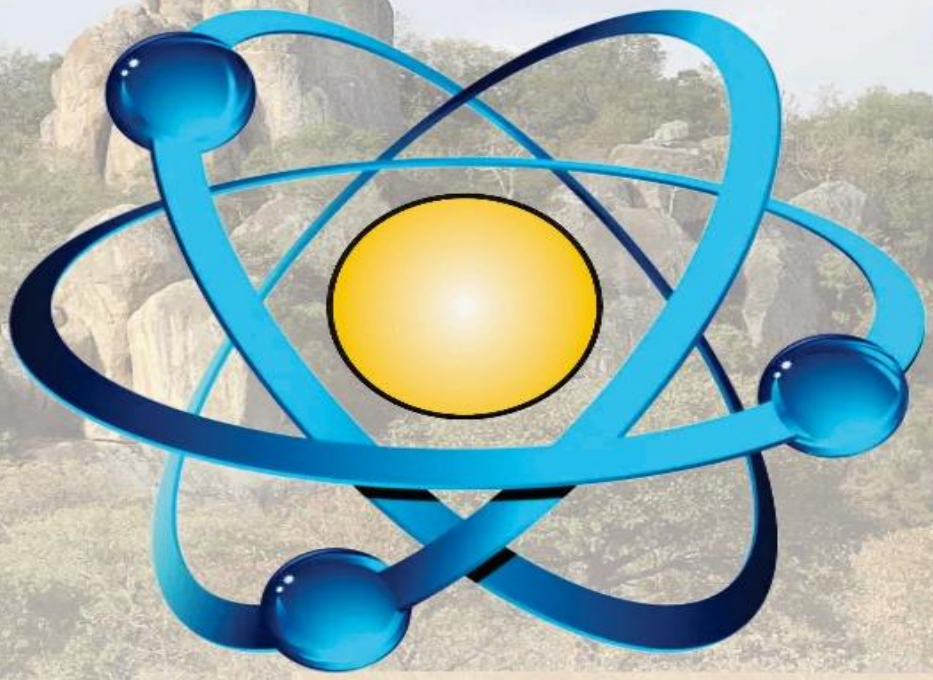
ZIMBABWE

Ministry of Primary and Secondary Education



PHYSICS

SYLLABUS

2024-2030

FORMS 3 - 4

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1.0 Preamble

1.1 Introduction

The forms 3 - 4 Physics syllabus is designed to put greater emphasis on the heritage based technological concepts acquired through a hands-on learner centred approach. The syllabus is hinged on the rich cultural heritage of our community and focuses to stimulate interest, imagination and critical thinking. Traditional scientific knowledge and modern innovations are used to connect scientific concepts to everyday lives and global challenges through hands on activities. By integrating physics syllabus with cultural relevant, learners are empowered to investigate, innovate, solve problems and become informed, responsible citizens who appreciate our heritage and promote sustainable development. The learners will be assessed through a continuous assessment system in the form of project-based assessments, hands on experiences and demonstrations.

1.2 Rationale

The Heritage-Based Physics syllabus provides an integration of traditional knowledge and contemporary technologies learners will develop essential critical thinking, problem solving and collaborations skills through hands on enquiry-based learning to apply scientific principles to real world challenges and impact the society positively. The syllabus fosters responsible stewardship of natural resources and cultural heritage.

1.3 Summary of Content

The Physics syllabus emphasizes integrating heritage-based knowledge into secondary education and supports diversity. The syllabus covers various topics aimed at fostering a deep connection with cultural roots while promoting scientific curiosity and technological skills. It encourages hands-on, learner-centred activities such as constructing, drawing, designing, programming, promoting critical thinking and problem-solving skills. The syllabus also addresses cross-cutting themes like digital competencies, climate change and disaster risk management, ensuring a holistic approach to learner development. Continuous assessment is based on academic performance, projects, presentations and observations to evaluate the understanding of both the scientific and cultural aspects of the learning area.

1.4 Assumptions

The Heritage-Based Physics syllabus for Zimbabwe has taken deliberate consideration of several assumptions critical for socio-economic transformation. The assumptions are based on the context of Zimbabwe's heritage, educational system, societal needs and aspirations. It therefore becomes critical to consider that learners:

- are exposed to scientific experiences
- live in diverse social contexts
- use technological devices
- are conscious of their environment
- are aware of their obligation towards health and well-being

The general assumption is that a Heritage-Based Physics syllabus can effectively integrate science and technology education, fostering a deeper understanding of scientific concepts, technological innovations and their relationship with Zimbabwe's heritage.

1.5 Summary of content

Forms 3 - 4 Physics syllabus will cover theory, projects and practical activities in the following areas:
Newtonian Mechanics, Dynamics, Waves, Electricity and Electromagnetism, Thermal Physics and Modern Physics.

1.6 Cross- Cutting Themes

This phase will develop an appreciation of:

- Environmental management
- Enterprise Education
- Gender Equality
- Climate Change
- Child rights and responsibilities
- Health and wellbeing
- Disaster risk management
- ICT

1.7 Assumptions

It is assumed that:

- the learner has successfully completed Form 1 and 2 Science syllabus
- Science clubs are existing and operational in schools
- use of ICT for research and presentation is known by learners
- use of measuring instruments such as rulers, balances, second-hand clocks, voltmeters, ammeters and thermometers is known by learners
- safety measures are available

2.0 PRESENTATION OF THE SYLLABUS

The Ordinary Level Physics syllabus is a single document covering Forms 3 - 4. It contains the Preamble, Aims, Syllabus Objectives, Syllabus Topics, Methodology and Time Allocation, Scope and Sequence, Competency Matrix and Assessment. The Scope and Sequence chart shows the progression of topics from Forms 3 - 4, while the syllabus matrix gives details of the content to be covered.

3.0 AIMS

The aims are to:

3.1 create opportunities for learners to acquire research, experimental and practical skills and attitudes in Physics.

3.2 enable learners to acquire basic principles of Physics for application in life and as a basis for further studies in Physics and related disciplinee.

3.3 inculcate in learners the desire to apply Physics for the benefit of society as guided by the principles of Unhu/Ubuntu and recognising the detrimental effects of misapplication of Physics.

3.4 inculcate in learners the appreciation of the usefulness of ICT in the study and application of Physics

3.5 develop, in learners the appreciation of the use of Physics in value creation, addition and beneficiation in mining and other industries.

3.6 inculcate in learners the regard for safety and protection of the environment in the study of Physics.

3.6 introduce learners to the principles of science and technology, through a heritage-based approach.

3.7 incorporate indigenous knowledge, cultural practices, historical perspectives and national endowments into science and technology education.

3.8 foster an understanding of the learning area matters and promoting cultural appreciation in its diverse nature.

4.0 OBJECTIVES OF THE SYLLABUS

Learners should be able to:

4.1 follow instructions in practical work in order to manipulate record observations and analyse data to confirm or establish relationships.
4.2 demonstrate knowledge about physical phenomena, facts, laws, definitions and concepts of Physics.
4.3 measure and express physical quantities in SI units to a given level of accuracy and precision.
4.4 solve problems using calculations
4.5 generate and transform information in Physics, from one form to another for presentation, interpretation and problem solving.
4.6 design a practical solution through a Physics project to solve a real-life problem.
4.7 use ICT to simulate Physics phenomena, present and analyse Physics data.
4.8 apply safety measures in all practical work.
4.9 explore the connections among heritage, science and technology.
4.10 explain and apply procedures in Physics to protect the environment.

5.0 METHODOLOGY AND TIME ALLOCATION

SUGGESTED METHODS

It is envisaged that teaching and learning programmes based on this Heritage based Physics syllabus shall create a wide variety of learning experiences designed to promote acquisition of scientific expertise and understanding, and to develop values and attitudes relevant to science and life. Ortho-didactic principles, such as visual tactile, simulation and self-activity, will be applied when need arises to cater for diverse needs of learners. Teachers are encouraged to use a combination of appropriate strategies to effectively and equitably engage and challenge their learners through:

- Planned experiments
- Problem based learning
- Individual and group work
- Educational tours

- Project based learning
- Design based learning
- Learning by discovery
- E-learning such as simulation
- Collaboration with museums and heritage sites.

