

c) Duration

This has been provided for each sub-topic. It is meant to guide the teacher in planning so as to cover all the content appropriately. However, the allocated time should allow for flexibility in order to cater for remedial teaching and carrying out practical activities where possible.

d) Suggested learning activities

These provide the teacher with guidance for example, on the tasks which the learners must accomplish to acquire the learning outcomes. However, these are not the only activities since other tasks as may be suggested by the teacher must be used. The teacher should use appropriate strategy e.g. individual or group work for learners to carry out the activities effectively. Teachers should also encourage learners to use a variety of resources such as library and ICT.

d) Sample assessment strategy

These are meant to test the level of understanding for each sub-topic. However, other assessment strategies as suggested by the teacher and textbooks appropriate to the sub-topic should be used to assess the learners' achievement. The sample assessment strategies are not meant to be a spot work for end of cycle examination but rather to assist the teacher in formative assessment. Some of this assessment is done by observation and can be used to assess attributes like teamwork, confidence, scientific literacy, communication, leadership and organisational skills of learners.

e) References

These have been provided for each sub-topic to help the teacher in the preparation of lessons. This is mainly because the topics are carefully selected and combine aspects that may be found in content for different classes in the normal programme.

f) Hint to the Teacher

These further clarify the scope and depth of coverage for some sub-topics. They should be taken seriously to avoid leaving out content or giving content beyond the scope of the learners.

Detailed Syllabus

Level 1

Topic 1: Introduction to Physics

Duration: 3 Hours

Competency

The learner understands the meaning and importance of Physics.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. explain the meaning of Physics. b. explain why it is important to study Physics, and relate it to different technologies and careers. c. know some Physics apparatus and their use. d. explain why it is important to follow the laboratory rules and regulations.	i) Learners, in groups, discuss the different aspects of Science they have studied in Primary school and use them to identify the branches of Science ii) In groups, learners discuss some of the natural phenomena whose occurrence can be explained using the understanding of Physics iii) Guided by the teacher, learners conduct a tour of the Physics laboratory or Science room or any facility used for keeping Physics apparatus and; a) identify some physics apparatus. b) discuss the importance of some	1. Task learners, in groups, to discuss the importance of studying Physics. Focus should be put on: i) Meaning of physics ii) Physics technologies iii) How the technologies can improve life 2. After learners have made a tour of the physics laboratory and have observed some physics apparatus, let them formulate some of the laboratory rules and discuss why

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
	of the apparatus. c) discuss how to stay safe in the laboratory.	they should follow them.

Hint to the Teacher

Ask learners to make and display a simple project from what they learnt in Science in Primary school. Use the display to guide the learners about what is more related to the study of Physics. This will help them understand the meaning of Physics.

Topic 2: Measurement

Sub-topic 1: Physical Quantities, Units and Measurement

Duration: 12 Hours

Competency

The learner estimates and measures length, mass, time, volume and density and expresses them using appropriate units.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. show understanding that all physical quantities consist of a numerical magnitude and a unit. b. recall the following base quantities and their units: mass (kg), length (m), time (s), current (A), temperature (K), amount of substance (mol). c. use the following prefixes and their symbols to indicate decimal sub-multiples and multiples of the SI units: milli (m), centi (c), deci (d), kilo (k), mega (M). d. measure a variety of lengths with appropriate accuracy by means of tapes,	i) In groups, learners discuss instances in everyday life where measurement is applied and explain what is done in each case. ii) Learners estimate and measure length for a variety of objects such as a desk, one's height, height of the classroom, etc., express the readings using different units and compare their readings. iii) Learners measure mass for different objects and compare their answers, then they discuss why their answers are different. iv) Learners record time for short events such as writing a sentence and express the	1. Learners work together to estimate, measure and record each of the following with the right accuracy: a) The length of a football pitch b) The width of the classroom c) The area of the desk top d) The thickness of the desk top e) The time a friend takes to walk 20 paces f) The mass of a pen 2. Task learners to calculate density and express it in g cm^{-3} and kg m^{-3} for a block of material of mass 600 g and volume 200 cm^3 and predict

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
rules and interconvert units of lengths. e. measure a short interval of time including the period of a simple pendulum with appropriate accuracy using stopwatches or appropriate instruments. f. state the meaning of mass and measure masses of different objects. g. express measured and calculated values to the right significant figures. h. express derived quantities in terms of base quantities and derive their units. i. carry out measurement of area, volume and density and express them appropriately. j. calculate density of objects and relate it to sinking and floating.	answer with appropriate units. v) In groups, learners measure the volume of regular and irregular objects by displacement method or otherwise and describe the steps they undertake. vi) In groups, learners collect various figures from Mathematics book under the topic **STATISTICS**, and then express them to different significant figures with guidance from the teacher. vii) In groups, learners plan and carry out experiments to determine densities of solids of different materials such as cork, plastic, wood, glass blocks and predict whether they float or sink in water.	whether this block will float or sink in water. Assess how learners state formulae and substitute. 3. Let learners determine the density of an irregular solid. 4. Assess the following: planning, setting up apparatus, procedures, observations, and conclusion.

Hint to the Teacher

i) The accuracy of the instruments should be emphasized.
ii) The use of significant figures throughout the syllabus is required.
iii) Learners should practice measuring using a metre rule /ruler, stop clock and a variety of balances as much as possible.
iv) Learners should carry out the inter-conversion of units for all the quantities as much as possible.

v) Allow learners to estimate these quantities especially in instances where accurate measurements may not be required.

References

1. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2016). Longhorn Secondary Physics (Senior 1) Pg 17-63, Longhorn.
2. Wilson, M. & Daniel, R. (2003). Comprehensive Secondary Physics (Form 1), Pg 4-15. Oxford University Press.
3. Wilson, M. & Daniel, R. (2004). Comprehensive Secondary Physics (Form 2). Pg 13-22, Oxford University Press.

Topic 3: Forces and their Effects

Duration: 45 Hours

Sub-topic 1: Types of Forces

Duration: 6 Hours

Competency

The learner explores the nature, types and effects of forces on objects.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. explain the meaning of force and state its units. b. identify the types of forces and where they occur and their consequences. c. explain the meaning of weight and compare it with mass. d. measure weight and apply the relationship *weight = mass × acceleration due to gravity* to solve related problems. e. explain the meaning of friction and its effects (positive and negative). f. describe methods of minimising friction in bodies. g. explain what is meant by *scalar* and	i) As individuals or groups, learners push a wooden block into plasticine/ clay, an inflated balloon/ used water bottle, or another block and use the observations to discuss what a force is and the effects of forces on objects. ii) Learners measure weight and mass of different objects using appropriate instruments and use the results to explain the relationship between mass and weight. **iii)** In groups, learners carry out experiments to	1. Using two springs, a stretched one and a compressed one, learners debate the effects of a pulling force and a pushing force 2. Ask learners to. calculate their own weight on earth and what it is expected to be on the moon and compare the two values. 3. Learners explain, in brief write up, the following observations in terms of friction: a) grease is applied to the moving parts of a machine b) heavy objects can be more easily moved on rollers than dragged c) objects slide more easily across a smooth surface than a rough

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
vector quantities and give common examples of each. h. add two vectors to determine a resultant by a graphical method and calculation for linear and perpendicular vectors only.	investigate the factors that affect frictional force between two surfaces in contact and summarise their findings.	surface d) car tyres become smoother and thinner with time e) it is easier to write with a pencil on paper than on glass

Hint to the Teacher

i) The concept of resultant force can be illustrated using a tug-of-war game.
ii) Forces to be mentioned should include weight, cohesion, adhesion, friction, magnetic, electrostatic, surface tension, centripetal, nuclear forces.
iii) The relation $F=ma$ will be met under motion.
iv) Numerical treatment of friction is not required.
v) Only the resultant of linear and perpendicular vectors should be treated using simple mathematical analysis.

