Republic of Zambia

MINISTRY OF EDUCATION

PHYSICS SYLLABUS

ORDINARY SECONDARY EDUCATION

[FORM 1-4]

PRODUCED BY THE CURRICULUM DEVELOPMENT CENTRE
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……………………………………

PHYSICS SYLLABUS

ORDINARY SECONDARY EDUCATION

[FORM 1 – 4]

Vision

Quality, life- long education for all which is accessible, inclusive and relevant to individual, national and global needs which aligns with the 8 NDP and SDG 4.

Preface

The Physics syllabus for Forms 1 to 4 is designed to equip learners with a comprehensive understanding of Physics concepts, fostering a deep appreciation for the role of Physics in everyday life and its applications in various fields. This syllabus aims to develop a solid foundation in Physics and cultivate critical thinking, analytical skills, and problem-solving strategies. Subsequently, apply Physics concepts to real-world problems and emerging technologies through the engagement of learners in hands-on, hearts-on and minds-on practical activities and simulations to reinforce theoretical understanding.

This Physics syllabus for Forms 1 to 4 intends to create a stimulating and supportive learning environment where learners can develop a profound understanding of Physics. By fostering curiosity, critical thinking, and practical skills, the syllabus prepares learners for further education and careers in Science and Technology, thereby contributing to their overall intellectual and personal growth.

It is hoped that the Physics syllabus will inspire learners to explore the fascinating world of Physics and appreciate its significance in shaping the future.

Joel Kamoko, (Mr.)
Permanent Secretary- Educational Services
MINISTRY OF EDUCATION

Acknowledgement

This syllabus is designed to provide the scope and sequence of topics for Physics considered necessary to be offered at secondary School level. This is with a view to provide guidance to the teaching and learning of this unique, but yet exiting blend of concepts from Physics for teachers and other experts in the field to appropriately offer relevant lessons at secondary ordinary level.

Many thanks go to individuals, institutions and organizations that provided the technical input to the successful development of this syllabus. These include; teachers, lecturers from colleges, public universities in Zambia. Sincere gratitude also goes to the Directorate of Secondary Education and National Science Centre in the Ministry of Education for their support and collaboration during the consultation period.

Last but not the least, the commitment and hard work of all the staff at the Curriculum Development Centre in ensuring that this syllabus comes to reality is recognised.

Charles Ndakala, (Dr.)
Director – Curriculum Development
MINISTRY OF EDUCATION

Contents

Introduction

The O-level physics syllabus covers the introductory part of the fundamental principles and concepts of physics. This syllabus aims to develop an understanding of the natural world, fostering critical thinking, problem-solving, and analytical skills. It provides a solid foundation for further studies in physics and related fields. This syllabus is committed to providing an enriching and supportive educational environment where learners can develop a lifelong interest in physics. By promoting inquiry, curiosity, and a passion for science, the syllabus aims to prepare learners not only for academic success but also for their future roles as informed and responsible citizens in a scientifically advanced society.

It is expected that this physics syllabus, once implemented successfully, will inspire and empower learners to achieve their full potential, equipping them with the knowledge and skills necessary to navigate and contribute to the world around them. This syllabus is designed to ensure learners develop a deep understanding of physics principles while also acquiring the practical skills and competencies needed for further education and careers in science. This O-level syllabus incorporates an interdisciplinary approach that integrates physics with science, technology, engineering, and mathematics to develop innovative solutions and critical thinking. The STEM part of physics refers to the Scientific, Technological, Engineering, and Mathematical aspects of Physics. This is composed of:

Scientific: Understanding the natural world through observation, experimentation, and evidence-based reasoning.

- Observing and measuring physical phenomena
- Formulating hypotheses and theories
- Testing and validating models through experimentation
- Analysing and interpreting data

Technological: Applying physics principles to develop innovative solutions, tools, and technologies.

- Applying physics principles to develop innovative solutions
- Designing and building instruments, devices, and systems
- Using computational tools and simulations
- Developing new materials and technologies

Engineering: Designing, optimising, and troubleshooting systems, structures, and processes using physics-based models and simulations.

- Designing, optimising, and troubleshooting systems
- Applying physics-based models and simulations
- Developing and testing prototypes
- Ensuring safety, efficiency, and effectiveness

Mathematical: Use mathematical contexts to describe, analyse, and predict physical phenomena, from classical mechanics to quantum mechanics.

- Developing and applying mathematical contexts
- Describing and analysing physical systems using equations
- Modeling and simulating complex phenomena
- Interpreting and predicting results

These STEM aspects of Physics drive innovation, from medical imaging to space exploration, and continue to shape our understanding of the world around us.

Structure of the Syllabus

The syllabus is organised into four levels, corresponding to Forms 1 to 4, with each level building upon the knowledge and skills acquired in the previous year. The content is divided into topics, each focusing on specific concepts of Physics.

- **Form 1:** Introduction to physics, General physics, Elementary astronomy, Geophysics, Mechanics I
- **Form 2**: Mechanics II, Thermal Physics, wave motion, sound
- **Form 3**: Light, Static Electricity, Current Electricity, Magnetism, Electromagnetism, Electromagnetic induction
- **Form 4**: Basic Electronics, Electronic communication systems, Atomic Physics, Renewable energy

Teaching Methodology

The effective teaching methodologies in STEM physics include:

- **Conducting experiments**: demonstrate key principles and encourage curiosity among learners.
- **Collaborative learning**: Pair learners to work together, promoting peer-to-peer teaching, discussion, and problem-solving.

- **Conceptual learning:** Connect chemical concepts to everyday life, industry, or current events, making learning relevant and meaningful.
- **Differentiated instructions:** Tailor teaching to meet diverse learning styles, abilities, and interests of different learners.
- **Feedback and Reflection:** Encourage learners to reflect on their learning, providing constructive feedback to guide improvement.
- **Inquiry-based learning**: encourage learners to explore, investigate, and discover physics concepts through hands-on experiments and activities.
- **Integration of Technology:** Use digital tools, simulations, and visualisations to enhance engagement, understanding, and analysis.
- **Problem-based learning**: Present real-world problems or case studies, requiring students to apply physics principles to develop solutions.
- **Project-based learning:** Assign open-ended projects, allowing students to design, conduct, and present research or applications of physics concepts.

By implementing these methodologies, a teacher can create an engaging, inclusive, and effective STEM physics learning environment.

Time Allocation

The standard minimum learner-teacher contact time for Physics at Secondary School Level is 4 hours per week, translating into Six (6) periods. The duration for a single period is 40 minutes. The contact time at Secondary School Level is planned in such a way as to give ample time for practical activities.

Assessment

This assessment shall include a variety of methods to evaluate the competences of learners in terms of knowledge, skills, and general understanding of scientific concepts. The assessment will involve both formative and summative. Summative assessment will be used to evaluate learners' learning at the end of the O level Physics course to measure their achievements against specific competences through Final Examinations. In order to help teachers and learners identify areas where learners need more support or revision, formative assessment will be used to track learner progress and knowledge throughout the teaching and learning process.

However, assessments shall follow the following pattern:

- School Based Assessment (SBA) shall comprise of assignments, projects, practical work, research and end of term tests during the period of study and as guided by the Examinations Council of Zambia (ECZ). This shall carry 30% of the total marks.
- Summative assessment shall carry 70% of the total marks.