TIME ALLOCATION:

A minimum of **8** periods of 40 minutes each in a week should be allocated as double periods for adequate coverage of the syllabus

TOPICS

6.1 Measurement and Physical Quantities
6.2 Kinematics
6.3 Forces
6.4 Work, Energy, and Power
6.5 Machines
6.6 Robotics
6.7 Mechanical Structures
6.8 Thermal Physics
6.9 Internal Combustion Engines
6.10 Waves
6.11 Electricity
6.12 Magnetism
6.13 Electromagnetism
6.14 Electronics
6.15 Atomic and Nuclear Physics

7.0 SCOPE AND SEQUENCE CHART

FORM 3 AND FORM 4

TOPIC	FORM 3	FORM 4
1.0 MEASUREMENT AND PHYSICAL QUANTITIES **1.1 Measurements**	• Measurement of physical quantities. - Base quantities - Derived quantities • S.I. units	• Experiments to measure voltage, current and determine resistance for ohmic conductors
1.2 Scalars and vectors	• Definitions and examples • Resultant of coplanar vectors using graphical method • Definitions of terms • Applications	
2.0 KINEMATICS **2.1 Speed, velocity, displacement and acceleration**	• Definitions of terms • Equations of linear motion and application	
2.2 Graphs of motion	• Drawing and interpretation of graphs	
2.3 Motion under gravity	• Definition of free fall • Calculation	
3.0 FORCES **3.1 Effect of force on materials**	• Types of forces • force extension-graphs / Hooke's	• Application of forces on beam, trusses and mechanical large structures
3.2 Effect of force on motion	• Definitions of weight, momentum, inertia • Newton's laws of motion • Friction • Circular motion	

TOPIC	FORM 3	FORM 4
3.3 Turning effects of a force	• moment of a force • Principle of moments	
3.4 Centre of mass/centre of gravity	• Centre of mass • Centre of gravity • stability	
3.5 PRESSURE	• Pressure in solids • Pressure in fluids • Hydraulic systems	
4.0 WORK, ENERGY AND POWER **4.1 Work**	• work done	
4.2 Energy	• Types and sources of energy • Law of conservation of energy • Energy conversion • Calculations involving energy	
4.3 Power	• Mechanical power	.
5.0 MACHINES **5.1 Simple machines**	• Simple machines: -inclined plane -levers -pulleys -gears Mechanical advantage velocity ratio and efficiency.	
6.0 ROBOTICS	• Sensors and actuators • Logic gates • Tools and application for robot design • Robot construction • Robot programming	

TOPIC	FORM 3	FORM 4
4.0 MECHANICAL STRUCTURES	• Beams and trusses • joining materials • large structures	
8.0 THERMAL PHYSICS **8.1 Kinetic theory of matter**	• States of matter and their physical properties • Brownian motion • Gas laws	
8.2 Thermal properties	• Thermal expansion and contraction in solids and fluids	• heat capacity and specific heat capacity • latent heats • Measurement of temperature
8.3 Heat transfer	• Modes and mechanisms of heat transfer and their application • Experiments on modes of heat transfer	
9.0 INTERNAL COMBUSTION ENGINES		• four stroke Petrol and diesel engine • the carburettor • The computer • multiple cylinders in an engine
10.0 WAVES **10.1 Wave properties**	• wave properties and characteristics	
10.2 Sound	• Production of sound waves • Experiments to determine speed of sound	
10.3 Electromagnetic waves	• Electromagnetic spectrum • Applications of electromagnetic waves	
10.4 OPTICS		• Ray diagrams -reflection - refraction • lenses • dispersion of light

TOPIC	FORM 3	FORM 4
11.0 ELECTRICITY **11.1 Electrostatics**		• types of charges • electric field lines • laws of charges • methods of charging • applications of electrostatics • hazards and safety precautions
11.2 Primary and Secondary cells		• primary cells • secondary cells
11.3 Current electricity		• Circuit components and their symbols • Circuit diagrams • Ohm's law • I-V characteristic graphs • Resistors
11.4 Electricity in the home		• The three pin plug • Two pin plug • Electrical costing • Electrical safety and precautions
12.0 MAGNETISM **12.1 magnetic properties**		• Magnetic properties and interactions • Magnetisation and demagnetisation • Application of magnetism
13.0 ELECTROMAGNETISM **13.1 magnetic effect of an electric current**		• Field patterns • Right hand rules •

TOPIC	FORM 3	FORM 4
13.2 force on a current carrying conductor in a magnetic field		• Flemings left hand rule • Motor effect • Applications
13.3 electromagnetic induction		• Flemings right hand rule • The generator principle • Lenz's Law • Application
13.4 Transformers		• Transformer principle • Transformer efficiency • AC transmission and power losses
14.0 ELECTRONICS **14.1 Thermionic emission**		• Cathode ray tubes • CRO
• **14.2 Electronic components**		• Electronic components
14.3 Logic gates		• Circuit symbols • Construction of truth tables
15.0 ATOMIC AND NUCLEAR PHYSICS		
15.1. Atomic model		• Description of an atomic model • Isotopes
15.2 Radioactivity		• Types of radioactive emission and their characteristics • Use storage handling and impact of radioactive emission

8.0 COMPETENCY MATRIX

FORM 3

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITIES AND NOTES	SUGGESTED RESOURCES
1.0MEASUREMENTS AND PHYSICA QUANTITIES **1.1Measurements**	• measure physical quantities; read an instrument scale to the nearest fraction of a division; determine density; • express quantities in terms of S.I. units; • derive other units from base units	• Length, area, volume, mass, time, temperature • Liquids, regular, irregular objects • S.I. units Newton, joule watt, volt and others	• Conducting experiments on measuring: length, time, mass, temperature, volume. • Determining area and volume • Determining density experimentally for liquids, regular and irregular objects • relating density to flotation and sinking deriving units from base units	• A ruler, vernier callipers, thermometer, balance stop-watch, micro meter screw gauge, measuring cylinder, force meter
1.2 Scalars and vectors	• distinguish between scalar and vector quantities; • Determine resultant vectors.	• Scalars and vectors • Two coplanar vectors	• Giving examples. • Using graphical method to determine resultant vector	• Mathematical sets, graph books, geo-board, ICT simulation

TOPICS	OBJECTIVES Learners should be able to:	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITIES AND NOTES	SUGGESTED RESOURCES
2.0 KINEMATICS **2.1 Speed, Velocity and Acceleration**	• define displacement, speed, velocity and acceleration	• Displacement, speed, velocity and acceleration	• experimenting with a ticker tape timer or any other method	• ticker timer and tape electronic speed detector
2.2 Graphs of motion	• plot, draw and interpret graphs of motion; • determine acceleration, speed and distance from graphs;	• Distance time graph • Speed time graph • slope of graphs: positive or negative acceleration • Area under graph: distance	• Determining distance travelled using speed time graphs. • Determining acceleration, speed and distance from graphs.	• Projector
2.3 Motion under gravity	• define free-fall. • describe qualitatively the motion of bodies falling in a uniform gravitational field • determine acceleration of free fall	• Free-fall • Terminal velocity • Velocity time graph of free fall.	• Conducting experiments on free fall • solving problems.	

CONTENT (knowledge, skills, values and attitudes)	CONTENT (knowledge, skills, values and attitudes)	CONTENT (knowledge, skills, values and attitudes)	CONTENT (knowledge, skills, values and attitudes)	CONTENT (knowledge, skills, values and attitudes)
8.0 FORCES **3.1 Effect of force on shape and size of materials.**	• explain the effects of a force on size an d shape of material plot, draw and interpret extension load graphs • explain Hooke's Law; • Calculate spring constant.	• Deformation of solids • Tension and compression • Hooke's Law • Spring constant	• demonstrating Hooke's Law practically. (**Treatment up to limit of proportionality in simple calculations**) • Determining spring constant. • Simulating spring-mass systems	• Foam rubber, springs, modelling putty, elastic bands, masses and mass hangers • Computers.
3.2 Effect of force on motion	• define weight, momentum and inertia; • Explain each of Newton's three laws of motion. • use relation between force, mass and acceleration	• Weight, momentum, inertia; F = ma, p = mv	• Discussing weight, moment and inertia **(Limited to linear motion -**Conservation of momentum is not required). • discussing Newton's three laws of motion • Experimenting on forces changing state of motion.	• Trolleys, force meters, masses, computers, air tracks, polished surfaces • Computer simulation.