References

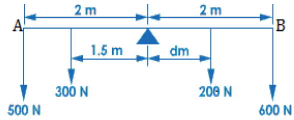
1. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2016). Longhorn Secondary Physics (Senior 1) Pg 120-135, Longhorn
2. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2016). Longhorn Secondary Physics (Senior 3) Pg 94-98, Longhorn
3. Wilson, M. & Daniel, R. (2003). Comprehensive Secondary Physics (Form 1), Pg 16-22, Oxford University Press
4. Wilson, M. & Daniel, R. (2004). Comprehensive Secondary Physics (Form 2), Pg 22-27, Oxford University Press

Sub-topic 2: Turning Effect of Forces

Duration: 9 Hours

Competency

The learner investigates the relation between turning effect of forces and stability of bodies.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. describe the moment of a force in terms of its turning effect and relate this to everyday examples. b. apply the relationship: *moment of a force (or torque) = force × perpendicular distance from the pivot* to new situations or to solve related problems. c. state the principle of moments for a body in equilibrium and verify it experimentally. d. apply the principle of moments to several experiments and to solve related	i) Learners raise a log/pole at different positions from the fixed end/pivot and use this activity to discuss the factors that determine turning effect. ii) Learners in groups carry out experiments to determine the mass of a meter rule and compare their results. iii) In groups, learners find out how far from the pivot of a seesaw a student of mass 80 kg should sit in order to exactly balance a student of mass 60 kg who is sitting 2 m from the pivot. iv) Learners in groups, cut cardboards of different irregular shapes to determine the centre of gravity of the cardboards. The	1. Let learners determine the value of distance **d** in the figure below, if AB is balanced.  Consider how learners analyse and resolve the diagram using principle of moments. 2. Task learners in a conversation, to explain why buses with loads in the underside boot are more stable than those where the load is in the rack at the top. 3. Ask learners to narrate their experience in relation to loading vehicles and allow learners to critique their peers

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
problems. e. show understanding of the centre of gravity and how it can be located for irregular shapes. f. describe qualitatively the effect of the position of the centre of gravity on the stability of objects.	learners then try to check for the actual centre of gravity of the cardboards by balancing and make reports. v) Learners in groups slightly displace a ball, plastic funnel and other small objects from rest positions and use the observations to discuss the various types of equilibrium.	

Hint to the Teacher

i) Examples on moments should involve one or two pivots/turning points only.
ii) Variety of examples and practical activities using a metre rule are recommended.
iii) Assessment of other practical abilities such as recording observations, data analysis and graphical work is recommended.

References

1. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2016). Longhorn Secondary Physics (Senior 1) Pg 25-50. Longhorn.

2. Wilson, M. & Daniel, R. (2004**).** Comprehensive Secondary Physics (Form 1), Pg 24-34. Oxford University Press.

Sub-topic 3: Energy, Work and Power

Duration: 10 Hours

Competency

The learner explores the relationship between force, distance and time in the operation of simple machines.

Learning Outcomes	Suggested Learning Activities	Sample Assessment Strategies
The learner should be able to: a. explain the meaning of energy and identify examples of different forms/types of energy. b. identify sources of energy and categorise them as renewable and non-renewable. c. apply the formulae E_k = ½ mv^2 and E_p = mgh to solve numerical problems (for KE and PE respectively). d. state the principle of the conservation of energy and apply the principle to different situations and to solve related problems. e. relate energy, work and power and solve related numerical problems. f. explain terminologies related to simple machines.	i) In groups or as individuals, learners lift blocks or bricks of different masses through different distances and calculate the work done in each case. Then the learners use their results to discuss the factors that determine the value of work done. ii) In groups or as individuals, learners lift blocks of known mass through a known distance in a given time and calculate the power developed iii) In groups, learners drop a small object to the ground and describe all the energy forms that take place. iv) In groups, learners are provided with a variety of simple machines such as pliers, opener, knife, etc. or their pictures if the machines are not	1. Task learners to calculate the work done and the power developed when a student lifts a mass of 40 kg through a vertical height of 5 m in 20 s. Critique how the learners identify the quantities, the formula to use, the substitution and how the final answer is stated. 2. Learners, in a class discussion, identify the energy transformations that take place: i) at a waterfall ii) when fruit falls to the ground from a tree iii) when a generator is used to provide light 3. Learners explain the causes of power loss in simple machines and how it can be minimised, using practical examples.

Learning Outcomes	Suggested Learning Activities	Sample Assessment Strategies
g. explain how levers, pulleys, wheel and axle, gears, etc. work. h. calculate MA, VR and efficiency of machines. i. explain how efficiency of machines can be improved.	readily available. Using positions of load, effort and fulcrum, learners classify the levers into three classes. v) In groups, learners discuss instances in which each simple machine is applied.	

Hint to the Teacher

i) Practical demonstrations in which work is done, energy is transformed and power is expended are recommended.
ii) Principle of conservation of energy should be demonstrated using a pendulum, falling bodies.
iii) Energy transformation can be demonstrated using lighting of bulbs and other appropriate illustrations.
iv) Using real machines such as opener, scissor, knife, wheel barrow, etc. to demonstrate levers and other simple machines is recommended.

References

1. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2016). Longhorn Secondary Physics (Senior 2) Pg 57-101, Longhorn

2. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2016). Longhorn Secondary Physics (Senior 3) Pg 99-103, Longhorn