The Examinations Council of Zambia (ECZ) shall prepare detailed procedures or guidelines on how SBA will be conducted by the teachers and the management of the assessment results. The standardised national examination shall be administered at the end of Form 4 by the Examination Council of Zambia.

Key Competences

In physics the following key competences are the fundamental abilities and qualities that will enable individual leaners to:

- Manage their own learning and knowledge.
- Interact with others and solve problems.
- Contribute to society and the economy.
- Adapt to change and navigate through emerging issues in the environment.

KEY COMPETENCE	DESCRIPTOR
Analytical Thinking	To analyse and interpret data, making evidence-based conclusions.
Collaboration	To work together, promoting peer-to-peer teaching, discussion, and problem-solving.
Communication	To communicate scientific information effectively, both orally and in writing.
Creativity and innovation	To create new ideas and products by applying processes and introducing new techniques that can add value.
Critical Thinking	To enhance learners' ability to think critically and solve problems through logical reasoning based on conclusions.
Digital literacy	Using a broad range of Information and Communication Technologies such as a cell phone, computer, calculator in specific contexts.
Environmental Sustainability	To apply physical principles to understand and mitigate the environmental impact of human activities.
Problem Solving	To use scientific knowledge, critical thinking, and analytical skills to develop a robust problem-solving mindset, enabling learners to tackle complex challenges and drive innovation in various fields.

[FORM 1]

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
1.1 INTRODUCTION TO PHYSICS	**1.1.1 Safety Rules** (Laboratory Safety)	1.1.1.1 Practise laboratory safety rules.	• Practising laboratory safety protocols (e.g. using safety protocol simulation or role play, solving laboratory safety related puzzles to escape within certain time limits…) • Identifying potential hazards and taking necessary precautions (e.g. using scavenger hunt) • Using personal protective equipment (PPE) • Creating posters to communicate safety information • Demonstrating emergency response skills • Administering first aid	• Safety laboratory rules practised correctly
	1.1.2 Waste Management	1.1.2.1 Practise waste management principles.	• Identifying waste materials in the Physics laboratory • Classifying waste materials according to physical state, properties, source and material type	• Principles of waste management practised correctly.
	1.1.3 Apparatus in Physics	1.1.3.1 Use apparatus in Physics.	• Identifying apparatus in Physics • Using apparatus in Physics • Improvising apparatus in Physics	• Apparatus in Physics used correctly
		1.1.3.2 Improvise apparatus in physics	• Improvising apparatus in Physics	• Apparatus in physics improvised
	1.1.4 Fundamental Concepts of Physics	1.1.4.1 Demonstrate curiosity and inquiry when exploring	• Recognising what physics is and its fundamental concepts such as motion, forces, energy, momentum, work and	• A system that demonstrates an understanding

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
		fundamental concepts of physics.	efficiency, waves and vibrations, and electricity and magnetism... • Classifying branches of Physics such as mechanics, thermodynamics, electricity and magnetism, atomic physics, electronics, geophysics… • Exploring the scientific methods of learning Physics such as observation, experimentation, data analysis, interpretation, scientific reporting and presentation	of the fundamental concepts of Physics created
	1.1.5 Applications of Physics in everyday life	1.1.5.1 Apply concepts of physics to real-world contexts.	• Identifying applications of Physics in everyday life e.g. in engineering, medicine, agriculture • Demonstrating the application of Physics in everyday life e.g. measuring mass, charging the phone…	• Apply concepts of physics to real-world contexts
1.2 GENERAL PHYSICS	**1.2.1 Basic Principles of Scientific investigations**	1.2.1.1 Apply principles of scientific investigations.	• Designing an experiment that involves basic scientific principles (Observation, Measurement, Data analysis, Report writing, Experimentation, Objectivity, Curiosity…) • Writing scientific reports to disseminate scientific ideas	• Basic principles of scientific investigation applied appropriately
	1.2.2 Physical Quantities	1.2.2.1 Classify physical quantities as basic and derived	• Identifying basic quantities and their units (including SI units) • Discussing derived quantities and their units (including SI units).	• Physical quantities classified as basic and derived

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• Applying prefixes, multiples, submultiples on basic and derived units • Using scientific notations • Using significant figures in numerical problems • Converting basic and derived units (converting from higher unit to lower or vice versa)	correctly
	1.2.3 Precision and Accuracy	1.2.3.1 Demonstrate precision and accuracy in measurements.	• Measuring length with precision and accuracy using appropriate instruments such as metre rule, calipers and micrometer screw gauge • Determining the area with precision and accuracy using appropriate apparatus and instruments • Measuring volume of liquids, regular and irregular solids with precision and accuracy using appropriate instruments • Measuring mass of gases, liquids and solids with precision and accuracy using appropriate instruments • Determining density of gases, liquids and solids with precision and accuracy using appropriate instruments • Measuring time with precision and accuracy using stop	• Precision and accuracy in measurements demonstrated correctly

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			watches, simple pendulum ….. • Experimenting on the factors that affect the period of the simple pendulum • Measuring weight with precision and accuracy using a spring balance • Carrying out experiments on measurements to demonstrate Precision errors (random, instrumental, methodical) and accuracy errors (systematic, gross, instrumental and relative)	
	1.2.4 Equilibrium	1.2.4.1 Apply equilibrium concepts to design systems to solve real world problems.	• Locating the center of mass • Designing systems in equilibrium to demonstrate stable, unstable and neutral equilibrium • Analysing equilibrium in real world situations e.g. structures such us bridges, cars, furniture …	• Equilibrium concepts in daily life applied correctly
1.3 ELEMENTARY ASTRONOMY	**1.3.1 The Universe**	1.3.1.1 Construct astronomical models to demonstrate conceptual understanding of elementary astronomy.	• Creating a scale model or diagram of planets and their relative sizes and positions • Simulating astronomical events like eclipse or planetary motion using computer software • Simulating space exploration using virtual reality • Using astronomical tools such as binoculars, telescopes, drones, spectroscope, and satellites… to	• Astronomical models to demonstrate conceptual understanding of elementary astronomy constructed

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			view the solar system, planets or celestial bodies	
1.4 GEOPHYSICS	**1.4.1 Structure and Composition of the Earth**	1.4.1.1 Construct a model to demonstrate an understanding of Earth's structure and composition.	• Exploring the structure and composition of the earth to layered structure, density and gravity seismic waves, thermal gradient, magnetic fields, temperature gradient and radiative transfer • Collecting and analyzing rock samples to understand the earths' composition • Construct a scale model of the earth's layers including the crust, mantle, outer and inner core	• A model to demonstrate an understanding of Earth's structure and composition constructed
	1.4.2 Structure and Composition of the Earth's Atmosphere	1.4.2.1 Create a model of the structure and composition of the earth's atmosphere.	• Analysing the structure and composition of the earth's atmosphere in relation to humidity and phase transition thermal gradient, temperature and altitude gradient, and radiative transfer • Creating a scale model of the atmospheric layers including the troposphere, stratosphere, mesosphere, thermosphere and exosphere	• A model to demonstrate an understanding of the structure and composition of the earth's atmosphere created
1.5 MECHANICS 1	**1.5.1 Scalar and Vector Quantities**	1.5.1.1 Apply the concepts of scalar and vector quantities in everyday life.	• Distinguishing scalar from vector quantities • Analysing scalar from vector quantities • Constructing vector diagrams	• Concepts of scalar and vector quantities in daily life applied