3.3 Friction and circular motion	• explain the effect of friction on the motion of a body. • Describe the ways in which force may change the motion of a body; • describe qualitatively motion in a curved path due to a perpendicular force	• Friction • Methods of reducing friction. • Centripetal force. • Centripetal acceleration.	• demonstrating experiments on friction (No reference to static and dynamic co-efficient of friction) • discussing advantages and disadvantages of friction. • Demonstrating circular motion	• Trolleys, masses, computers, air tracks, polished surfaces, rough surfaces, oil/grease surfaces • Inextensible strings, bobs/plumb-line
3.4 Turning effect of a force	• define moment of a force • describe the moment of a force in terms of its turning effect and give everyday examples • perform an experiment to verify the principle of moments. • make calculations involving the principle of moments	• Moments, principle of moments • Turning effect of a force	• Illustrating using everyday examples • Verifying the principle of moment practically	• Doors, levers, wheelbarrows, crowbar, strings, masses, supporters, stands, bars, retort stands, beams

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITIES AND NOTES	SUGGESTED RESOURSES
3.5 Centre of mass	• define centre of mass; • determine the centre of mass of a plane lamina; • describe qualitatively the effect of the position of the centre of mass on the stability of objects	• Centre of mass • Centre of gravity • Regular and irregular lamina • Stable, unstable and neutral equilibria.	• Determining position of centre of mass of regular and irregular lamina and other objects experimentally. • Demonstrating stable, unstable and neutral equilibrium experimentally.	• Irregular laminas, plumb line / bob + string, support stands. • Cones, cubes, chairs • ICT Tools
3.6 Pressure	• define pressure; • calculate pressure • calculate pressure in fluids • Describe the effects of depth of pressure • Describe atmospheric pressure • Use bar patterns to predict type of weather strength and direction	• definition of pressure • P = F/A	• demonstrating pressure due to different surface areas • Calculating pressure of solid objects using appropriate units.	• Cuboids, regular blocks of wood, balances, metre rule

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITIES AND NOTES	SUGGESTED RESOURSES
	• manometer describe effect of depth on pressure; • describe atmospheric pressure; • use bar patterns to predict type of weather including wind strength and direction; • describe the construction and use of a barometer; • describe the construction and use of a simple manometer	• Pressure in fluids $P=\rho gh$ • Atmospheric pressure • Pressure cooker • Weather patterns • Manometer • Applications and hazards	• demonstrating variation of pressure with depth experimentally • demonstrating atmospheric pressure • Analysing simple treatment of the barometer weather charts • Calculating problems on the manometer • hydraulic systems • water reticulation	• Manometer and liquid containers • Magdeburg hemisphere • Drinking straws • Rubber suckers • Pressure cooker
9.0 **WORK, ENERGY AND POWER** **4.1 Work**	• define work done; • calculate work done	• Work done;	• Carrying out experiments to illustrate work done Work = Force x distance	Force metres, wooden block, metre rule, stop watch, pulleys, and inclined planes.

4.2 Energy	• define energy; • describe forms and sources of energy • relate energy conversions and work done	• Energy Sources • Law of conversions of energy • Energy conversions • Calculations involving energy and work • Safe disposal of batteries and accumulators	• Naming forms of energy and their sources (Heat, light, sound, electrical, chemical kinetic gravitational potential and nuclear energy) • Listing sources of energy, including renewable and non-renewable. • Giving relation between energy and work • Calculating problems in energy	• Wooden blocks • Batteries, cells, chemicals, metals Generator/turbines • Solar cells/panels, solar chargers, solar water heater systems • Academic trips to hot springs e.g. Chimanimani hot springs • Computer simulations
4.3 Mechanical Power	• define power; • relate power to rate of energy transferred • perform calculations involving power	• $\text{Power} = \frac{\text{Energy}}{\text{Time}}$ • $\text{Power} = \frac{\text{Work done}}{\text{Time}}$ = Fv	• calculating power	• Electric motor, meter rule, stop watch, load, string, block of wood, • Force meter

5.0 MACHINES 5.1 Simple machines	• describe the use and application of machines; • calculate mechanical advantage and velocity ratio and efficiency of levers and pulley system • explain energy losses in machine • describe methods of improving efficiency	• Levers, single string pulley systems, inclined plane: MA = Load / Effort; VR = Distance moved by the effort force/distance moved by the load force. • Friction and mass of the machine. • Lubrication and mass reduction • Ball bearings • Smooth surfaces	• Classifying levers is <u>not</u> required. **(Calculations limited to levers, pulley systems)** • Experiments to measure efficiency	• Pulleys, inclined plane, levers, force metre, metre rule, loads and masses
6.0 **ROBOTICS** 6.1Principles of robotic systems - Sensors and actuators	• Identify sensors and actuators • Explain the functions of the sensors • Describe function of actuators	• Temperature sensors, ultrasonic sensors, light sensor, pressure sensor, proximity sensor, • Actuators - electric, -hydraulic • - pneumatic	• Identifying sensors and actuators • Discussing functions of sensors and actuators	• ICT tools • Robotic kits • Resource persons • Braille/jaws software • ICs
6.2 robot design methodologies	• Identify tools and applications for robot design • apply tools and applications for robot design	• CAD tools, simulation software, micro controllers (ESP32, ESP8266 and Arduino)	• Computer simulating and coding (scratch) • Writing structured programs to control	• ICT tools • Robotic kits • Resource persons • Braille

			robots for defined tasks	
6.3 Robot construction and programming	• Construct and code	• Robot design and construction	• Constructing robots	• ICT tools • Robotic kits

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITIES AND NOTES	SUGGESTED RESOURCES
7.0 MECHANICAL STRUCTURES **7.1 Beams**	• define a beam • describe a beam by its cross-sectional area; • compare the strength of beams; • explain the effects of push and pull forces; • explain how stress is distributed in a loaded beam;	• Beams • Types of Beams • Qualitative relation between strength, cross-sectional shape and depth. • Compression, tension, shear and buckle • Compression, tension and natural zones. Internal stress, areas of strength and weakness.	• Listing types of beams • demonstrating crushing, compressing, buckling and bending, stretching and snapping	• Different types of Beams, • Beams, supports and loads • Beams of different area sections; T, L, I, W etc. beams, wooden splits • Metre rules, supports, loads • Foam rubber, elastic bands, glass rods, load/stress • Hollow stems, green twigs, foam rubber
7.2 Trusses	• construct a trusses • explain the use of triangles in a truss; • explain the advantages of trusses over beams;	• Trusses. • Stability. • Economy, strength and strength/mass ratio. • Compressive and tensile forces.	• determining which members are under tension and which are under compression. • Constructing models	• Beams, pins, nails, loads, retort stands, pivot, metre rule • Trusses on buildings • Laboratory models of trusses using wooden splints
	• explain how a load can be distributed throughout a truss; • identify struts and ties in a truss;	• Transmission of forces by connecting members.	•	

	• explain the design of a roof truss;	• Distribution of load		
7.3 Joining materials	• describe methods of joining materials; • compare the strength of joints	• Joining mechanisms; - Pinning: - Surface contact: • Size of contact area, number and position of pins.	• Making and testing strength of joints • Gluing with or without dowels and tongue; • Soldering, brazing and welding; Plastics – welding and gluing.	• Wooden, metallic and plastic materials/beam, screws, nails and bolts; bolts and rivets; • Glue • Joints

7.4 Large structures	• identify materials used in large structures; • compare properties of construction materials; • explain the design and materials used in different types of bridges; • explain the use of arches in construction of large structures; • explain composition and shape of dam walls.	• Wood, metal, concrete and stone. • Compressive and tensile strength, mass and durability. • Pier bridge and Beam bridge, Arch bridge, and Suspension bridge. • Earth and concrete; straight and arch dams.	• Identifying materials used in large structures • Comparing properties of construction of materials • Comparing durability in relation to decay, corrosion and rusting. • Constructing and loading of models (No knowledge of material cost is required but an appreciation of both durability and cost as factors in determining choice) Identifying materials which make dam walls	• Metals beams, wooden beams, cement, concrete, reinforce concrete beams, quarry stones, gravel, sand • Wooden splints, sand, stones, gravel, clay soil • ICT Tools
8.0 THERMAL PHYSICS **8.1 The kinetic theory of matter**	• apply the kinetic theory of matter to describe the particle arrangement of matter • explain the physical properties of matter; • explain qualitatively in terms of particles the relationship between:	• Brownian motion. • Solids, liquids and gases. • Charles's law • Boyle's law	• demonstrating change of state including sublimation • Discussing physical states of matter. • Explaining the effect of temperature in change of state. • Demonstrating Boyle's law	• Kinetic theory model kit • Brownian motion model kit • Chalk/dust • 2 large syringes communicated by rubber tubing, warm water, thermometer, manometer • Ice water in a beaker, source of heat, thermometer