3. Wilson, M. & Daniel, R. (2004). Comprehensive Secondary Physics (Form 3), Pg 36-53, Oxford University Press

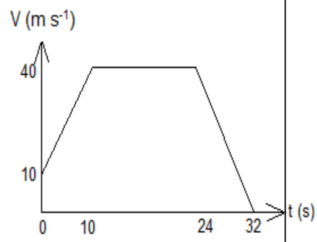
Sub-topic 4: Motion

Duration: 12 Hours

Competency

The learner investigates the concept of motion, its laws and their implications in everyday life.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. explain what is meant by displacement, speed and velocity. b. calculate speed and average speed. c. plot and/or interpret a displacement-time graph when a body is: at rest, moving with uniform velocity, or moving with non-uniform velocity and use it to calculate velocity. d. explain what is meant by acceleration and apply the equations of motion to solve numerical problems. e. plot and/or interpret a velocity-time graph and use it to determine displacement and acceleration. f. explain the term acceleration due to gravity and determine it	i) In groups, learners mark two points which are 100 m apart on a playing field. They measure the time taken by a student: a) walking b) running c) riding a bicycle between the points, if possible d) remains at the same point ii) Using the above data, learners calculate the average speed of the student in each case iii) Learners carry out an activity to determine acceleration due to gravity using a pendulum and compare their results to the quoted value. iv) Learners interpret the graph shown below (describing the motion of a body as shown by the graph)	1. Ask learners to sketch a velocity –time graph for this data: A body moving at 5 ms^{-1} accelerates uniformly until its velocity becomes 15 ms^{-1} in 5 s. It then maintains a constant velocity for 10 s and is finally brought to rest 20 s from the start. Asses the labelling of axes, the fitting of variables and the use of the graph to calculate total distance covered. 2. Let learners explain their feeling when they are sitting in a stationary vehicle that suddenly starts to move. 3. Learners solve this problem: A force of 20 N acts on a mass of 500 g. Find the acceleration of the mass. Assess how learners substitute in a right equation and how they simplify the expression and express the final answer.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
experimentally. g. State Newton's laws of motion and describe their implications/applications. h. apply the relationship *resultant force = mass × acceleration* to solve related numerical problems.		

Hint to the Teacher

i) derivation of the equations of uniformly accelerated motion is not required.
ii) derivation of the equation ***F=ma*** is not required.
iii) variety of problems are required for this sub-topic.
iv) allow learners to draw a variety of graphs and interpret them.
v) In the practical activity to determine the acceleration due to gravity, assist learners to develop other practical skills such as data presentation and data analysis.

References

1. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2016). Longhorn Secondary Physics (Senior 3) Pg 1-37, Longhorn

2. Wilson, M. & Daniel, R. (2004). Comprehensive Secondary Physics (Form 3), Pg 1-9, Oxford University Press

Sub-topic 5: Pressure

Duration: 8 Hours

Competency

The learner determines pressure in solids and fluids and explains its implication in everyday life.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. explain the term pressure and derive its units. b. apply the relationship *pressure = force / area* to explain situations and to solve numerical problems related to minimum and maximum pressure. c. demonstrate the factors that affect liquid pressure. *d.* explain the transmission of liquid pressure and its applications. *e.* apply the relationship $p = h \times \rho \times g$ to different situations and to solve related numerical problems (**derivation of the equation not required**). *f.* describe the cause,	i) In groups or as individuals, learners place different faces of the same rectangular brick/block onto a flat heap of sand or clay and compare how much the sand or clay is depressed by the different faces. ii) In groups, learners measure the length, width and thickness of a rectangular block/ brick. Then they measure its mass and use these readings to calculate the least and greatest pressure it exerts on a smooth table. iii) Learners in groups or as individuals make holes on a used water bottle at different/ same depth and pour water into the bottle. Then they discuss what they observe. iv) In groups or as individuals, learners plan and carry out an activity to demonstrate the	1. Task learners to explain the following phenomena using knowledge of pressure: a) farm tractors have large wheels with wide tyres b) a hippo can easily walk in mud than a goat 2. Learners calculate the pressure a drawing pin exerts in a soft board if its tip area is 1 mm^2 and the force used to push it is 2 N. Assess how the units are harmonised. 3. Task learners to: a) explain why the pressure at a depth of 10 m in the sea is higher than that on the surface and its

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
effects and applications of *atmospheric* pressure. *g.* describe construction and use of a mercury barometer. *h.* describe the use of a manometer in the measurement of pressure difference.	existence of atmospheric pressure using: a) Crushing can b) Siphoning c) Partial vacuum v) In groups, learners plan an activity to demonstrate the hydraulic press using syringes and straws.	implication. b) suggest reasons why dams are built so that they become increasingly thicker from top to bottom. 4. Assess scientific literacy and communication in this activity

Hint to the Teacher

i) Minimum and maximum pressure should be demonstrated practically.

ii) Everyday life implications and applications of solid, liquid and gas pressure should be emphasised.

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1. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2016). Longhorn Secondary Physics (Senior 2) Pg 132-148, Longhorn

2. Wabwire, H. C., Sekkoba, A. S., Kasirye, S & George, W. S. (2013). Secondary Physics Student's Book 2, Pg 104-133, MK Publishers Limited

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Topic 3: Light: Behaviour of Light

Duration: 14 Hours

Competency

The learner demonstrates the behaviour of light in different media and explains its implications and applications.

Learning Outcomes	Suggested Learning Activities	Sample Assessment Strategies
The learner should be able to: a. demonstrate that light travels in straight lines. b. explain how shadows and eclipses are formed. c. describe the terminologies related to reflection at plane surfaces. d. describe experiments to demonstrate the laws of reflection and use them in different situations. e. describe image formation in plane mirrors and its applications. f. describe how curved mirrors form images and their applications (scale drawings may not be required). g. describe terminologies related to refraction at plane surfaces. h. describe an experiment to demonstrate the laws of refraction and apply them to different situations (e.g. effects of refraction,	i) Learners as individuals or as groups make an artificial eclipse using items such as the globe, bulb, balls, etc. and make a report. ii) In groups, learners carry out activities on measuring the angles of reflection for different angles of incidence and discuss the results. iii) As individuals, learners observe themselves through plane mirrors and discuss the nature of the images formed. iv) Learners observe themselves using curved mirrors and describe the nature of the images formed	1. Task learners to draw a diagram of solar eclipse and label the umbra and penumbra. Then let them explain why it happens that way. 2. Task learners to determine how far the image of X is behind the mirror from this kind of data: An object X is 4 cm behind a second object Y. Object Y is 6 cm from a plane mirror. Assess how learners sketch a diagram that they use to solve the problem. 3. Task learners to describe, using appropriate ray diagrams, the characteristics of the image formed by a concave mirror when object is: i) At a distance less than f

Learning Outcomes	Suggested Learning Activities	Sample Assessment Strategies
determining refractive index). i. explain the terms *critical angle* and *total internal reflection* and their implications/applications. j. describe the properties and action of lenses (both converging and diverging) (**construction of ray diagrams not required**). k. determine focal length of convex lens. l. describe applications of lenses. m. explain the dispersion of white light, its implications and application.	by the mirrors. v) Carry out activities to determine the refractive index of glass using a variety of methods. vi) Carry out activities to show the splitting of white light and discuss what causes it. vii) Observe objects of different colours through filters and discuss why the objects appear that way. viii) Carry out activities to determine focal length of a convex lens, by estimation and accurate methods. ix) Carry out activities to demonstrate dispersion of white light and identify the colours.	ii) At a distance greater than r 4. Ask learners to identify and observe the effects of refraction of light in everyday life and summarise what they see. 5. Ask learners to confidently explain why some objects appear coloured and others black when viewed in different coloured lights. 6. Ask learners to draw ray diagrams to show what happens to parallel rays of light passing through: a) a converging lens. b) a diverging lens when objects are at different positions

Hint to the Teacher

i) Emphasise the difference between reflection and refraction of light and where they are applied.
ii) Emphasise the rays used for locating images in curved mirrors for different object positions.
iii) Accurate scale drawings for both the curved mirrors and lenses **may** be left out. However, you can support learners who show curiosity in this aspect.
iv) Provide learners with a variety of practical exercises involving the glass block and convex lenses.
v) Operation of projector, compound microscope and telescopes should be left out.
vi) The lens formula should not be taught.