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			representing physical quantities and relationships • Determining resultant vectors using mathematical operation such as addition, subtraction, Pythagoras and Parallelogram rule: $(F_R = F_1 + F_2$, $F_R = F_1 - F_2$ and $F_R = \sqrt{F_1^2 + F_2^2})$ • Applying graphical methods to determine resultant vectors in everyday life	correctly
	1.5.2 Linear Motion	1.5.2.1 Apply concepts of linear motion in real life situations.	• Distinguish the terms used in mechanics such as distance, displacement, speed, velocity, and acceleration • Determining distance, displacement, time, speed, velocity and acceleration of moving objects using tools like rulers, sensors, ticker tape and stopwatches • Deriving the basic equations of uniformly accelerated motion; $v = u + at$ $v^2 = u^2 + 2as$ $s = ut + \frac{1}{2}at^2$ $s = \left(\frac{u+v}{2}\right)t$ • Using the equations of	• Concepts of linear motion applied in real life situations accordingly

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			uniformly accelerated motion to solve numerical problems • Plotting linear motion graphs (*distance-time, velocity-time, acceleration-time*) • Calculating thinking distance, breaking distance, and reaction time on different real-life scenarios	
		1.5.2.2 Apply concepts of falling bodies in real life situations.	• Experimenting the motion of falling bodies in a uniform gravitational field with and without air resistance (qualitatively including terminal velocity) • Determining the numerical value of g experimentally • Solving problems on free fall using equations: $v = u + gt$ $v^2 = u^2 + 2gs$ $s = ut + \frac{1}{2}gt^2$	• Concepts of falling bodies in real life situation applied
	1.5.3 Forces	1.5.3.1 Apply force-body interaction concepts to make predictions on the shape, size, motion and direction of the body.	• Investigating the effect of a force on a body such as; shape and size, motion, and direction • Describing the inertia law • Describing the relationship between force and acceleration • Demonstrating the effect of friction on the motion of a body • Demonstrating the relationship	• Force-body interaction concepts applied to make predictions on the shape, size, motion and direction of the body correctly

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			between mass and acceleration • Solving problems involving force (F= ma) • Verifying Hooke's law using an experiment $(F \propto e)$	
	1.5.4 Circular Motion	1.5.4.1 Apply circular motion concepts to solve problems and make predictions.	• Describing motion in a circular path due to centripetal force • Showing that $F = m\left(\frac{v^2}{r}\right)$ Is derived from $F=ma_c$ where ac= centripetal acceleration $\left(\frac{v^2}{r}\right)$ • Solving problems involving circular motion (*centripetal and centrifugal force*) • Demonstrating how circular motion is applied in real life situations such as satellite orbits, banked roads….	• Circular motion concepts applied to solve problems and make predictions correctly
	1.5.5 Moment of a Force	1.5.5.1 Create a tool that applies moment of a force in solving problems in everyday life.	• Demonstrating the concept of moment of a force using a lever • Exploring how forces and distance affect moment of force $M = Fd$ • Solving real life problems involving moment of a force. • Designing tools that apply moment of a force (e.g., a lever, …)	• A tool that applies moment of a force in solving problems in everyday life created accordingly

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
	1.5.6 Equilibrium	1.5.6.1 Apply equilibrium concepts to design systems to solve real world problems.	• Locating the center of mass • Applying principle of moments as a condition for equilibrium (for a system to be in equilibrium the sum of the clockwise moments about a point is equal to the sum of the anticlockwise moment about the same point • Designing systems in equilibrium to demonstrate stable, unstable and neutral equilibrium • Analysing equilibrium in real world situations such as structures such us bridges, cars, furniture …	• Equilibrium concept to design systems to solve real world problems in daily life applied correctly

[FORM 2]

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
2.1 MECHANICS 2	**2.1.1 Work, Energy, and Power**	2.1.1.1 Create a system that applies work, energy, and power concepts.	• Developing a system that maximises the mechanical energy such as a simple pendulum, inclined plane, and water tank • Determining the work done on an object by a force • Investigating the relationship between force and displacement through experimenting $W = Fs$ • Conducting experiments to measure and calculate mechanical energy (kinetic and potential) in different systems $E_p = mgh$ $E_K = \frac{1}{2}mv^2$ • Demonstrating the law of conservation of energy in mechanical energy • Exploring how machines can change the amount of mechanical energy required to perform a task, such as cranes • Calculating the efficiency of energy conversion using the appropriate formula $\eta = \frac{energy\ output}{energy\ input} \times 100\%$ • Solving mathematical problems involving power developed by mechanical energy systems • Calculating the efficiency of power using	• A system that applies work, energy, and power concepts created accordingly

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			the appropriate formula $$\eta = \frac{power\ output}{power\ input} \times 100\%$$	
	2.1.2 Linear Momentum	2.1.2.1 Apply the principle of linear momentum in everyday life	• Exploring linear momentum in real world scenarios such as sport, transportation, car accidents analyses, safety features built in cars and engineering • Exploring the concept of momentum • Solving numerical problems involving linear momentum $$P = m_1u_1 + m_2u_2$$ • Demonstrating the law of conservation of momentum (elastic and inelastic collision) $$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$ • Demonstrate an understanding the effects and consequences of excessive speeding	• The principle of linear momentum in everyday life applied correctly
	2.1.3 Simple Machine	2.1.3.1 Build simple machines to solve real life problems.	• Building simple machines to solve real life problems • Demonstrating the application of the various types of simple machines (lever, pulley, inclined plane/wedge, screw, wheel and axle, and gears) • Determining Mechanical Advantage (MA), and Velocity Ratio (VR) of a simple machine; $$MA = \frac{load}{effort}$$ $$VR = \frac{distance\ moved\ by\ effort}{distance\ moved\ by\ load}$$	• Simple machines built to solve real life problems accordingly

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• Deriving the formula for efficiency of a simple machine as $\eta = \frac{MA}{VR} \times 100\%$	
	2.1.4 Pressure	2.1.4.1 Create a model that uses principles of pressure to solve real-life problems	• Creating a model that uses the principle of pressure (hydraulic press/brake and car jack, simple manometer, a mercury barometer...) • Measuring pressure using pressure sensors (manometer, barometer and other appropriate instruments) • Determining pressure using the relationship between force and area. $P = \frac{F}{A}$ • Deriving the equation for pressure in fluids (Pascal's Law); $p = \rho hg$ • Calculating pressure in liquids and gas $P = \rho gh$ • Exploring factors affecting pressure in liquids such as density (ρ), height (h) and gravity (g) • Conducting an experiment to demonstrate principles of up thrust and floatation (Archimedes principle) • Conducting an experiment to demonstrate principles of up thrust and floatation (Archimedes principle)	• A model that uses principles of pressure to solve real-life problems created