	- pressure and temperature at constant volume - volume and temperature at constant pressure - pressure and volume at constant temperature • apply equation $P_1V_1/T_1 = P_2V_2/T_2$ in solving gas problems.	• Graphical representation of gas laws • Charles' Law $P_1V_1/T_1=P_2V_2/T_2$	• Discussing Charles' and Pressure laws	• Perfume, bromine, smoke • Charles' law apparatus • Boyle's law apparatus
8.2 Thermal Properties	• compare qualitatively order of magnitude of expansion of solids, liquids and gases; • explain applications and consequences of thermal expansion and contraction; • describe how a physical property which varies with temperature may be used for measurement of temperature. • state such properties; • state the need for and identify fixed points;	• Thermal expansion and contraction. • Thermostats, thermometers, bridges, railway lines and electrical cables, etc. • Measurement of temperature, fixed points liquid in glass thermometer (laboratory and clinical), thermocouple thermometer, advantages	• comparing expansion and contraction in solids, liquids and gases. • Experimenting with different thermometers • demonstrating expansion and contraction of matter. • Determining melting point and boiling point experimentally and graphically. • drawing heating and cooling curves. • Demonstrating influence of	• Ball and ring experiment, gouge and bar, empty flask fitted with a rubber stopper with a glass tubing, warm water, cold cloth. • Flask filled with water fitted with a rubber stopper with a glass tubing and warm water and ice water in a bowl. • Thermostats, thermometers, bimetallic strips • Calorimeter, elements, solids, water, thermometers, balance • Flat bottomed flasks, tongs

	• describe sensitivity range and linearity; • describe different types of thermometers; • define and describe melting and boiling in terms of energy transfer without change of temperature; • describe the effect of impurities and pressure on melting points and boiling points of substances	and disadvantages • Melting and boiling. • Latent heat • Impurities and pressure	atmospheric pressure and impurities on melting points and boiling points experimentally	
	• determine the specific heat capacity of a liquid and a solid; • calculate the heat capacities of objects from experimental data; • explain why different materials have different heat capacities • define specific latent heat;	• Definition of specific heat capacity(c). $\Delta Q = mc(\vartheta_f - \vartheta_i) = IVt$ • Heat supplied = heat gained • Explanation based on particles • Fusion, vaporization	• Determining specific heat capacity by experiments. • Carrying out calculations on specific heat capacity. • Explaining differences in heat capacities. • Determining specific latent heat experimentally. • Calculations involving specific latent heat.	• Calorimeter, elements, solids, water, thermometers, balance

	• calculate specific latent heat;	Heat supplied = heat gained. $\Delta Q = ml$	(**Assumption: No heat is lost or gained to surrounding**).	
8.3 Heat Transfer	• identify good and bad conductors of heat; • describe a molecular account of heat transfer in solids; • relate convection to density changes in liquids and gases;	• Metals, non-metals, liquids and gases • Conduction • Convection	• Distinguishing good and bad conductors of heat. • Demonstrating conduction experimentally • demonstrating convection experimentally.	• Lesley cube/wax Conductor meter • Beaker with water + a colorant i.e. potassium permanganate. • Convection chamber

TOPIC	OBJECTIVES **Learners should be able to**:	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITIES AND NOTES	SUGGESTED RESOURCES
	• describe experiments to distinguish between good and bad emitters/absorbers of infra-red radiation; • deduce that good absorbers are also good emitters; • explain applications of conduction, convection and radiation; • describe the function and design of a solar water heater	• Radiation • Good and bad emitters/absorbers; • Solar cooker and vacuum flask, etc. • Solar water heater	• Experimenting with dull and bright surfaces. • Experimenting with parabolic reflectors. • Demonstrating the operations of a solar water heating system.	• Reflectors, vacuum flask and different surfaces • Parabolic dish, solar water heater • Wax, thermometer, heater, air conditioner
9.0 INTERNAL COMBUSION ENGINES 9.1 Four stroke petrol and diesel engines	• describe the operations of a four-stroke engine; • explain the role of the carburettor; • state the advantage of multiple cylinders in an engine; • compare the operations of a diesel and petrol engine	• Compression, power, exhaust and inlet strokes. • Fuel and air supply • Even firing and power distribution • Ignition methods, relevant efficiency and carbon monoxide production	• Explaining importance of a clean fuel supply, effects of limitation of air supply (choke control, blocked filters) and fuel supply (worn out jets). • Using a model to demonstrate strokes. • Explaining efficiency as measured by fuel economy (kilometres per litre).	• Engine models, • Computer models, carburettor • Spark plugs

TOPIC	OBJECTIVES **Learners should be able to**:	CONTENT **(knowledge, skills, values and attitudes)**	SUGGESTED ACTIVITIES AND NOTES	SUGGESTED RESOURCES
9.2 Social and economic considerations of using fuels	• identify renewable and non- renewable resources; • describe the social and economic implication of using fuels;	• Renewable and non-renewable fuels. • Deforestation, effects of the by-products, pollution. • Safe handling of fuels.	• Identifying renewable and non-renewable resources • fuels	• Wood, charcoal, coal, petroleum, bio gas, ethanol • Candles
10.0 WAVES **10.1 Wave properties**	• describe wave motion; • describe characteristics of a wave; • calculate velocity, frequency and wavelength	• Transverse and longitudinal waves • Amplitude, wavelength, frequency and period T= 1/f, V =fλ • Media for mechanical waves.	• Demonstrating reflection and refraction of wave fronts practically. • Calculating period, velocity, frequency and wavelength of waves. • Carrying out experiments to demonstrate waves	• Springs/slinky, ropes, ripple tanks

	• describe propagation of waves in terms of wave fronts and rays.	• Reflection and refraction wave fronts and rays		

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITIES AND NOTES	SUGGESTED RESOURCES
10.2 Sound	• describe how sound is produced; • describe longitudinal nature of sound waves; • state the approximate range of audible frequency; • explain the need of a medium in the transmission of sound waves; • describe experiments to determine the	• Vibrations • Compressions and rarefactions • Transmission of sound • Speed of sound • Pitch, loudness and quality • Reflection of sound • Applications of echoes • Fishing industries • Depth determination	• Carrying out experiments on sound production. • Carrying out experiments involving transmission of sound in different media. • Determining speed of sound practically. • Carrying out simple experiments to demonstrate echoes. • Carrying out experiments on pitch, loudness and quality **(no treatment of overtones).**	• Tuning forks and simple musical instruments • ICT tools • vacuum pump and electric bell • C.R.O, microphone, signal generator, • Starter gun/wooden block wall, shallow well • CRO, microphone, signal generator.

	speed of sound in air; • relate pitch, loudness and quality of sound waves to amplitude and frequency • describe echoes and their applications.		• Carrying out simple experiments to demonstrate echoes.	
10.3 Electromagnetic waves	• identify the regions of the electromagnetic spectrum in order of wavelength or frequency • state the differences and similarities between electromagnetic waves; • state the uses of the different components of the	• Electromagnetic spectrum • Wavelength, frequency, speed and transmission • Uses of the different components	• Identifying the regions of the electromagnetic spectrum (**No recall of actual wavelengths or frequencies is required**) • Discussing differences and similarities between electromagnetic waves. • Discussing applications of electromagnetic waves in communication cooking, medical field remote sensing	• Mirror, ICT tools, UV and infrared sources, filters, computer

	electromagnetic spectrum			

FORM 4

COMPETENCY MATRIX

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITIES AND NOTES	SUGGESTED RESOURCES
10.4 OPTICS **10.4.1 Reflection of light**	• describe an experiment to illustrate the laws of reflection • use the law: i= r, in reflection;	• Laws of reflection, • Formation of images by plane mirrors. • Ray diagrams	• Carrying out experiments on reflection • Carrying out experiment to find the image of an object • Constructing images formed by a plane mirror.	• Optic kit • ICT tools

	• describe the position and characteristics of an optical image formed by a plane mirror; • perform simple constructions, measurements and calculations;			

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITIES AND NOTES	SUGGESTED RESOURCES
10.4.2 Refraction of light	• state laws of refraction; • describe refraction using ray diagrams; • describe refraction of light through transparent blocks and liquids; • define refractive index; • define critical angle;	• Optically dense and optically less dense media. • Refraction at plane surfaces. $\frac{sini}{sinr} = constant$ • Apparent depth • Ray diagrams • Total internal reflection and critical angle. • Fibre optics	• Carrying out experiments to investigate refraction. • Drawing ray diagrams to illustrate various situations of refraction • demonstrating apparent depth practically • carrying out experiments to determine refractive index. • Experiments to demonstrate total internal reflection. • Demonstrating application of total internal reflection in fibre optics;	• Optic kit • Binoculars, microscope and periscope

	• describe total internal reflection; • describe applications of total internal reflection.	• Glass prisms instruments • Mirage • Straight object in water.		