References

1. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2016). Longhorn Secondary Physics (Senior 1) Pg 139-180, Longhorn
2. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2016). Longhorn Secondary Physics (Senior 2) Pg 1-21, Longhorn
3. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2016). Longhorn Secondary Physics (Senior 3) Pg 138-189, Longhorn
4. Wabwire, H. C., Sekkoba, A. S., Kasirye, S & George, W. S. (2013). Secondary Physics Student's Book 1, Pg 81-97, MK Publishers Limited
5. Wabwire, H. C., Sekkoba, A. S., Kasirye, S & George, W. S. (2013). Secondary Physics Student's Book 2, Pg 1-18, MK Publishers Limited
6. Wabwire, H. C., Sekkoba, A. S., Kasirye, S & George, W. S. (2013). Secondary Physics Student's Book 3, Pg 98-144, MK Publishers Limited
7. Wilson, M. & Daniel, R. (2003). Comprehensive Secondary Physics (Form 1), Pg 76-87, Oxford University Press
8. Wilson, M. & Daniel, R. (2004). Comprehensive Secondary Physics (Form 2), Pg 35-43, Oxford University Press

9. Wilson, M. & Daniel, R. (2004). Comprehensive Secondary Physics (Form 3), Pg 11-21, Oxford University Press
10. Wilson, M. & Daniel, R. (2010). Comprehensive Secondary Physics (Form 4), Pg 1-17, Oxford University Press

Topic 4: Waves

Duration: 14 Hours

Sub-topic 1: General Wave Properties

Duration: 8 Hours

Competency

The learner investigates the properties of transverse and longitudinal wave forms and explains how waves transmit energy and its applications.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. describe what is meant by wave motion as illustrated by vibrations in ropes, springs and disturbances in water. b. explain the meaning of *speed, frequency, wavelength, period, amplitude, crest and trough.* c. apply the relationship $v = f\times\lambda$ to solve related problems. d. compare transverse and longitudinal waves and give suitable examples of each. e. describe the behaviour of waves in terms of reflection, refraction, diffraction and interference.	i) Using ropes or water in a basin or pond, learners demonstrate what waves are and make a report. ii) Carry out an activity to demonstrate the movement of transverse and longitudinal waves using a slinky spring or other methods. iii) Investigate reflection, refraction, diffraction and interference of water waves using a ripple tank and discuss the observations. iv) In groups or as individuals, learners search and display the components of the e.m spectrum,	1. Task learners to compare longitudinal and transverse waves using appropriate sketches. 2. In a ripple tank, the distance between 10 successive crests is 18 cm and the frequency of the ripples is 50 Hz. Ask learners to find the speed of the ripples and assess how they substitute. 3. Task learners to draw sketches of wave patterns obtained when waves are reflected and diffracted in different cases. Allow for peer assessment.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
f. identify the components of the electromagnetic spectrum in order of their frequencies and wavelength. g. describe the properties of the electromagnetic waves. h. describe the uses/applications of each of the components of the electromagnetic spectrum.	their sources, frequencies, wavelengths and their uses. v) Learners solve a numerical problem such as: calculate the wave length of radio waves transmitted from a station that broadcasts at a given frequency e.g. 150 MHz.	4. Task learners to identify the applications of X-rays, visible light, radio waves, ultraviolet radiation, infra-red radiation and micro-waves and make a peer assessed presentation.

Hint to the Teacher

i) Provide a variety of opportunities for the learners to explore the behaviour of waves.

ii) The use of the equation $v = f\lambda$ should be emphasised in a variety of situations.

iii) Learners should not memorise the values of the frequencies and wavelength of electromagnetic waves but should consider the order increasing/decreasing magnitude of these parameters among the electromagnetic waves since their applications are related to frequencies and wavelengths.

References

1. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2016). Longhorn Secondary Physics (Senior 2) Pg 197-225, Longhorn

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3. Wilson, M. & Daniel, R. (2004). Comprehensive Secondary Physics (Form 2), Pg 67-71, Oxford University Press
4. Wilson, M. & Daniel, R. (2004). Comprehensive Secondary Physics (Form 3), Pg 67-74, Oxford University Press
5. Wilson, M. & Daniel, R. (2010). Comprehensive Secondary Physics (Form 4), Pg 37-45, Oxford University Press

Sub-topic 2: Sound

Duration: 6 Hours

Competency

The learner investigates the nature of sound waves, how they are transmitted in different media and their applications.

Learning Outcomes	Suggested Learning Activities	Sample Assessment Strategies
The learner should be able to: a. describe the production of sound by vibrating sources. b. describe the longitudinal nature of sound waves in terms of the processes of compression and rarefaction. c. explain that a medium is required in order to transmit sound waves and that the speed of sound differs in air, liquids and solids. d. describe the echo method for the determination of the speed of sound in air and make the necessary calculation. e. relate loudness of a sound wave to its	i) Learners carry out activity to produce sound and discuss what happens during the process. ii) In groups, learners demonstrate that sound requires a medium to travel. iii) Learners carry out activity to show that sound waves undergo interference and diffraction. iv) In groups, learners plan and carry out an activity to measure the velocity of sound in air using the echo method and discuss the limitations of the	1. Task learners to compare sound and light waves in a group discussion and assess how learners express themselves. 2. Ask learners to solve this problem: A student standing 100 m from a large building blows a whistle and hears the echo after 0.6 s. Calculate the speed of sound in air. Assess how learners

Learning Outcomes	Suggested Learning Activities	Sample Assessment Strategies
amplitude and pitch to its frequency. f. describe refraction, diffraction and interference of sound waves and their implications.	method. v) In groups, learners demonstrate the difference between loudness and pitch.	select the formula and substitute in the variables to obtain the final answer.

Hint to the Teacher

A comparison of sound and light as forms of wave motion should be emphasised.

References

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2. Wabwire, H. C., Sekkoba, A. S., Kasirye, S & George, W. S. (2013). Secondary Physics Student's Book 2, Pg 199-242, MK Publishers Limited.