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
2.2 THERMAL PHYSICS	**2.2.1 Simple Kinetic Theory of Matter**	2.2.1.1 Analyse the impact of simple kinetic Theory of matter on technological innovations.	• Exploring the molecular model of matter • Demonstrating kinetic theory of matter such as Brownian motion, diffusion, evaporation, cooling effect of evaporation • Developing an innovation on simple kinetic theory of matter to solve a real-world problem e.g. gas leak detector, thermal insulators, refrigeration system,	• The impact of simple kinetic theory of matter on technological innovation analysed
	2.2.2 Measurement of Temperature	2.2.2.1 Measure temperature using appropriate instruments.	• Measuring temperature using appropriate instruments • Interpreting temperature data from various sources (e.g. experiments...) • Recognising various types of thermometers: (liquid in glass, thermocouple, thermo scanners (infrared scanners) • Determining the boiling and melting points of different substances • Experimenting on the effects of pressure and impurities on the boiling and melting points of substances • Calibrating unmarked thermometer • Experimenting on the physical properties that change with temperature such as volume, density, electrical resistance, gas pressure • Experimenting on suitability of alcohol and mercury for use in liquid-in-glass thermometers • Exploring the relationship between Celsius and kelvin scales	• Temperature measured using appropriate instruments

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
	2.2.3 Expansion of Solids, Liquids and Gases	2.2.3.1 Demonstrate expansion of solids, liquids and gases.	• Demonstrating thermal expansion of solids, liquids (including anomalous expansion of water) and gases • Demonstrating that various solids, liquids and gasses expand at different rates • Determining the boiling and melting points of different substances • Experimenting on the effects of pressure and impurities on the boiling and melting points of substances • Demonstrating the use of equations on gas laws to solve numerical problems (Boyle's Law, Charles' Law and Gay Lussac's and Ideal gas equation $P_1V_1 = P_2V_2$ $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$	• Expansion of solids, liquids and gases demonstrated correctly
	2.2.4 The Internal Combustion Engine	2.2.4.1 Demonstrate how various internal combustion engines types operate (four stroke engine).	• Recognising different types of internal combustion engines in terms of spark ignition, compression ignition, rotary….. • Exploring the operation of the internal combustion engine • Creating a model of an internal combustion engine • Comparing efficiency of diesel and petrol engine	• The operations of various internal combustion engine types demonstrated correctly

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• Exploring emerging engine technologies such as hybrid, homogeneous charge compression ignition……	
	2.2.5 Heat Transfer	2.2.5.1 Create a device that uses the concepts of heat transfer.	• Applying heat transfer in everyday life such as food warmers, flasks, textile industry, refrigerators, sea and land breeze, heating elements, car radiators... • Demonstrating heat transfer by conduction, convection and radiation • Exploring the relationship between kinetic theory and heat transfer • Demonstrating the use of bad and good conductors of heat • Distinguishing good from bad absorbers/emitters of radiant energy • Demonstrating greenhouse effects	• A device that uses the concepts of heat transfer created
	2.2.6 Measurement of Heat	**2.2.6.1** Demonstrate the ability to solve practical and numerical problems involving measurement of heat in everyday life.	• Solving practical and numerical problems involving measurement of heat in everyday life • Exploring the differences between temperature and heat energy. • Measuring heat capacity $(c = \frac{H}{\Delta T})$ and specific heat capacity $(c = \frac{H}{m\Delta T})$ of solids and liquids • Determining the latent heat of fusion $(H = mL_f)$ and latent heat of vaporization $(H = mL_v)$ of substances	• The ability to solve practical and numerical problems involving measurement of heat demonstrated in everyday life
2.3 WAVE MOTION	**2.3.1 Longitudinal and Transverse Waves**	**2.3.1.1** Create a device that generates waves.	• Creating a device that generates waves to demonstrate longitudinal and transverse	• A device that generates waves created

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			waves • Distinguishing between longitudinal and transverse waves • Describing the terms associated with waves (amplitude (A), wavelength, period (T), frequency (f), wave front... • Solving numerical problems involving wave motion	
	2.3.2 Electromagnetic Spectrum	2.3.2.1 Interpret information related to electromagnetic waves.	• Illustrating an electromagnetic spectrum with all types of electromagnetic waves • Exploring properties of electromagnetic waves • Exploring the sources, and uses of electromagnetic waves • Recognising the methods of detection of each of the components of the electromagnetic spectrum • Exploring the harmful effects of each of the electromagnetic waves • Practising safety precautions against harmful effects of each of the electromagnetic waves	• Information related to electromagnetic waves interpreted correctly
2.4 SOUND	**2.4.1 Properties and Application of Sound**	2.4.1.1 Create simple devices to demonstrate fundamental properties of sound.	• Experimenting on the transmission of sound in solids, liquids and gasses. • Identifying vibrating parts in the production of sound by various sources such as guitar, tuning fork, piano, whistle, drums, ruler ... • Measuring sound using different instruments such as oscilloscope, sound level meter	• Simple devices to demonstrate fundamental properties of sound and its application created

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• Demonstrating rarefaction and compression in sound waves using slinky spring • Conducting experiments to determine the speed of sound in air using methods such as direct, echo, computer based • Discussing properties of sound such as frequency, wavelength, period, speed, amplitude, timbre, pitch, loudness intensity, reflection, refraction, interference, diffraction • Simulating the following properties of sound using software (timbre, pitch, intensity, reflection, refraction, interference, diffraction) • Explaining factors that influence quality of sound such as overtones and wave form of a note. • Categorising types of sound based on (a) Frequency (b) Source (c) Medium of transmission (d) Perception (e) Physical properties (f) Directionality • Discussing application of sound such as; (a) Music and entertainment (b) Communication (c) Ultrasound technology (d) Infrasonic (e) Sonar technology for navigation (f) Industrial application	

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			(g) Non-destructive testing (h) Sound proofing (i) Acoustic design (j) Environmental monitoring (k) Medical therapy (l) Aerospace (m) Geological exploration (n) Underwater exploration (o) Researching the health and environmental impact of sound pollution and intervention measure.	

[FORM 3]

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
3.1 LIGHT	**3.1.1 Rectilinear Propagation of Light**	3.1.1.1 Create a device that applies the concept of rectilinear propagation of light.	• Creating a pinhole camera to show how light travels in a straight line • Demonstrating rectilinear propagation of light using a source of light (e.g. laser, mirrors, screen) to trace the path of light rays • Analyzing shadows (eclipses) using various light sources and objects • Exploring the behavior of rectilinear propagation of light using software or applications • Researching on real world application of rectilinear propagation of light such as optical instrument, medical imaging and laser surgery	• A device that applies the concept of rectilinear propagation of light
	3.1.2 Reflection of Light	3.1.2.1 Create an optical instrument using the concept of reflection of light.	• Designing and building a periscope using mirrors and tubes • Creating a kaleidoscope to demonstrate reflection symmetry • Creating a mirror maze to explore reflection and optical illusion • Exploring images of plane, concave, and convex mirrors, and other reflecting surfaces (regular and irregular) • Carrying out experiments to verify the laws of reflection • Utilising simulation or applications to model reflection to adjust angles and observe changes	• An optical instrument that uses the concept of reflection of light created accordingly