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
10.4.3 Lenses	• describe the action of a converging lens and diverging lens on a beam of light; • draw ray diagrams to illustrate the formation of real and virtual images	• Converging and diverging lenses, focal point • Nature and position of images	• Carrying out experiments to show convergence and divergence • Carrying out experiments on formation of real and virtual images by converging lens (**No treatment of images formed by diverging lenses is required)**	• Optic kit, camera

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES

	• explain how to measure the focal length of a converging lens; • describe magnification of a converging lens • describe the use of a single lens as a magnifying glass; • describe the use of a single lens to form a real image; • explain the use of lenses in the correction of short and long sight	• Focal length • Magnification $m = \frac{v}{u} = hi/ho$ • Image characteristics • Short and long sights	• Carrying out experiments to measure the focal length of a converging lens.**(no calculations required)** • Demonstrating the action of a magnifying glass.	Optical kit Meter rule Magnifying glass Camera and projector ICT tools
10.4.4 Dispersion of light	• Describe the dispersion of light	• Visible spectrum	• Carrying out experiments on dispersion of light using a glass prism. (**Order of colours to be specified**)	Optic kit and glass prism ICT tools

TOPIC	**OBJECTIVES** **Learners should be able to:**	**CONTENT** **(knowledge, skills, values and attitudes)**	**SUGGESTED ACTIVITIES AND NOTES**	**SUGGESTED RESOURCES**

11.0 ELECTRICITY **11.1 Electrostatics**	• describe experiments to show electrostatic charging • describe forces between charges of static electricity • describe an electric field	• negatives and positive charges. • Unit of charge • The Coulomb • Laws of charges • Force and electric charges	• Carrying out experiments to show electrostatic charging • demonstrating attraction repulsion of charges practically. (**Qualitative treatment only**)	• Van de Graaf generator, gold leaf electroscope, Perspex, ebonite, cellulose • rods/plates, cotton, fur, glass rods

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITIES AND NOTES	SUGGESTED RESOURCES

	• describe the direction of field lines and simple field patterns. • distinguish between conductors and insulators; • explain conductors and insulators; explain separation by induction; • describe natural phenomena of static electricity. • Describe applications and hazards of electric charges.	• Field lines and field patterns • Conductors and insulators • Induced charge in conductors • Lightning conductors.	• Drawing diagram to show field -patterns. • Demonstrating inductive charging using electroscopes. • Construction a lightning conductor • Discussing lighting, safety precautions Applications and hazards • Formation, dangers, earthing, shielding.	• Gold leaf electroscope • Lightning conductors/shields • ICT tools

TOPIC	**OBJECTIVES** **Learners should be able to:**	**CONTENT (knowledge, skills, values and attitudes)**	**SUGGESTED ACTIVITIES AND** NOTES	**SUGGESTED RESOURCES**

11.2 Primary and secondary cells **11.2.1 Electromotive force**	• use the concept that the e.m.f is measured by energy dissipated by a source in driving a charge round a complete circuit • differentiate e.m.f and p.d • show an understanding that the volt is given by J/C;	• e.m.f of a cell/battery • cells in series and parallel • difference between e.m.f and potential difference • V=W/Q • The volt	• Listing sources of e.m.f • Explaining the difference between e.m.f and p.d. • Calculating voltage using V=W/Q • Defining the volt	• Power supplies, cells, batteries, rechargeable batteries, accumulators, voltmeter, photo voltaic cells
11.3 Current electricity	• explain the flow of current in a circuit; • use the equation $I = \frac{Q}{t}$ • measure current and voltage; • define potential differences	• Electron flow • Ammeter, ampere, • Conventional direction of current	• Ampere, the volt, milliampere range. • Using a voltmeter to measure p.d. • Using an ammeter to measure current.	• Ammeter, voltmeter, multimeters

TOPIC	OBJECTIVES Learners should be able to	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITES AND NOTES	SUGGESTED RESOURCES

	• use the concept that the sum of the potential differences in a series circuit is the same as the potential difference across the whole circuit; • state and apply Ohm's law; • describe an experiment to determine resistance using a voltmeter and an ammeter; • state the limitations of Ohm's law; • sketch and interpret the I/V characteristics graphs for metallic (ohmic) and non-ohmic conductors.	• Voltage in a series circuit. $V_T=V_1+V_2+$------- • Law of conservation of energy • Resistance $R = V/I$ • Experimental determination of resistance • Thickness and length of a conductors. $R = \rho l/A$	• Carrying out experiments using voltmeter in a series circuit. • Carrying out experiments to verify Ohm's Law and calculations involving Ohm's law. • Carrying put experiments to determine resistance. • Carrying out simple experiments to investigate the limitations of Ohm's law. • Sketching and interpreting I/V characteristics graphs. • Variations of resistance of conductor with temperature (e.g. in a bulb), tension or if placed in a strong magnetic field. • Carrying out experiments to investigate the relationships between R, L and A.	• Carbon Resistors Ammeter, voltmeters, multimeters, sources, leads • Colour code chart • Different swg wires of e.g. Constantine, nichrome, copper, micrometre screw gauge, metre rule

	• Use the relationship between the resistance, length and cross-sectional area of a wire			

TOPIC	OBJECTIVES Learners should be able to	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITES AND NOTES	SUGGESTED RESOURCES
11.4 Electric circuits	• set up simple electric circuits; • draw and interpret circuit diagrams; • use the fact that the current from the source is the sum of currents in the separate branches of a parallel circuit; • calculate resistance in simple circuits;	• simple circuits • I=I1+I2+I3 • $R=R_1+R_2+R_3$ • Series and parallel resistors. $\frac{1}{R}=\frac{1}{R1}+\frac{1}{R2}+--$	• Carrying out Practical activities on electric circuits. • Drawing and interpreting circuit diagrams • Calculating resistance for series and parallel resistors. • Calculations on series and parallel resistors.	• Cells, switches, resistors variable resistors, bulbs, ammeters, voltmeters and fuses, connecting leads. • Circuit boards, fuses, switches, computer

TOPIC	OBJECTIVES Learners should be able to	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITES AND NOTES	SUGGESTED RESOURCES

11.5 Electricity in the home	• describe uses of electricity in the home; • calculate electrical power, energy and the cost of electricity • describe electrical hazards and safety precautions; • describe the wiring of a three-pin plug; • explain the use of a two-pin plug; • explain the use of fuses, fuse ratings and switches;	• Heating, lighting and motors, lamps in parallel • The kilowatt-hour P=VI E=Vlt • Hazards • Safety precautions Live, neutral and earth • Double insulation of appliance	• Discussing and listing uses of electricity in the home. • Reading of electricity meters and costing. • Damaged insulation, overheating cables and damp conditions. • **Experiments demonstrating electrical hazards must NOT be done.** • wiring plug practically. • Examining appliances with double insulation. • Demonstrating the operation of a fuse and a switch. • Explaining why fuses and switches are always on live wire.	• Three-pin plug, two-pin plug, fuses, breakers • Heating elements, electric iron, electric fan, electric motors • ICT tools • Fuses, switches on live wire • Insulated cables, electricity meters

TOPIC	OBJECTIVES Learners should be able to	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITES AND NOTES	SUGGESTED RESOURCES