3. Wilson, M. & Daniel, R. (2004). Comprehensive Secondary Physics (Form 2), Pg 73-79, Oxford University Press.

LEVEL 2

Topic 5: Thermal Physics

Duration: 25 Hours

Sub-topic 1: Kinetic Model of Matter

Duration: 3 Hours

Competency

The learner uses the knowledge of the arrangement and motion of particles to explain the properties of solids, liquids and gases.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. compare the properties of solids, liquids and gases. b. describe qualitatively the molecular structure of solids, liquids and gases, relating their properties to the forces and distances between molecules and to the motion of the molecules. c. infer from Brownian motion and diffusion experiments the evidence for the movement of molecules. d. describe the factors that determine the motion of molecules in matter. e. describe changes of states of matter as processes of energy transfer without a change in temperature.	i) In groups, learners investigate the properties of solids, liquids and gases (shape, pouring and compressing using common substances like sand, water and air). ii) Learners observe and describe the motion of dust particles when a room is being swept and light is entering from one end. iii) As individuals or groups, learners plan and carry out an activity to demonstrate how diffusion takes place in gases and liquids. iv) In groups, learners discuss the importance of change of state in everyday life and present a report.	1. Task learners to use models (from local materials) to explain the difference between solids, liquids and gases in terms of arrangement of particles. 2. Learners use Brownian motion to explain why smells of objects spread fastest during hot weather than cold weather.

Hint to the Teacher

i) Introduce the sub-topic by reviewing with the learners the meaning of matter.

ii) Assessment should consider other factors that determine motion of particles as well.

References

1. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2016). Longhorn Secondary Physics (Senior 1) Pg 68-77, Longhorn.
2. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2016). Longhorn Secondary Physics (Senior 2) Pg 167-169, Longhorn.
3. Wabwire, H. C., Sekkoba, A. S., Kasirye, S & George, W. S. (2013). Secondary Physics Student's Book 1, Pg 37-40, MK Publishers Limited
4. Wabwire, H. C., Sekkoba, A. S., Kasirye, S & George, W. S. (2013). Secondary Physics Student's Book 2, Pg 139-149, MK Publishers Limited.
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Sub-topic 2: Temperature

Duration: 4 Hours

Competency

The learner describes the construction and use of thermometers.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. explain the difference between temperature and heat. b. explain and give examples of thermometric properties. c. compare mercury, alcohol and water as thermometric liquids. d. describe how the upper and lower fixed temperature points are determined. e. solve numerical problems related to temperature scales including the Kelvin scale. f. describe the construction and use of a clinical thermometer.	i) As groups, learners make an improvised thermometer. ii) As individuals or in groups, learners discuss the features of a clinical thermometer and the laboratory thermometer and the best practices of caring for a clinical thermometer and make a report. iii) In groups, learners measure their body temperature and compare it with the known value. iv) Learners debate the motion "**mercury is a better** thermometric **liquid than alcohol**".	1. Task learners to write a brief note describing the care of clinical thermometers. Consider how learners effectively communicate scientific literacy. 2. Provide learners with corresponding values of Celsius and Kelvin temperatures and tasks the learners to develop a relationship between them.

Hint to the Teacher

i) Digital thermometers may be used to measure body temperature.
ii) Gas and resistance thermometers should **NOT** be discussed at this level.

References

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2. Wabwire, H. C., Sekkoba, A. S., Kasirye, S & George, W. S. (2013). Secondary Physics Student's Book 1, Pg 43-49, MK Publishers Limited
3. Wilson, M. & Daniel, R. (2003). Comprehensive Secondary Physics (Form 1), Pg 56, 60, Oxford University Press

Sub-topic 3: Transfer of Heat Energy

Duration: 6 Hours

Competency

The learner investigates the modes of heat transfer and their applications.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategy
The learner should be able to: a. show understanding that thermal energy is transferred from a region of higher temperature to a region of lower temperature. b. describe, in molecular terms, how heat transfer occurs in solids. c. describe experiments to compare the rates of conduction of different solids. d. describe, in terms of density changes, convection in fluids. e. describe heat transfer by radiation. f. investigate the factors that affect the rate of heat	i) In groups, learners hold one end of a metallic material such as a knife and a piece of wood in a fire flame and discuss what happens and state where this behaviour is applied. ii) In groups, learners put water in a volumetric flask and add coloured material. Then they apply a small flame at the bottom and discuss what they observe and how it can be applied.	Task learners to explain the examples of the applications of heat energy transfer by conduction, convection and radiation and allow for peer assessment.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategy
transfer by radiation. g. describe applications of heat transfer in everyday life.	iii) Learners use a thermos flask and discuss in groups how it keeps heat transfer to a minimum.	

Hint to the Teacher

i) Aspects of global warming and greenhouse effect should be discussed in relation to heat transfer.
ii) It is important to discuss other forms of flasks e.g. food flasks which are not vacuum flasks.
iii) A wide range of the applications of **each** of the modes of heat transfer should be discussed.

References

1. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2016). Longhorn Secondary Physics (Senior 1) Pg 80-90, Longhorn.
2. Wabwire, H. C., Sekkoba, A. S., Kasirye, S & George, W. S. (2013). Secondary Physics Student's Book 1, Pg 52, MK Publishers Limited.
3. Wilson, M. & Daniel, R. (2003). Comprehensive Secondary Physics (Form 1), Pg 63-71, Oxford University Press.

Sub-topic 4: Expansion of Solids, Liquids and Gases

Duration: 4 Hours

Competency

The learner explains the application and disadvantages of the expansion of solids, liquids and gases.

Learning outcomes	Suggested Learning Activities	Sample Assessment Strategies
The learner should be able to: a. explain the term expansion and explain what causes it. b. design experiments to compare the rates of expansion of solids and liquids. c. explain daily observations of expansion of gases e.g. bursting of balloons and tyres during hot weather. d. describe applications of expansion of materials in everyday life. e. describe the anomalous expansion of water and its significance.	i) In groups, learners plan, carry out activities and present a report to show that when solids, liquids and gases are heated, they expand. ii) In groups, learners carry out an activity to investigate and compare the rates of expansion of solids and liquids and discuss instances where the results are applied. iii) In groups, learners discuss why ice forms on the surface of water and not within the water and the biological significance of this phenomenon.	1. Ask learners to use the knowledge of expansion to: a) explain why gases expand more easily than solids and liquids at the same temperature. b) explain why tyres are safer when driving at night than during hot day on the same road surface. 2. Learners draw a sketch graph and explain how the volume and density of water changes between 0°C and 100°C. Consider how learners indicate axes and how they explain the shape of the graph.

Hint to the Teacher

i) Gas laws may not be used to explain expansion of gases. Numerical treatment of gas expansion may not be required. Only simple illustration of gas expansion in everyday life is required. However, if some learners can show enthusiasm about gas laws, you can support them.

ii) Emphasise the expansion of solids and liquids in assessment using local examples.