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• Solving problems involving reflection, including mirror arrangement and image formation: • Using formula: (a) Law of reflection $\hat{i} = \hat{r}$ (b) Mirror equation $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$ (c) Magnification equation $M = \frac{v}{u}$ (d) Number of images when two mirrors are at an angle. $n = \left[\frac{360^0}{\theta} - 1\right]$	
	3.1.3 Refraction of Light	3.1.3.1 Create an optical instrument using the concept of refraction of light.	• Creating optical illusions such as mirage and apparent depth using refraction • Carrying out an experiment to verify the laws of refraction (Snell's law) using glass block, optical pins or laser beam, water and air. $n = \frac{sine\ \hat{i}}{sine\ \hat{r}}$ • Investigating dispersion and refraction using a prism • Demonstrating critical angle and total internal reflection using prisms and glass blocks	• Problems involving total internal reflection and critical angles solved correctly

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• Solving numerical problems on critical angle formula , $\sin C = \frac{1}{n}$. • Exploring how the concept of refraction is applied in telescopes, optical fibre, cameras, microscopes, endoscope ...	
	3.1.4 Lenses	3.1.4.1 Improvise a system of lenses that can be used to solve problems in real life situations.	• Improvising a system of thin lenses such as telescope and microscope and test its performance • Investigating the action of converging and diverging thin lenses • Exploring thin lenses and light sources to create ray diagrams, demonstrating image formation. • Applying the lens equation to calculate focal length, image distance, object distance and power of the lens. Formula $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$, $P = \frac{1}{f}$ • Exploring how lenses create real and virtual images, and calculating magnification using the formula $M = \frac{v}{u}$ • Exploring computer simulations on thin lenses • Researching on thin lenses and applications in everyday life such as in correcting defects in vision, LCD,	• A system of lenses that can be used to solve problems in real life situations improvised

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			cameras …	
3.2 STATIC ELECTRICITY	**3.2.1 Introduction to Static Electricity**	3.2.1.1 Design experiments to investigate static electricity everyday life.	• Carrying out experiments with suitable materials (Perspex, polythene...) to verify the law of static electricity • Generating static electricity by rubbing (friction, triboelectrification), induction and conduction (contact) • Investigating how heat causes static electricity using a heat gun or a lamp • Investigating how humidity causes static electricity • Demonstrating how an object can be charged or discharged by induction. • Discussing how lightening is formed • Testing how different materials conduct or insulate static electricity • Creating a patterns of static electric field lines around a charged object • Exploring how distance affects the strength of electrostatic force • Demonstrating how contact and separation of materials can transfer electrons and create static electricity • Researching on real world application of charging and discharging methods • Simulating charging and discharging methods using software or application	• Experiments to investigate static electricity everyday life designed correcctly
		3.2.1.2 Design a lightning	• Designing a lightening arrester • Simulating the danger of static	• A lightning arrestor

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
		arrester	electricity • Discussing the importance of grounding and earthling • Proposing safety procedures for working with electrostatic charge. • Analysing real world cases of electrostatic accidents	designed
3.3 CURRENT ELECTRICITY	**3.3.1 Electric Charge, Current and Potential Difference**	3.3.1.1 Construct a simple electric circuit.	• Constructing a simple electric circuit and use it to explain electric charge, current, and potential difference • Distinguishing between direction of flow of electrons and conventional current • Measuring voltage (V), and current (I) in series and parallel electric circuits • Calculating effective resistance (R) in series $(R_T = R_1 + R_2 + R_3 + -- R_N)$ an d parallel $(\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + -- + \frac{1}{R_N})$ electric circuits. • Investigating factors that affect resistance of a wire such as (temperature (T), cross section of area (A), length (l) and type of material • Calculating resistivity (ρ) $R = \rho\frac{l}{A}$	• A simple electric circuit constructed
	3.3.2 Electric Cells	3.2.1.1 Develop a sustainable	• Developing a sustainable energy solution	• Sustainable energy

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
		energy solution	• Exploring the structure of electric cells • Exploring electric cells as a fundamental component of energy storage systems • Demonstrating charging and discharging of accumulators (batteries, capacitors…) • Investigating internal resistance (r) of a cell $E = IR + Ir \text{ or } E = V + V_r$ • Exploring environmental implications that electric cells bring about such as battery disposal and energy consumption	solution(s) developed accordingly
	3.3.3 Ohm's Law	3.3.3.1 Construct an electrical circuit system where the concept of ohms' law is applied.	• Creating an electrical circuit system where the concept of ohms' law is applied Verifying Ohm's law using Ohmic and non-Ohmic conductors. • Investigating the relationship between voltage and current. • Solving numerical problems involving Ohm's Law ($V = IR$)	• An electrical circuit system where the concept of ohms' law is applied constructed
	3.3.4 Electric Energy and Power.	3.3.4.1 Construct electrical energy efficient systems	• Constructing electrical energy efficient systems (inductor stove…) • Calculating power $P = VI$ and energy $E = VIt$ consumption • Costing electrical energy in kilowatt-hour (kWh)	• Electrical energy efficient systems constructed accordingly
	3.3.5 Electric Safety	3.3.5.1 Develop a domestic electric	• Developing a domestic electric circuit, considering safety and efficiency	• A domestic electric circuit,

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
		circuit, considering safety and efficiency	• Demonstrating uses of fuse and circuit breakers to automatically interrupt the circuit in case of over current or short circuit • Insulating to prevent accidental contact with live wires or components • Exploring the importance of earthing metal cases and double insulation • Demonstrating how surge protectors protect electrical devices against voltage surges and sparks • Demonstrating adherence to set safety guidelines and regulations on electrical appliances	considering safety and efficiency developed.
3.4 MAGNETISM	**3.4.1 Phenomenon of Magnetism**	3.4.1.1 Design an innovation that applies the phenomenon of magnetism.	• Designing an innovation that demonstrates the use of magnets • Demonstrating the properties of magnets • Exploring the domain theory • Demonstrating induced magnetism in steel and iron • Carrying out experiments with suitable materials to plot magnetic field lines • Creating permanent and temporary magnets by stroking (touching) and using electricity • Demagnetising a magnet using electrical, heating or mechanical method • Demonstrating the use of magnetic keepers and magnetic screening	• An innovation that applies the phenomenon of magnetism designed

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
3.5 LECTROMAGNETISM	**3.5.1 Magnetic effect of Electric-Current**	3.5.1.1 Design innovative solutions involving the magnetic effect of electric	• Demonstrating the magnetic field patterns of electric currents including the direction using the right-hand grip rule, Corkscrew rule … • Creating a system that uses the magnetic effect of an electric current (e.g. electric bell, relay switches …) • Demonstrating the behaviour of an electric current in a magnetic field (apply Fleming's left-hand rule) • Demonstrating the nature of forces between parallel currents • Investigating the effects of magnetic fields on human health and environment • Designing innovative solutions to real-world problems involving the magnetic effect of electric that uses the application of current-carrying conductor placed in the magnetic field (e.g. DC motor, galvanometers, ammeters …)	• A system that uses the application of current-carrying conductor created
3.6 ELECTROMAGNETIC INDUCTION	**3.6.1 Introduction to Electromagnetic Induction**	3.6.1.1 Creating a system that applies Faraday's law of electromagnetic induction.	• Demonstrating Faraday's law of electromagnetic induction • Demonstrating factors that affect the magnitude of induced current • Demonstrating the direction of the induced current using Lenz's and Fleming's right hand rules	• A system that applies Faraday's law of electromagnetic induction created
	3.6.2 The Simple AC and DC	3.6.2.1 Create simple AC	• Creating a simple generator using a magnet, coil.	• Simple AC and DC