12.0 MAGNETISM **12.1 Magnetic properties**	• state the properties of magnets; • describe magnetic field lines around magnets; • explain induced magnetism; • describe methods of magnetisation; • describe methods of demagnetisation; • distinguish between magnetic and • non-magnetic materials; • distinguish between the magnetic properties of iron and steel	• Polarity; • Attraction and repulsion • Magnetic field lines Pattern and direction • Induction • Single and double stroking, using a solenoid • Demagnetisation by hammering, heating and electrical methods • Relative ease of magnetisation and demagnetization temporary and permanent magnets.	• Carrying out experiments to investigate properties of magnets. • Plotting magnetic field lines. • Carrying out experiments to demonstrate induced magnetism. • Carrying out experiments to demonstrate magnetisation. • Magnetising and demagnetising pieces of iron and steel.	• Magnets, pocket campus, cell, solenoid/coils, different materials both magnetic and non-magnetic • Iron filings, paper, heat, hammer • Iron and steel rods/cores
12.2Application of magnetism	• describe uses of temporary magnets; • describe uses of permanent magnets.		• Discussing uses of temporary magnets. • Discussing uses of permanent magnets.	• Video and audio tapes, computer discs, electric bell, • Electric motors, loudspeakers, generators, telephone receivers

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITIES AND NOTES	SUGGESTED RESOURCES
13.0 ELECTROMAGNETISM **13.1 Magnetic effect of an electric current**	• describe an experiment to demonstrate that a current-carrying conductor has a magnetic field around it; • describe an experiment to plot magnetic field patterns due to a current-carrying solenoid; • predict the direction of magnetic field of straight conductor and of a solenoid	• Magnetic field patterns • Magnetic field patterns of solenoid • Direction of magnetic field • Right hand grip rule	• Demonstrating field around current-carrying conductor using iron fillings or plotting compass. • Plotting magnetic field due to a solenoid. • Predicting direction of field lines.	• Long straight conductor, solenoids, switch, leads, pocket /plotting campus, cell, DC source,

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITIES AND NOTES	SUGGESTED RESOURCES

13.2 Force on current carrying conductor in a magnetic field	• describe an experiment to show that a current-carrying conductor in a magnetic field experiences a force; • Describe the field patterns between parallel currents and relate these to the forces which exist between the currents; • predict the direction of motion of a current-carrying conductor in a magnetic; • describe the application of the magnetic effect of an electric current • describe the operation of a d.c. motor	• Fleming's rule left hand • Force between parallel currents, field patterns • Factors affecting magnitude of force • Action of an electric bell and a simple relay Electrical to mechanical energy	• Carrying out experiments on field patterns between parallel currents. • Demonstrating the effect of a magnetic field on a current carrying conductor. • Demonstrating experimentally to show relationship between direction of current, field and motion • Constructing a simple d.c. motor	• Two Long straight conductors, switch, leads, pocket /plotting campus, cell • Electric bell, relay, reed switch, microphone, speaker etc. • DC motor model, insulated wire, block of wood, leads

TOPIC	OBJECTIVES Learners should be able to	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITIES AND NOTES	SUGGESTED RESOURCES

13.3 Electromagnetic induction	• describe an experiment which shows that a changing magnetic field can induce an e.m.f. in a circuit or conductor; • state the factors affecting the magnitude of induced e.m.f; • use the fact that direction of an induced e.m.f opposes the change producing it; • predict the direction of induced current in a conductor; • describe the operation of an a.c. and d.c. generator.	• The generator principle • Strength of magnet, relative motion, number of turns, area of coil. • Lenz's law • Fleming's right-hand rule • mechanical to electrical energy • differences between a.c and d.c generators.	• Carrying out experiments to show the generator principle. • Carrying out experiments to investigate factors which affect the magnitude of the induced e.m.f • Carrying out experiments to show Lenz's Law. **(No calculations required).** • Using Flemming's right-hand rule to make predictions. • Identifying slip rings, commutators, brush, coil and magnets • Sketching the voltage-time graphs of the output voltage • discussing the factors affecting output voltage	• Coils with different number of turns and cross-sectional area of coils, solenoids, bar magnets, galvanometer, • CRO. ICT tools

			• comparing a.c and d.c generators.	

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITIES AND NOTES	SUGGESTED RESOURCES
13.4 Transformers	• describe the structure and principle of operation of a basic iron-cored transformer; • use transformer equations • describe the use of transformer in high-voltage transmission; • discuss the energy loss in cables; • give advantages of high voltage transmission;	• Primary and secondary coils, laminated core, • Transformer efficiency, cooling and eddy currents. • Magnetic flux heating • Joule heating V_p /N_s=N_p/N_s and V_pI_p=V_sI_s • Current and potential difference in step-up and step-down transformers	• Demonstrating the operation of a simple transformer. • Solving problems using the transformer equation. • Discussing efficiency (energy loss) • Discussing advantages of high-voltage transmission.	• Coils with multiple tapings, iron cores, voltmeters, multi-metres, • C.R.O, ac sources, Hall probe • ICT tools
14.0 ELECTRONICS	• explain that a hot filament emits electrons	• Emission of electrons from hot metals	• Demonstrating thermionic emission.	• Cathode ray tubes and kits, computer, magnetic field source

14.1 Thermionic emission	• describe how these electrons can be directed into an electron beam • describe the effect of a magnetic or electric field on an electron beam	• Acceleration and collimation of electrons • deflection of electron beam	• Discussing acceleration and collimation of electrons NOTE: Direction of deflection of electron beam. Relate to TV tube and CRO	• ICT tools

TOPIC	**OBJECTIVES** **Learners should be able to**	**CONTENT (knowledge, skills, values and attitudes)**	**SUGGESTED ACTIVITIES AND NOTES**	**SUGGESTED RESOURCES**
14.2 Diodes	• describe the function of diodes	• Function of diodes • Switch and rectification • Circuit symbol • LEDs	• Carrying out experiments to demonstrate the function of a diode	• LEDs, cells, diodes, circuit boards, electronic kits • breadboards
14.3 Rectification	• define rectification • explain half and full wave rectification	• Conversion of a.c. to d.c. • Use of diodes, • voltage – time graphs	• Carrying out experiments on rectification and smoothening • Sketching voltage-time graphs	• Electronic kit, diodes, AC source, capacitor, CRO • Power supplies

14.4 Electronic Components	• describe the behaviour of resistors; • use a given colour code for resistance values; • choose components with suitable power ratings	• colour and coding • Potentiometer use as input transducers Energy store • Time delay circuits	• Reading resistor colour codes and tolerance • Measuring resistance. • Carrying out experiments with resistors, capacitors, thermistors, LED, potentiometer	• Coded carbon resistors of various ratings and ranges • Potential dividers/rheostat, thermostats/thermistor
	• describe the action of a variable potential divider • describe the action of thermostats and light dependent resistors; • describe the action of a capacitor; • explain the use of reed switches in circuits • describe circuits incorporating light sensitive switches			• capacitors, bulbs, reed switches, strain-gauge, potentiometers, buzzers

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITIES AND NOTES	SUGGESTED RESOURCES

14.5 Logic Gates	• describe logic gates	• Logic gates: OR, AND, NOT, NAND and NOR Truth Tables • Combination of logic of not more than three inputs.	• Constructing Truth Tables.	• Electronic kits, logic gates • computer
15.0 ATOMIC AND NUCLEAR PHYSICS **15.1 Rutherford's Atomic Model**	• describe the structure of an atom in terms of nucleus and electrons; • explain proton and nucleon numbers; • explain isotopes	• Nucleus and electrons • Composition of nucleus • Proton number Z and nucleon number A. • A = Z + N • Nuclide notation $^{A}_{Z}X$ • Isotopes	• Drawing diagrams of the atomic structure. • Calculating proton and nucleon numbers. • Giving examples of isotopes	• Computer, atomic models • ICT tools • Periodic table

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITIES AND NOTES	SUGGESTED RESOURCES
15.2 Radioactivity	• describe radioactivity;	• Radioactivity	• describing detection of radiation.	• Computer, radiation detectors

	• state types of radioactive emission; • describe the nature and properties of radiation; • describe the mechanism of radioactive decay • explain the meaning of half-life; • distinguish between fusion and fission; • describe the uses of radioactive isotopes.	• Stability of nuclei, and particles and rays, detection • Nature of radiation • Nuclear decay; • radiation • Decay curve Half-life • Fusion and fission, nuclear reactions carbon – 14 dating - Biochemical tracers - Radiotherapy	• Carrying out experiments of chances of radioactive decay • Discussing nature and properties of radiation. • Discussing ionising effects, penetrating power and deflection by magnetic and electric fields • Calculating nucleon and proton numbers of balanced equations. • Drawing and interpreting decay curves. • Graphical representation of radioactive decay • Carrying out calculations on half life • Writing nuclear equations. • Discussing uses of radioactive materials	• Computer, simulation software

TOPIC	OBJECTIVES Learners should be able to:	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED ACTIVITIES AND NOTES	SUGGESTED RESOURCES
15.2 Radioactivity	• describe how radioactive materials are handled, used and stored in a safe way. • describe the effects of radioactive emission on the environment	• Detection of leaks in pipes • Determination of thickness of materials • Power generation • Sterilisation • Use, storage, handling • Soil, water, air, plant and animal life • Safe disposal of radio-active waste	• Discussing use of photographic film badges for exposure detection. • Discussing the impact of radioactive emission on the environment	• Photographic films, computers • ICT tools, simulation software • Dice, coins • CT scans • Photographic films, computers.