Reference

Wilson, M. & Daniel, R. (2003). Comprehensive Secondary Physics (Form 1), Pg 50-61, Oxford University Press

Sub-topic 5: Heat Quantities

Duration: 8 Hours

Competency

The learner explores the concept of heat capacity and latent heat and their implication to real life.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. describe the change in temperature of a body in terms of a change in its internal energy. b. explain the terms *heat capacity* and *specific heat capacity.* c. apply the relationship *heat energy = mass × specific heat capacity × change in temperature* to solve numerical problems.	i) Learners carry out an activity to investigate the effect of supplying the same amount of heat energy **(heat from the same source supplied for the same period)** on the temperature of different materials of the same mass. ii) Learners plan and carry out an activity to obtain a	1. Task learners to explain land and sea breeze. Consider how learners use the concept of heat capacities in this explanation. 2. Solving numerical problems like: Hot water is poured into three times its mass of water at 20^{o}C. The resulting temperature of the mixture is 30^{o}C.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
d. determine the specific heat capacity of a material e.g. cork by method of mixtures. e. explain the difference between boiling and evaporation. f. explain the terms *latent heat* and *specific latent heat.* g. apply the relationship *heat energy = mass* × *specific latent heat* to solve numerical problems. h. explain latent heat in terms of molecular behaviour. i. describe implications and applications of the high heat capacity and latent heat of water. j. sketch and interpret cooling/heating curves.	cooling/heating curve for a substance e.g. water and naphthalene, and explain the shapes obtained. iii) With guidance from the teacher, learners in groups, discuss the applications of latent heats in devices such as refrigerators, power stations, generators, etc. and make reports.	Find the temperature of the hot water before mixing. **3.** Ask learners to calculate the total heat energy required to convert 5 kg of ice at -20^{0}C to steam at 100^{0}C and draw the heating curve.

Hint to the Teacher

i) Give learners a variety of numerical activities related to the heat quantities so that they become familiar with the concept.
ii) The concept of vapours should **NOT** be emphasised.

References

1. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2016). Longhorn Secondary Physics (Senior 3) Pg 260-290, Longhorn.
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3. Wabwire, H. C., Sekkoba, A. S., Kasirye, S & George, W. S. (2013). Secondary Physics Student's Book 3, Pg 175-197, MK Publishers Limited.
4. Wilson, M. & Daniel, R. (2003). Comprehensive Secondary Physics (Form 3), Pg 99-100, Oxford University Press.

Topic 6: Electricity and Magnetism

Duration: 38 Hours

Sub-topic 1: Static Electricity

Duration: 4 Hours

Competency

The learner investigates static electricity and its implications and applications.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategy
The learner should be able to: a. explain how charges are produced on insulators. b. state the law of electrostatics and use it to explain electrostatic induction. c. distinguish between conductors and insulators. d. describe the structure of a gold leaf electroscope (GLE) and its uses. e. explain the meaning of electric field and sketch electric field patterns for different situations. f. explain how lightning occurs and describe how the lightning conductor works. **g.** state other applications of electrostatics.	i) In groups learners carry out an activity in which a plastic material rubbed with cotton or fur attracts small pieces of paper and explain why. ii) Learners bring a charged plastic rod near the cap of a charged and uncharged GLE and discuss the observation. iii) In groups, learners use ICT or other sources to search for recent destruction caused by lightning in Uganda and write a report, highlighting the places/regions most prone to lightning strikes and why.	1. Let learners explain in a conversation, why two balloons suspended together will move away from each other when they have been rubbed with a dry cloth. 2. Task learners to confidently explain why it would be very unwise for a person to walk holding an opened umbrella during a thunderstorm. 3. Let learners sketch electric field patterns for the following cases: i) between similar charges. ii) between two oppositely charged parallel plates.

Hint to the Teacher

i) There is need to emphasise the meaning of static electricity at the beginning of this sub-topic.
ii) Use a variety of examples related to charges at rest e.g. holding a comb near hair, chains in vehicles, etc.
iii) The operation of a van der Graff generator and ice pail experiment should be left out.

References

1. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2016). Longhorn Secondary Physics (Senior 3) Pg 222-235, 250-257. Longhorn.
2. Wabwire, H. C., Sekkoba, A. S., Kasirye, S & George, W. S. (2013). Secondary Physics Student's Book 3, Pg 150-171, MK Publishers Limited
3. Wilson, M. & Daniel, R. (2003). Comprehensive Secondary Physics (Form 1), Pg 91-98, Oxford University Press
4. Wilson, M. & Daniel, R. (2003). Comprehensive Secondary Physics (Form 3), Pg 76-79, Oxford University Press

Sub-topic 2: Current Electricity

Duration: 12 Hours

Competency

The learner investigates what an electric current is, its sources and explores the concept of electrical resistance.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. explain what is meant by electric current and state its units. b. apply the relationship *charge = current × time* to solve related numerical problems. c. differentiate between potential difference (p.d) and electromotive force (e.m.f.) and identify the sources of e.m.f. d. describe the structure and action of a simple cell and a dry cell. e. distinguish between primary and secondary cells. f. describe how electric current and p.d are measured. g. draw circuit diagrams with power sources (cell, battery, d.c. supply or a.c. supply), switches, lamps, resistors (fixed and variable), fuses, ammeters and	i) Learners construct a simple cell using materials such as oranges, wires, etc. and describe how it works. ii) In groups, learners design working series and parallel circuits with bulbs, cells and switches, and discuss the differences in lighting of the bulbs. **iii)** In groups and with guidance from the teacher, learners design a circuit containing a resistor, battery, voltmeter, ammeter and switch and take the readings to appropriate accuracy. Then they change the	1. Task learners, in a class discussion to analyse the advantages and disadvantages of the various sources of electricity, with reference to Uganda. Assess the self-confidence of the learners. 2. Task individual learners to explain why domestic electric devices are always connected in parallel. They should make a brief write up for this task. 3. Task learners to draw a circuit diagram showing how the instruments should be positioned to measure the current and potential

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
voltmeters. h. state Ohm's Law and define electrical resistance. i. apply the relationship $R = V/I$ to solve related problems. j. describe an experiment to verify Ohm's law. k. describe the properties of series and parallel resistor networks and use them to solve related numerical problems (**derivation not required).** l. investigate the factors that affect the resistance of a conductor.	resistance several times and note the differences in the readings. iv) In groups, learners carry out an activity to investigate Ohm's law and present and analyse their results appropriately. v) In groups, learners calculate the total resistance when three resistors of values 1 Ω, 2 Ω and 5 Ω are connected in parallel and in series and compare their answers.	difference across a bulb. In a conversation, ask learners to give reasons for that arrangement.

Hint to the Teacher

i) Derivation of the resistor network formulae is not required but only their applications in solving numerical problems should be emphasised.
ii) Emphasis should be put on the significant figures/accuracy of ammeters and voltmeters.
iii) Variety of practical activities involving ammeters, voltmeters, switches, bulbs and resistance wire are recommended.