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
	generators	and DC generators	• Researching on how Electric Vehicles (EVs) apply electromagnetic induction. • Exploring the benefits of EVs compared to traditional fossil fuel propelled vehicles • Researching on the efficiency of EVs compared to traditional fossil fuel propelled vehicles	generators created
	3.6.3 Transformers	3.6.3.1 Build a simple and efficient iron core transformer	• Building a simple and efficient iron core transformer • Demonstrating mutual induction • Demonstrating the operation of an iron core transformer • Solving problems involving transformers $\frac{V_P}{V_S} = \frac{N_P}{N_S}$ $V_P I_P = V_S I_S$ (for ideal transformer) • Calculating the efficiency of a transformer $\eta = \frac{power\ output}{power\ input} \times 100\%$ • Demonstrating the effects of improper management of transformers	• A simple and efficient iron core transformer built
	3.6.4 Electric Generation and Transmission	3.6.4.1 Design transmission lines considering factors such as voltage	• Designing transmission lines considering factors such as voltage current and distance • Exploring the structure and function of transmission lines • Investigating on different types of	• Transmission lines considering factors such as voltage current and distance

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
		current and distance	transmission lines transmission systems and technologies (overhead, underground, submarine…)	designed

[FORM 4]

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
4.1 BASIC ELECTRONICS	**4.1.1 Introduction to Basic Electronics**	4.1.1.1 Construct a system that applies the concept of thermionic emission in its operations	• Constructing a system that applies the concept of thermionic emission in its operations • Demonstrating thermionic emission • Investigating properties of cathodes rays • Distinguishing between direction of flow of electrons and conventional current • Exploring the application of electron beams in cathode ray tubes, x-ray machines… • Describing the basic structure and action of the cathode ray oscilloscope (CRO) • Solving numerical problems on CRO (voltage, period and frequency).	• A system that applies the concept of thermionic emission in its operations constructed
	4.1.2 Circuit Components	4.1.2.1 Build an electronic circuit.	• Building an electronic circuits such as robot system (traffic control lights…) • Identifying circuit components such as resistors, capacitors, thermistors, diodes, transistors, reed switches, relay switches, inductor, integrated circuits... • Determining resistor values using standard colour codes • Demonstrating the action and application of a variable	• Electronic circuit built accordingly

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			potential divider • Demonstrating the process of rectification (forward and reverse bias of a diode) • Demonstrating the action of electronic switching: Light sensitive switch such as light dependant resistor, temperature sensitive switch…. • Investigating the charging and discharging of capacitors and their roles in electronic equipment	
	4.1.3 Digital Electronic System	4.1.3.1 Create an electronic system.	• Creating an electronic system using breadboards, printed circuits boards (PCBs) or any other suitable materials • Making circuits to demonstrate the operation of the logic gates. • Demonstrating the action of a bipolar transistor • Discussing types of logic gates (AND, OR, NOT, NOR, and NAND) • Deriving truth tables of logic gates • Describing the use of bistable and astable circuits	• An electronic system created accordingly
	4.1.4 Electronic Waste Management	4.1.4.1 Practise sustainable ways of electronic waste management.	• Developing an electronic waste (e-waste) management program (prevention/elimination, reuse, recycle, recovery, reduce, and disposal) • Investigating effects of	• Sustainable ways of electronic waste management practised

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			electronic waste in our environment • Investigating the current electronic waste management practises	
4.2 COMMUNICATION SYSTEM	**4.2.1 Communication System**	4.2.1.1 Build a communication system using a transmitter, receiver and channel.	• Building a communication system using a transmitter, receiver and channel • Explaining the basic principles of communication systems (analogue and digital, optical, wireless…) • Analysing stages in communication (message (signal), encoding, channel selection, message transmission and noise mitigation, decoding, feedback to the sender). • Investigating signal propagation techniques (amplification, modulation and demodulation, error correction, diversity, repeater…) • Demonstrating factors that affect signal propagation (distance, frequency, medium, noise interference, attenuation) • Investigating the use of communication systems in the real-world such as weather monitoring, medical imaging, earthquake monitoring, tsunami warning systems, data lodging, telecommunication	• A communication system using a transmitter, receiver and channel built accordingly

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			transmission, media…	
4.3 ATOMIC PHYSICS	4.3.1 **Nuclear Atom**	4.3.1.1 Create a model of a nuclear atom	• Creating a model of nuclear atom • Exploring the basic structure of an atom including a nucleus composed of protons and neutrons, surrounded by electrons in orbit • Recognising the concepts of atomic number, mass number, and how these relate to the identity of elements • Demonstrating the strong forces that hold protons and neutrons together in the nucleus • Exploring the role of electrostatic force and how it acts between protons in the nucleus, leading to potential instability in certain nuclei.	• A model of a nuclear atom created accordingly
	4.3.2 **Radioactivity**	4.3.2.1 Demonstrate the theoretical understanding of the nature, characteristics, detection and application of radiations.	• Simulating radioactive decay by using computer software • Simulating nuclear fusion and fission by using computer software • Exploring the nature of radioactivity • Discussing characteristics of the three types of radiation • Detecting radiations using instruments such as Geiger Muller Counter, Scintillation Counter and Ionisation Chamber	• The theoretical understanding of the nature, characteristics, detection and application of radiations demonstrated

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			• Explaining the origin and effects of background radiation. • Explaining radioactive decay (alpha, beta and gamma) • Solving numerical problems on radioactivity using the equations $\frac{N_t}{N_o} = \left(\frac{1}{2}\right)^{\left(\frac{t}{T}\right)}$ $\frac{N_t}{N_o} = e^{\lambda t}$ • Determining half-life of radioactive materials (numerically and graphically)	
		4.3.2.2 Explore the applications of radioactive substances.	• Discussing the applications of radioactive substances • Researching on precautions to take when handling radioactive substances • Discussing the effects of radioactive substances on health and the environment • Investigating nuclear waste management practices which safeguard the environment from radioactive contamination such as Zambia Environmental Management Agency (ZEMA) regulations, Radiation Protection Authority (RPA) regulations, International Atomic Energy Agency (IAEA) regulations, testing	• Applications of radioactive substances explored

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			the local environment regularly, conduction of environmental impact assessment…	
		4.3.2.3 Design innovative solutions for effective nuclear waste management.	• Designing innovative solutions for effective nuclear waste management such as (Collaboration and knowledge sharing, waste to energy conversion technology, recycling nuclear waste…)	• Innovative solutions for effective nuclear waste management designed accordingly
4.4 RENEWABLE ENERGY SYSTEM	**4.2.1 Renewable Energy Systems**	4.2.1.1 Build renewable energy systems using locally available materials	• Building renewable energy systems using locally available materials such as: (a) Wind energy system (b) Solar energy system (c) Hydro power system (d) Biomass energy system • Identifying renewable energy systems • Researching on renewable energy systems, geothermal energy system… • Applying knowledge of renewable energy systems to improve energy efficiency in buildings and industries • Exploring the contributions of renewable systems to sustainable development • Proposing climate change mitigation strategies on renewable energy systems that can help reduce greenhouse gas	• Renewable energy systems built using locally available materials accordingly