9.0 ASSESSMENT

The Lower Secondary Physics syllabus learning area for Forms 3 – 4 shall be assessed through School Based Continuous Assessment (SBCA) and Summative Assessment (SA). These assessments shall be guided by the principles of inclusivity, practicability, authenticity, transparency, flexibility, validity and reliability. The principles are crucial for creating a supportive and effective learning environment that fosters growth and development in learners at secondary school level. Arrangements, accommodations and modifications shall be visible to enable candidates with special needs to access assessments.

This section covers the assessment objectives, the assessment model, the scheme of assessment, and the specification grid.

9.1 Assessment Objectives

By the end of the Lower Secondary Physics syllabus learning area for Forms 3 - 4, learners will be assessed on their ability to:

9.1.1 Show knowledge and understanding.
9.1.2 Handle information and solve problems.
9.1.3 Display experimental skills and investigations.

9.2 Assessment Model

Assessment of learners at Lower Secondary school level for Physics Syllabus shall be both Continuous and Summative as illustrated in Figure 1. School Based Continuous Assessment shall include recorded activities from the School Based Projects. The mark shall be included on the learner's end of term and year report. Summative assessment at school level shall include terminal examinations which are at the end of the term and year.

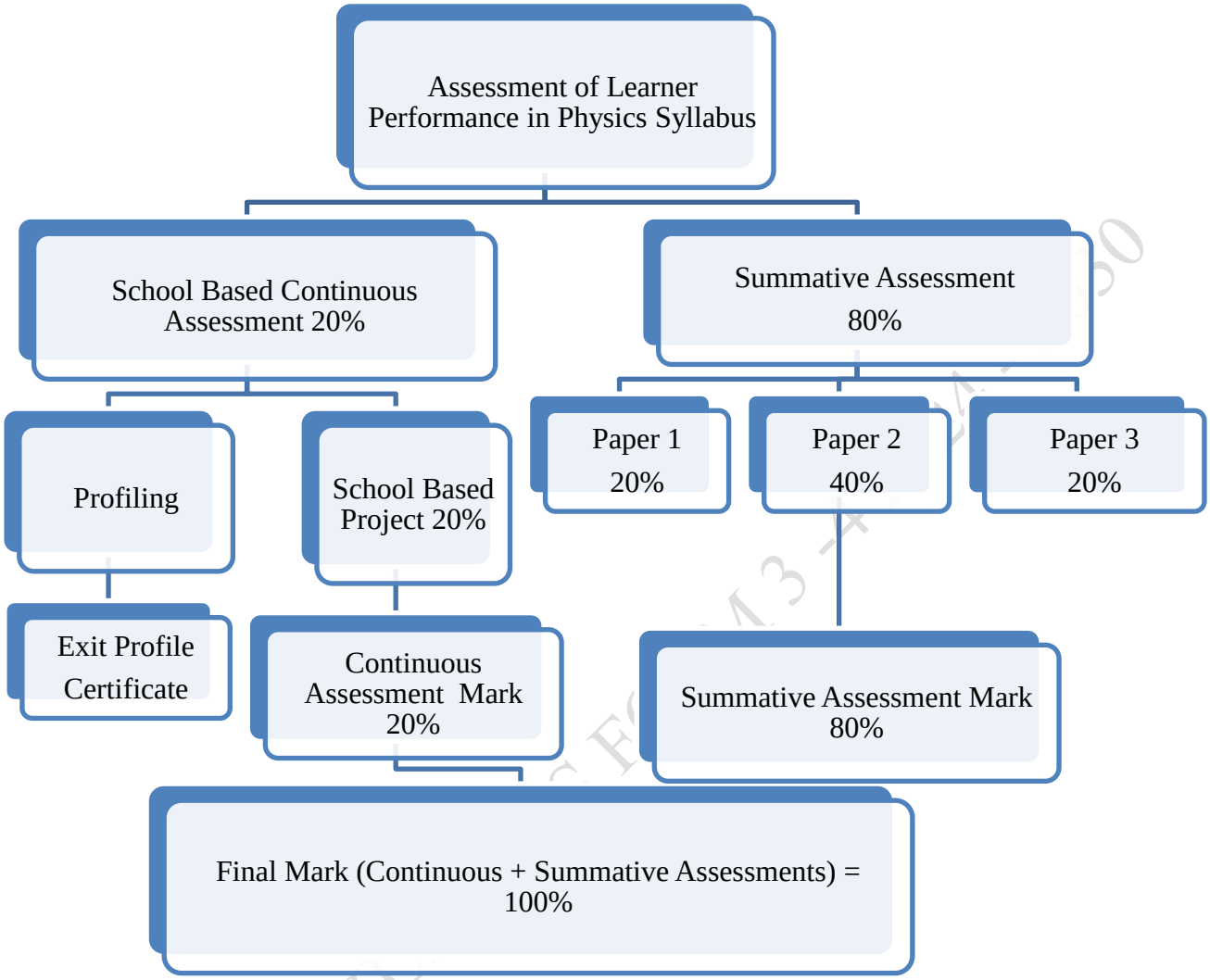

Fig. 1 Assessment Model

In addition, learners shall be profiled and learner profile records established. Learner profile certificates shall be issued for checkpoints assessment in schools as per the dictates of the Teacher's Guide to Learning and Assessment. The aspects to be profiled shall include learner's prior knowledge, values and skills, and subsequently the new competences acquired at any given point.

9.3 Scheme of Assessment

The Assessment Model shows that learners shall be assessed using both School Based Continuous Assessment and Summative Assessment for both School and ZIMSEC assessments.

The table shows the Scheme of Assessment where 20% is allocated to School Based Continuous Assessment and 80% to School or ZIMSEC Summative Assessment.

FORM OF ASSESSMENT	WEIGHTING
School Based Continuous Assessment	**20%**
Summative Assessment	**80%**
Total	**100%**

9.3.1 Description of School Based Continuous Assessment

Learners shall do one school-based project per Form which contributes to 20% of the end of year final mark. The end of year summative assessment shall then contribute 80%. However, for ZIMSEC public examinations, two (2) school-based projects shall be considered as School Based Continuous Assessment at Form 4. The two School Based Projects shall include those done during Form 3 and Form 4 sessions. Each will contribute 10%.

9.3.1.1: School – Based Project Continuous Assessment Scheme

The Table given below shows the Learning and Assessment Scheme for the School Based Project.

Project Execution Stages	Project Stage Description	Timelines	Marks
1	Problem Identification	January	5
2	Investigation of related ideas to the problem/innovation	February	10
3	Generation of possible solutions	March	10
4	Selecting the most suitable solution	April-May	5
5	Refinement of selected solution	June	5
6	Presentation of the final solution	July	10
7	Evaluation of the solution and Recommendations	August-September	5
	TOTAL		**50**

The learning and assessment scheme shows the stages that shall be executed by pupils and the timeline at which each stage shall be carried out. Possible marks, totalling 50, are highlighted to indicate how much can be allocated.

9.3.2 Description of the ZIMSEC Summative Assessment

ZIMSEC Summative Assessment shall be a public examination at Form 4. The examination shall consist of three (3) papers of different weighting

Paper	Paper type	Marks	Duration	Weighting
1	Multiple choice	40	1hr	18%
2	Theory	100	2hrs 15mins	44%
3	Practical test	40	2hrs	18%
TOTAL				**80%**

Paper 1: Multiple choice
Duration: 1 hour
The paper consists of 40 compulsory multiple-choice items of the direct choice type. Each question shall have 4 response items.