References

1. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2016). Longhorn Secondary Physics (Senior 1) Pg 187-190), Longhorn
2. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2015). Longhorn Secondary Physics (Senior 4) Pg 27-126, Longhorn
3. Wabwire, H. C., Sekkoba, A. S., Kasirye, S & George, W. S. (2013). Secondary Physics Student's Book 1, Pg 79-87 & Pg 103-113, MK Publishers Limited
4. Wilson, M. & Daniel, R. (2004). Comprehensive Secondary Physics (Form 3), Pg 54-64, Oxford University Press

Sub-topic 3: Practical Electricity

Duration: 8 Hours

Competency

The learner explores how electric energy is distributed and consumed in order to ensure electric power saving and safety.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. identify domestic electrical appliances and describe the energy transformations that occur in them. b. apply the relationships energy, $E = V I t$ and power, $P = V I$ to solve related numerical problems. c. read and interpret power ratings of electrical appliances. d. interpret the kWh and relate it to joules. e. calculate the cost of using electrical appliances. f. identify the non-renewable	In groups and with guidance from the teacher, learners; **i)** carry out an activity to demonstrate the heating effect of a conductor. **ii)** read the power ratings on kettles, bulbs, and other related appliances and discuss their implications. **iii)** solve the problem: calculate the electric power	1. Task learners to identify domestic appliances that convert electrical energy into each of the following: i) heat energy ii) heat and light energy iii) sound energy iv) sound and mechanical energy v) heat, sound

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
and renewable sources of electricity and discuss their merits and demerits. g. state the hazards of using electricity in the following situations: i) damaged insulation ii) overheating of cables iii) damp conditions h. explain the use of fuses and circuit breakers in electrical circuits and of fuse ratings. i. explain the need for earthing metal cases and for double insulation. j. state the meaning of the terms *live, neutral* and *earth.* k. describe the wiring in a mains plug. l. explain why switches, fuses, and circuit breakers are wired into the live conductor.	dissipated in a device that draws a certain voltage when a certain amount of current passes through. iv) In groups, learners discuss how they can identify bare live wires in domestic wiring and which action they should take. v) Learners open and draw the inside of a three-pin plug and label the live, neutral and earth pins, and identify the colour codes of the wires related to them. vi) discuss the safety measures in wiring a house.	and mechanical energy 2. Task learners to calculate the cost of running a 100 W filament bulb for one day if each unit of electricity costs Shs 524 and the amount of money that would be saved if a 15 W energy saver bulb of the same brightness was used.

Hint to the Teacher

Students should be exposed to the real electrical appliances as much as possible.

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2. Wilson, M. & Daniel, R. (2010). Comprehensive Secondary Physics (Form 4), Pg 61-70, Oxford University Press

Sub-topic 4: Magnets and their Properties

Duration: 4 Hours

Competency

The learner investigates the properties and applications of magnets.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. state the properties of magnets including the law of magnetism. b. describe methods of magnetisation and demagnetisation. c. demonstrate and describe the plotting of magnetic field lines with a compass. d. demonstrate and draw the magnetic field patterns around magnet(s) in different situations. e. describe practices of storage of magnets. f. investigate the properties of soft and hard magnetic materials. g. state the general applications of magnets.	i) In groups, learners move magnets towards and away from other magnets and use the observations made to state the law of magnetism. ii) In groups, learners carry out an activity to magnetise a steel nail/bar using single touch and test for its polarity. iii) In groups, learners hold a magnet that has attracted a chain of small nails or pins and use the observation to discuss the concept of magnetic induction. iv) In groups, learners move a magnet repeatedly under a paper on which iron filings are sprinkled and use the observations to discuss magnetic fields.	1. Task learners to test for the presence of magnets. Assess how learners arrange their apparatus and how they state/write the procedure and observations. 2. Ask learners to draw diagrams to show the magnetic domains of a magnetised and un-magnetised metal bar and use this to explain the process of magnetisation and magnetic saturation. 3. Task learners sketch magnetic field patterns for two bar magnets arranged in various ways.

Hint to the Teacher

i) Only field lines around magnets should be drawn.
ii) Magnetic field lines around current carrying conductors shall be introduced in the next sub-topic.
iii) Concept of magnetic and geographic meridians should be left out.

References

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3. Wilson, M. & Daniel, R. (2004). Comprehensive Secondary Physics (Form 2), Pg 1-12, Oxford University Press

Sub-topic 5: Electromagnets and their Applications

Duration: 6 Hours

Competency

The learner explores the interaction between magnetic fields and electric fields and how this interaction is applied.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. explain the meaning of electromagnet. b. demonstrate the existence of a force on a current-carrying conductor in a magnetic field. c. investigate the factors which affect the size of the force on a current-	i) In groups, learners carry out an activity to demonstrate the existence of a force around a current-carrying conductor in a magnetic field and how this force can be varied. ii) Learners with	1. Observe how individual learners draw a diagram to show the magnetic field: a) around a wire carrying an electric current in a magnetic

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
carrying conductor placed in a magnetic field. **d.** investigate the direction of force on a current carrying conductor in relation to the direction of current and magnetic field. **e.** sketch magnetic field patterns around current carrying conductors in various situations. **f.** describe the construction and operation of electric bell, d.c. motor, and loudspeakers.	guidance from the teacher, carry out an activity to investigate the direction of force on a current-carrying conductor in relation to the direction of current and magnetic field. **iii)** Guided by the teacher, learners construct an electric bell and a d.c. motor and describe how they operate.	field. b) around a solenoid carrying an electric current 2. Task learners in a group project to design an electric bell using readily available materials and describe how it works.

Hint to the Teacher

The effect of magnetic field on a current carrying conductor should be investigated practically.

References

1. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2016). Longhorn Secondary Physics (Senior 2) Pg 118-127, Longhorn
2. Wabwire, H. C., Sekkoba, A. S., Kasirye, S & George, W. S. (2013). Secondary Physics Student's Book 2, Pg 91-100, MK Publishers Limited
3. Wilson, M. & Daniel, R. (2004). Comprehensive Secondary Physics (Form 2), Pg 4-58, Oxford University Press

Sub-topic 6: Electromagnetic Induction

Duration: 4 Hours

Competency

The learner investigates how electricity is obtained from magnets and the applications of this phenomenon.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. demonstrate electromagnetic induction. b. investigate the factors that determine the size of the e.m.f/current induced in a conductor in a magnetic field. c. describe the construction and operation of simple forms of a.c. and d.c. generators. d. sketch a graph of voltage output against time for a simple a.c. and d.c. generators. e. describe the structure and principle of operation of a simple transformer. f. explain why practical transformers are not 100% efficient. g. solve numerical problems related to transformers. h. describe the transmission of electricity from the station to the consumer and deduce the advantages of high voltage transmission.	i) In groups and with guidance from the teacher, learners carry out an activity to demonstrate that current/e.m.f is induced in a conductor in a magnetic field and show how to vary the current/e.m.f. ii) In groups or as individuals, learners construct a simple transformer and describe how it works. iii) In groups, learners discuss the importance of each of the components of the electricity transmission line. iv) In groups, learners search for cases of accidents	1. Task learners in groups to discuss the difference between a step-up and a step-down transformer. Assess how learners identify instances where both are applied. 2. Task learners to calculate the output voltage of a transformer that has 50 turns on the primary coil and 500 turns on the secondary coil if the primary coil is connected to a 240 V supply. Observe how learners make the right substitution in the right formula and how they simplify the expressions. 3. Task learners to analyse the uses of the components of a

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
	resulting from high voltages in the recent past.	power transmission line.

Hint to the Teacher

i) Engage learners in simple projects involving the construction of a simple d.c. generator and a transformer.
ii) The stepping up and down of a transformer should be demonstrated

References

1. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2016). Longhorn Secondary Physics (Senior 4) Pg 132-171, Longhorn.
2. Wilson, M. & Daniel, R. (2010). Comprehensive Secondary Physics (Form 4), Pg 46-60, Oxford University Press.