TOPIC	SUBTOPIC	SPECIFIC COMPETENCES	LEARNING ACTIVITIES	EXPECTED STANDARD
			emissions	

Appendix: DETAILED SPECIFICATIONS -Apparatus/Equipment

	Physics Laboratory	
ITEM	DESCRIPTION	SPECIFICATION
1	SPRING BALANCES	Flat aluminium or brass scale, regular metal body, suspension ring at top and hook at bottom for load. Spring balance of various capability as follows: 1 Newton 2 Newton 5Newton
2	FORCE BOARD AND	Board Forces Kit- Two Pulleys Running on Ball Bearings Mounted on Clamps to fit Force Board. Twenty 10 Gram Pieces,

Physics Laboratory

ITEM	DESCRIPTION	SPECIFICATION
	ACCESSORIES	Three Hooks, Reel of Cotton and Three Ten Newton Spring Balances.
3	ELASTIC MATERIALS KIT	Spiral springs 300mm long, 5mm diameter (pack of 3) (Low elastic limit)
4	BAROMETER TUBE	Glass of 900mm length thick walled, closed at one end
5	HARES APPARATUS U- Tube Manometer	Three limbed glass tube 600mm long and 10mm outer diameter on graduated stand, complete with rubber tube and punch- dip Glass U- tube, on graduated stand, tube 600mm long and 10mm outside diameter
6	LINEAR EXPANSION APPARATUS Ring and Ball	Pullinger's type: Consisting of a half metre brass tube with inlet and outlet for steam and hole thermometer, supported in wooden frame with 3 rods of brass, copper and steel Ring and Ball: Brass with wooden handle and chain, 18mm diameter ball and 25mm diameter ring
7	CHARLES; LAW APPARATUS	Mounted on Metal Base, Scale Graduated in mm, Glass Air Reservoir, Vertical Clamping Rod Mercury Levelling Tube with Open End, with Thermometer Bulb and Other Accessories(Tall form beaker included)
8	CONDUCTIVITY (KIT)	- 5 Rods of different metals on metal ring with wooden handle - Consists of 8 rods ; brass, aluminuim, glass of 250 x 3mm and 8 each of copper, brass and iron 250 x 1.5mm, contained in box
9	RADIATION KIT	Kit contains radiant heat source, copper 200mm with iron handle; glass plates 230x 230 x3mm, asbestos square
10	SOLAR ENERGY KIT	A solar cell is held in a clamp on a base. The clamp is adjustable so that solar cell panel can be held at right angle to the rays of the sun (4082)
11	MIRRORS: PLA IN CONCAVE CONVEX	Back silvered and spray painted Size 70x 30 x3mm 50mm Diameter 50mm Diameter
ITEM	**DESCRIPTION**	**SPECIFICATION**
12	LENSES: CONCAVE 50/CONVEX 50	Clear glass double convex, double concave, convex, concave (setoff 6 lenses 38mm, 60mm diameter
13	CONVEX LENSE	Optically true clear of 100mm and 150mm focal lengths
14	OPTICAL SETS	Each set to have the following: - Light ray box of rectangular 175 mm length, 90mm wide, 55mm light with bulb to work on 12 volts battery ACCESSORIES 5 Perspex Blocks of true optical glass - 1 rectangular 115mm x 65mm x 18mm - Perspex Blocks of true optical glass - 1 Semi- circular of 90mm Diameter x 18mm thickness - 1 prism 90° of 45° of 75mm hypotenuse, 18mm thick

	Physics Laboratory	
ITEM	DESCRIPTION	SPECIFICATION
		- 1 prism 60º of 60 mm side, 18mm thick - 1 prism 90º x60º of 75mm hypotenuse, 18mm thick - 3 cylindrical lenses - 1 double concave 150mm size 40 x 42mm - 1 double concave x75mm size 40 x42mm 3 Mirrors - 1 plane mirror - 1 semi- circular mirror - 1 mirror 30mm x 75mm 2 Slit Plates - 1 Plate with 3 narrow slits on one end and 1 narrow slit on the other end - 1 plate with 4 narrow slits and 1 slit 8 Colour filters mounted to fit ray box 3 primary and 5 secondary colours Six colour cards (3 primary and 3 secondary colours spare bulb 12 volts power supply
15	SONOMETER (STANDARD)	Fitted with wires, 2 bridges, box wood scale, on hollow wood sounding box 1020x 115 x 60mm with tightening keys and pulley for hanging weights
16	TUNING FORKS	CERG: Each has a set of 4 forks Nickel plated or blue steel with screwed shanks, frequency(256h2, 120mm long) D288, E320,C512
17	MAGNETS HORSE SHOE	750MM length, powerful, N and S poles clearly indicated 60mm across limbs with keepers
18	BAR MAGNETS	Powerful Alnico size with keepers 150mm length
19	MALVERN CURRENT BALANCE KIT	Curved rectangular copper wire frame Size 300x100mm wooden boards of 220 x 150mm Plastic index fixed on board of size 70x220mm
20	ELECTRIC BELLS	Large demonstration model, open type on wooden stand
21	DYNAMO	Model AC/DC on wood or synthetic base with selector switch for A,C, or d,c output
22	RHEOSTAT	Sliding Type, %A 10. 7Ohms
23	POTENTIOMETER	2 Meter Model- For measuring an unknown potential difference more accurately than with a voltmeter. Mounted on Hardwood Base with graduated Metre Rule and Three Terminals, Supplied with jockey and Lead

	Physics Laboratory	
ITEM	**DESCRIPTION**	**SPECIFICATION**
24	RESISTANCE UNITS ASSORTED	To demonstrate resistance varies with material, length and cross –section area A set of five wire each mounted on a synthetic resign bonded paper of 65 mm long x 11mm diameter and connected to a pair of 4mm sockets. The units are: Nickel- chromium 200mm length x 0.45 diameter

	Physics Laboratory	
ITEM	DESCRIPTION	SPECIFICATION
		Nickel –chromium 400mm length x 0.45 diameter Nickel- chromium 600mm length x 0.45 diameter Copper-200mm length x 0.45 diameter
25	OSCILLOSCOPE	Single Channel DC to 5Mhz with Marker System
	OSCILLOSCOPE	Dual Channel DC to 20 Mhz as per page 61
26	RADIOACTIVE SET	Radioactive- Active Source set of 3
27	RESISTANCE WIRE	Resistance wire – Assorted in Rolls including copper, fusewire constantan rolls of 60m nichrone, managnin, eureka (250g)
28	AMMETERS; ASSORTED	0- 10A DC, 0-5A DC and to 1ADC Assorted 40/40/40
29	VOLTMETER	0-15V (50), 0-15V 100 Moving coil 0-5v= (50) 0-15V = (100)
30	LOW VOLTAGE POWER SUPPLY	Power Supply 12 Volt AC/DC to operate on 220-240V
31	ALUMINIUM BLOCK	Size 100.100 x 200mm solid block, cylindrical with central hole for heater and small hole for thermometer
32	VERNIER CALIPERS	(i) All Steel construction (ii) Heavy, chrome plated vernier reading 0.1mm
33	BIMETALLIC STRIPS	Bimetallic strip of iron and copper with wooden handle
34	CATHODE RAY TUBES AND ACCESSORIES	Cathode Ray, Tubes and Base with Accessories (horizontal tube fitted with fluorescent painted aluminium plate, cathode side bent at right angles with slit)
35	CIRCUIT BOARDS	Worcester Complete with all fittings: connectors, lamps lamp holders Leads,4mm plugs, crocodile clips, wire/connections wire, cells
36	NEWTONS COLOUR DISCS	200mm diameter discs mounted on stand with large turning wheel with handle and belt
37	DENSITY BOTTLES: 25ML	Unadjusted, capillary stoppers, neck grounded glass, flat bottom round flask type, soda glass capacity 25ml
38	DENSITY BOTTLES: 25ML	Density bottles with thermometer. Soda glass flat bottom round flask type, soda glass neck grounded glass capped, side arm with thermometer 15 to 35^{o} of 0.5^{o} C divisions capacity 50ml