Paper 2: Theory
Duration: 2 hours 15minutes.
The paper has 2 sections
Section A will carry 40 marks and will consists of number of compulsory structured questions of variable mark valve.
Section B carries 60 marks and will consist of 4 structured questions. Each question will carry 20 marks. Candidates will be required to answer any 3 questions.

Paper 3: Practical Test
Duration: 2hours
This paper will consist of 2 compulsory questions each carrying 20 marks.

Paper 4: Continuous Assessment
This paper will consist of 2 projects during the 6 terms.

9.4 Specification Grid

SKILL	Paper 1	Paper 2	Paper 3

Knowledge and understanding	15%	15%	
Analysis, synthesis and evaluation	45%	45%	
Application and problem solving	40%	40%	
Practical			100%
TOTAL	**100%**	**100%**	**100%**

APPENDIX

SUMMARY OF KEY QUANTITIES, SYMBOLS AND UNITS

Learners should be able to state the symbols for the following physical quantities and, where indicated, state the units in which they are measured. Learners should be able to define those items indicated by an asterisk (*).

Quantity Symbol Unit

length l, h / km, m, cm, mm
area A/ m^2, cm^2
volume V/ m^3, cm^3
weight* W/ N*
mass m, M/ kg, g, mg
time t/ h, min, s, ms
period* T/ s
density* ρ/ g / cm^3, kg / m^3
speed* u, v/ km / h, m / s, cm / s
acceleration* a /m / s^2
acceleration of free fall g/ m / s^2, N / kg
force* F, f/ N
moment of force* N /m
work done* W, E /J*
energy E/ J, kW h*
power* P/ W*
pressure* p, P/ Pa*, N / m^2, mm Hg
temperature θ , T /^{0}C, K
heat capacity C /J / ^{0}C, J / K
specific heat capacity* c/ J / (g °C), J / (g K)
latent heat L /J
specific latent heat* l/ J / kg, J / g
frequency* f/ Hz

wavelength* λ/ m, cm
focal length f/ m, cm
angle of incidence i /degree (°)
angles of reflection, refraction r degree/ (°)
critical angle c degree/ (°)
potential difference*/voltage V /V*, mV
current* I /A, mA
charge q, Q /C, A s
e.m.f.* E /V
resistance R/ Ω
MATHEMATICAL REQUIREMENTS
Arithmetic
Learners should be able to:
(a) recognise and use expressions in decimal and standard form (scientific) notation
(b) use appropriate calculating aids (electronic calculator or tables) for addition, subtraction, multiplication and division. Find arithmetic means, powers (including reciprocals and square roots), sines, cosines and tangents (and the inverse functions)
(c) take account of accuracy in numerical work and handle calculations so that significant figures are neither lost unnecessarily nor carried beyond what is justified, rounding answers correctly when necessary
(d) make approximations and estimates to obtain reasonable answers
Algebra
Learners should be able to:
(a) change the subject of an equation
(b) solve simple algebraic equations, including linear simultaneous equations
(c) use direct and inverse proportion
(d) substitute physical quantities into physical equations using consistent units
(e) formulate simple algebraic equations as mathematical models of physical situations and to represent information given in words
Geometry and trigonometry

Learners should be able to:
(a) understand the meaning of angle, curve, circle, radius, diameter, square, parallelogram, rectangle and diagonal
(b) calculate areas of right-angled triangles and circles, areas and volumes of rectangular blocks, volumes of cylinders
(c) use the angle sum of a right angle and adjacent angles on a straight line
(d) use sines, cosines and tangents
(e) use usual mathematical instruments (rules, compasses, protractor, set square)
(f) recognise and use points of the compass (N, S, E, W)
Graphs
Learners should be able to:

(a) translate information between graphical, numerical, algebraic and verbal forms

(b) select appropriate variables and scales for graph plotting

(c) for linear graphs, determine the slope and state the intercept and intersection

(d) choose, by inspection, a straight line which will serve as the best straight line through a set of data points presented graphically

(e) recall standard linear form y = mx + c and rearrange relationships into linear form where appropriate

(f) understand, draw and use the slope of a tangent to a curve as a means to obtain the gradient

GLOSSARY OF TERMS

It is hoped that the glossary will prove helpful to learners as a guide, although it is not exhaustive. The glossary has been deliberately kept brief not only with respect to the number of terms included but also to the descriptions of their meanings. Learners should appreciate that the meaning of a term must depend in part on its context. They should also note that the number of marks allocated for any part of a question is a guide to the depth of treatment required for the answer.

1. Define (the term(s) ...) is intended literally. Only a formal statement or equivalent paraphrase, such as the defining equation with symbols identified, being required.

2. Explain/What is meant by ... normally implies that a definition should be given, together with some relevant comment on the significance or context of the term(s) concerned, especially where two or more terms are included in the question. The amount of supplementary comment intended should be interpreted in the light of the indicated mark value.

3. State implies a concise answer with little or no supporting argument, e.g. a numerical answer that can be obtained 'by inspection'.

4. List requires a number of points with no elaboration. Where a given number of points is specified, this should not be exceeded.

5. Describe requires learners to state in words (using diagrams where appropriate) the main points of the topic. It is often used with reference either to particular phenomena or to particular experiments. In the former instance, the term usually implies that the answer should include reference to (visual) observations associated with the phenomena. The amount of description intended should be interpreted in the light of the indicated mark value.

6. Discuss requires learners to give a critical account of the points involved in the topic.

7. Predict or deduce implies that candidates are not expected to produce the required answer by recall but by making a logical connection between other pieces of information. Such information may be wholly given in the question or may depend on answers extracted in an earlier part of the question.

8. Suggest is used in two main contexts. It may either imply that there is no unique answer or that learners are expected to apply their general knowledge to a 'novel' situation, one that formally may not be 'in the syllabus'.

9. Calculate is used when a numerical answer is required. In general, working should be shown.

10. Measure implies that the quantity concerned can be directly obtained from a suitable measuring instrument, e.g. length, using a rule, or angle, using a protractor.

11. Determine often implies that the quantity concerned cannot be measured directly but is obtained by calculation, substituting measured or known values of other quantities into a standard formula.

12. Show is used when an algebraic deduction has to be made to prove a given equation. It is important that the terms being used by learners are stated explicitly.

13. Estimate implies a reasoned order of magnitude statement or calculation of the quantity concerned. Learners should make such simplifying assumptions as may be necessary about points of principle and about the values of quantities not otherwise included in the question.

14. Sketch, when applied to graph work, implies that the shape and/or position of the curve need only be qualitatively correct. However, learners should be aware that, depending on the context, some quantitative aspects may be looked for, e.g. passing through the origin, having an intercept, asymptote or discontinuity at a particular value. On a sketch graph it is essential that candidates clearly indicate what is being plotted on each axis.

Sketch, when applied to diagrams, implies that a simple, freehand drawing is acceptable:

nevertheless, care should be taken over proportions and the clear exposition of important details

.*SPECIAL NOTE*

Nomenclature

The proposals in 'Signs, Symbols and Systematics (The Association for Science Education Companion to 16–19 Science, 2000)' will generally be adopted.

Units, significant figures

Learners should be aware that misuse of units and/or significant figures, i.e. failure to quote units

where necessary, the inclusion of units in quantities defined as ratios or quoting answers to an

inappropriate number of significant figures, is liable to be penalised.

Calculators

An approved calculator may be used in all papers.

Geometrical Instruments

Learners should have geometrical instruments with them for Paper 1 and Paper 2.

Apparatus list

This list below details the apparatus expected to be generally available for examination purposes. The

list is not exhaustive: in particular, items that are commonly regarded as standard equipment in a physics laboratory are not included. The apparatus listed should be available for each candidate:

• ammeter FSD 1 A or 1.5 A

• voltmeter FSD 1 V, 5 V

• cells and holders to enable several cells to be joined

• connecting leads and crocodile clips

• d.c. power supply – variable to 12 V

• metre rule

• converging lens with a focal length f = 15 cm

• low voltage filament bulbs in holders

• a supply of masses and holders

• newton meter/force meter

• plastic or polystyrene cup

• modelling clay (Plasticine)

• various resistors, including a variable resistor (rheostat)

• switch
• thermometer, –10 °C to +110 °C at 1 °C graduations
• wooden board
• glass or perspex block, rectangular and semi-circular
• measuring cylinder, 25 cm^3, 100 cm^3
• beaker, 250 cm^3
• springs
• stopwatch
• ray box.