Topic 7: Modern Physics

Duration:

Sub-topic 1: Atomic Structure

Duration: 4 Hours

Competency

The learner describes the fundamental particles in an atom and their arrangement.

Learning Outcomes	Suggested Teaching and Learning Activity	Sample Assessment Strategy
The learner should be able to: a. name the fundamental atomic particles and state their properties. b. explain the models of the atom according to Dalton and Rutherford (include electronic configurations). c. explain the meaning of atomic number, mass number and isotopes and represent different nuclides.	In groups, learners use ICT or other sources to search for the Rutherford model and write a report about his work in relation to the structure of the atom.	Task learners to use local materials to make a design of a Rutherford model of an atom whose atomic number is 8, 10 and 20. Assess how the learners plan the activity and how they communicate.

Hint to the Teacher

Engage learners in a variety of activities involving mass number, atomic number and isotopes.

Reference

Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2015). Longhorn Secondary Physics (Senior 4) Pg 208-209, Longhorn

Sub-topic 2: Cathode Rays and X-rays

Duration: 6 Hours

Competency

The learner describes how electrons are emitted from matter and the applications of the emitted electrons.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategy
The learner should be able to: a. explain the meaning of thermionic emission and photoelectric effect. b. state properties of cathode rays. c. describe the structure of a cathode-ray oscilloscope (CRO) and explain how it works. d. describe the uses of CRO. e. describe how X-rays are produced in an X-ray tube. f. describe properties and applications of X-rays. g. explain the dangers of exposure to X-rays and the safety precautions.	i) Learners watch simulations about the thermionic emission and photoelectric effect and make a report. ii) In groups, learners discuss best safety practices against the effects of X-rays.	Ask individual learners to write an article explaining the dangers associated with the use of X-rays. Assess how the learners communicate confidently and the values they develop in advising the public.

Hint to the Teacher

i) Experiments showing that photoelectric effect and thermionic emission occur are required.
ii) Laws of photoelectric effect are **NOT** required.
iii) Numerical problems related to acceleration of electrons are beyond this level.
iv) The use of illustrations/diagrams/computer simulations should be used as much as possible

References

1. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2015). Longhorn Secondary Physics (Senior 4) Pg 176-206, Longhorn

2. Wilson, M. & Daniel, R. (2010). Comprehensive Secondary Physics (Form 4), Pg 72-94, Oxford University Press

Sub-topic 3: Radioactivity

Duration: 8 Hours

Competency
The learner explores how nuclear processes occur, their applications and dangers.

Learning Outcomes	Suggested Teaching and Learning Activities	Sample Assessment Strategies
The learner should be able to: a. explain the meaning of radioactivity. b. identify the three types of the radiations emitted from radioactive substances and their properties. c. write balanced equations for nuclear reactions. d. describe how nuclear radiations can be detected using a cloud chamber and electric fields. e. explain the meaning of half-life and solve numerical problems related to half-life (including graphical methods). f. explain nuclear fission and fusion and their applications. g. identify the applications of radioisotopes. h. state the dangers of radioisotopes and the associated safety measures.	i) In a group discussion, learners compare the three radiations emitted by radioactive materials. ii) In groups, learners discuss the social, health, political and environmental dimensions associated with the use of radioactive materials.	1. Ask learners to sketch a graph to show how the activity of a radioactive source changes over time until it almost ceases to be radioactive. Also show how the graph can be used to determine half-life. 2. Task learners to explain why radioactive waste presents a serious environmental problem. In a conversation, assess how learners approach this global issue. 3. Task learners to copy and complete the diagram in the Figure below this table to show the different penetrating powers of three types of radiation. Ask learners explain the basis of their answers.

Hint to the Teacher

i) Calculation of half-life should only be based on simple decay series or graph but **NOT** the decay law formula.

ii) Use a variety of sources to discuss the accidents and dangers posed by radioactive materials.

References

1. Balaram, K., Kariuki, C., Waweru, E., Masika, M., & Mutisya, I. (2015). Longhorn Secondary Physics (Senior 4) Pg 208-229, Longhorn

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Appendix

A list of equipment /apparatus that will support the teaching and learning of the AEP Physics Syllabus is provided below. However, even improvised apparatus can be used to support the teaching of Physics in some instances.

1. Slotted masses on hangers (5g, 10g, 20g, 50g and 100g)
2. Ammeter (0-1.0A) and (0-5.0A)
3. Bunsen burners / stoves
4. Diverging / concave lenses (focal length 10, 15 and 20 cm)
5. Converging / concave mirrors (focal length 10, 15 and 20 cm)
6. Connecting wires
7. Constantan wires (SWG, 20, 22, 24, 26, 28, 30 and 32)
8. Convex / converging lens (focal length 10, 15 and 20 cm)
9. Copper calorimeters (150 ml, 200 ml and 300 ml)
10. Crocodile clips
11. Convex / diverging mirror (focal length 10, 15 and 20 cm)
12. Galvanometers (centre zero)
13. Glass blocks (rectangular 11 x 6 x 2 cm)
14. Metre rules/half metre rules
15. Measuring cylinders (10 ml, 25 ml, 100 ml, 250 ml, and 1000 ml)
16. Nichrome wires (SWG 22, 24 and 26)
17. Optical pins
18. Pendulum bobs
19. Plane mirrors
20. Plasticine
21. Glass Prisms (60° x 60° equilateral and right angled)
22. Retort stands and clamps
23. Rheostats (0 – 50Ω)
24. Spiral spring (Nuffield type)
25. Spring balances
26. Standard resistors (1, 2, 3, 5 and 10Ω)
27. Stop clocks / watches
28. Contact switches
29. Thermometers (-10° - 110°C)
30. Tripod stands
31. Voltmeters (0 – 3.0V) and (0 – 5.0V)
32. Wire gauzes
33. Soft boards
34. Bulb holders
35. Touch bulbs
36. Thumb pins
37. Threads

38. Cell holders (single and double)
39. Glass beakers (100 ml, 150 ml, 500 ml and 600 ml)
40. Wooden blocks (various sizes)
41. Pulleys (Single and double)
42. Wedges / knife edge
43. Magnets and plotting compass
44. Chemical balance
45. Keys (contact and tapping)
46. Copper wire (SWG 20 -30)
47. Capillary tubes (siameter 0.5 – 4.0 mm)
48. Test-tubes, test tube racks and test tube holders
49. Lead shots / ball bearings
50. Calorimeters jackets
51. Stirrers (Aluminium, Copper and Glass)
52. Wooden corks (various sizes)
53. Glass marbles
54. G-clamps
55. Dry cells
56. Rubber bungs (various sizes)
57. White screens
58. Screens with a hole fitted with wire gauge
59. Lens / mirror holders
60. Plastic beaker / mugs (250 ml)
61. Boiling tubes
62. Burettes (50 ml)
63. A torch
64. A globe

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