	Physics Laboratory	
ITEM	DESCRIPTION	SPECIFICATION
39	DOMESTIC HEATING MODEL	Model showing how house can be heated with central heating system
40	ELECTRODES COPPER	125 x 50 x 2mm plates with 4mm socket (some black some red) terminals supplied with heavy cylindrical glass jars with grounded edges of height 150mm and diameter 100mm Copper rod, 100mm length, 5mm diameter in glass tube with 4mm socket terminals

	Physics Laboratory	
ITEM	DESCRIPTION	SPECIFICATION
41	ELECTRODES CARBON	Carbon plates 125 x 38 x 38 x 10mm with 4mm socket terminals Carbon rod, 100mm length x 5mm (Metal Mounted Electrodes)
42	ELECTRODES PLATINUM	Platinum foil, width 26mm, thickness 0.05mm Platinum wire, 26mm length, 0.5mm diameter in glass
43	CALORIMETER COPPER	Consisting a plated pun copper blocks, top has hole for thermometer, with terminals, outer vessels and insulating case 80mm
44	CLAMPS: RETORT	(i) Clamps: Retort Universals Type with cork lined clamping jaws Aluminium alloys, cork-lined jaws, clamping bolt. Jaw capacity 98mm overall length clamps
		(ii) Clamps: Die- cast aluminium alloy, three prong clamp, replaceable rubber sleeves fitted to jaws, with thumberscrew. Jaw capacity 100mm, length of rod 116mm
		(iii) Clamps: Die-cast aluminuim alloy, four prongs, plated steel rod. Cork-lined jaws, plated thumberscrew. Jaw capacity 65mm. Length of rod 132mm
		(iv) Clamps 'G' Aluminuim alloy, fast screw tightening and loosening. Jaw width of 75mm
		(i) Rings: cast iron, with boss, painted hammerstone. Plated thumb screw fitted to boss. Distance between centre of ring and supporting rod is about 120mm. Rings of various sizes 45mm, 75mm 100mm

	Physics Laboratory	
ITEM	DESCRIPTION	SPECIFICATION
45	CLAMPS: BOSES	(i) Clamp Bosses Universal boss: Aluminium alloy, one half is provided with slots and a clamping plate to hold rods from 6mm to 10mm diameter. The other half is open ended to grip rods up to 16mm diameter, plated screws
		(ii) Boss Head: Die-cast aluminium alloy, plated steel thumbscrews. For rods up to 16mm diameter
		(iii) Retort Stands: with heavy tripod feet, and up-right of 13 mm diameter. The spread of tripod base increases with the length of rods. Height 450mm 900mm
		(iv) Retort Stand Rods (v) Chrome plated mild steel rods of varying lengths 500mm up to 1000mm
46	GALVANOMETERS	35-0-35m V Resistance of 10 Ohm, 200uA/Division with Colour coded 4mm socked Terminals
47	LAMP HOLDERS: FLAT	Screw in type, For use with flashing Bulbs supplied with screw threaded lamp 3.8V

Physics Laboratory

ITEM	DESCRIPTION	SPECIFICATION
48	FLOW METERS (ELECTRONIC FLOW RATES OF STREAMS AND RIVERS) FLOW METER LABKIT FOR GASES AND LIQUIDS	Counter which records revolutions of a study impelled unit mounted on the rod, 1m long. A simple calibration chart to convert revolutions per unit into metres per second. Complete with battery the whole unit should be fitted into a compact carrying case with full instructions. Kit comprises a series of precision bore borosilicate glass metering tubes, anodized aluminuim and stainless steel floats, stainless end nozzled for 5 to 13 mm bore flexible tubing, mounting frame and stand for vertical mounting overrall height of tubes mounted on a stand is 216 mm. It should have 100mm scale. Kit should include five metering tubes, nine floats, three fine control valves, mounting frame and stand. Calibration charts and carrying case should be supplied. Flow ranges 5ml/ min to 100 ltrs/ min for air Flow ranges 10ml/min to 4.4 ltrs /min for water
49	STOP WATCHES	Large LCD Display with Count Down Timer Function
50	THERMOMETERS (-10^0 C- 110^0 C)	Engraved stem, mecury –in –glass, white back, length 300mm. diameter 7mm, immersion 76mm. Rubber ring Range: - 10^o C to 110^o C with divisions at 1 ^{o}C
51	BAROMETER ANEROID	Wall-mounted instrument in metal frame of 100mm diameter of + 1h Pa of mercury over the normal range of 960 to 1060hPa

Physics Laboratory

ITEM	DESCRIPTION	SPECIFICATION
52	BAROMETER FORTIN	Barometer fortin with thermometer 10 ^{o}C of 1^o divisions
53	RIPPLE TANK	Perspex Base, Plastic Surroundings to Absorb wave Reflection from sides, c/w lamp support and lamp, concave, convex and Rectangular Prisms and Metal Barriers. TO come with Electric Wave Generator with Rheostat Hand Stroboscope
54	LAB CLOCKS	Laboratory, Countdown and Count up, Digital reading Counts up and down from 1 second to 23 Hours and 59 Minutes and 59 second
55	STROBOSCOPES	Hand Held Mounted on Wooden Handle 12 Slots 50mm long x 4mm wide and Finger Hole for Rotation
56	STEPDOWN TRASFORMER 220v-2v	Rectangular steel metal case with output meter, carrying handle, mains switch, fuse mains cable and 13A socket outlet Input 220volts AC output 2 volts
57	TICKER TAPE TIMERS	D.C, spring steel vibrator which marks dots on tape with help of stylus and carbon paper disc., on metal on metal or wood base with solenoid and terminals. Accessories to include: 1 roll ticker tape 9.5 mm wide, approximately 30m roll, 12 carbon discs, ticker tape

	Physics Laboratory	
ITEM	**DESCRIPTION**	**SPECIFICATION**
		pulley, metal pulley on support rod, ticker tape clamp –metal clamp with swivel pad, screw and support rod and transformer for timer
58	STEAM ENGINE (STEAM ENGINE UNIT) (Steam Engine Model)	Steam Engine Unit: to use solid fuel tablets, safety valve, drain cock/overflow plug, whistle and flywheel with 25mm diameter pulley. Complete with fuel burner, supply of fuel tablets, spring driving belt and instructions. Extra supply of fuel tablets needed. “Hargosons” for actual use, all metal model on boars, all parts visible through a glass plate front, uses a cycle pump to work fly wheel.
59	RADIATION PROTECTIVE WEAR (APRONS)	(i) Shield made of 9.5 mm thick acrylic. Transparent and free standing Angled top to allow viewing behind shield, 305mm deep base as flat work surface

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