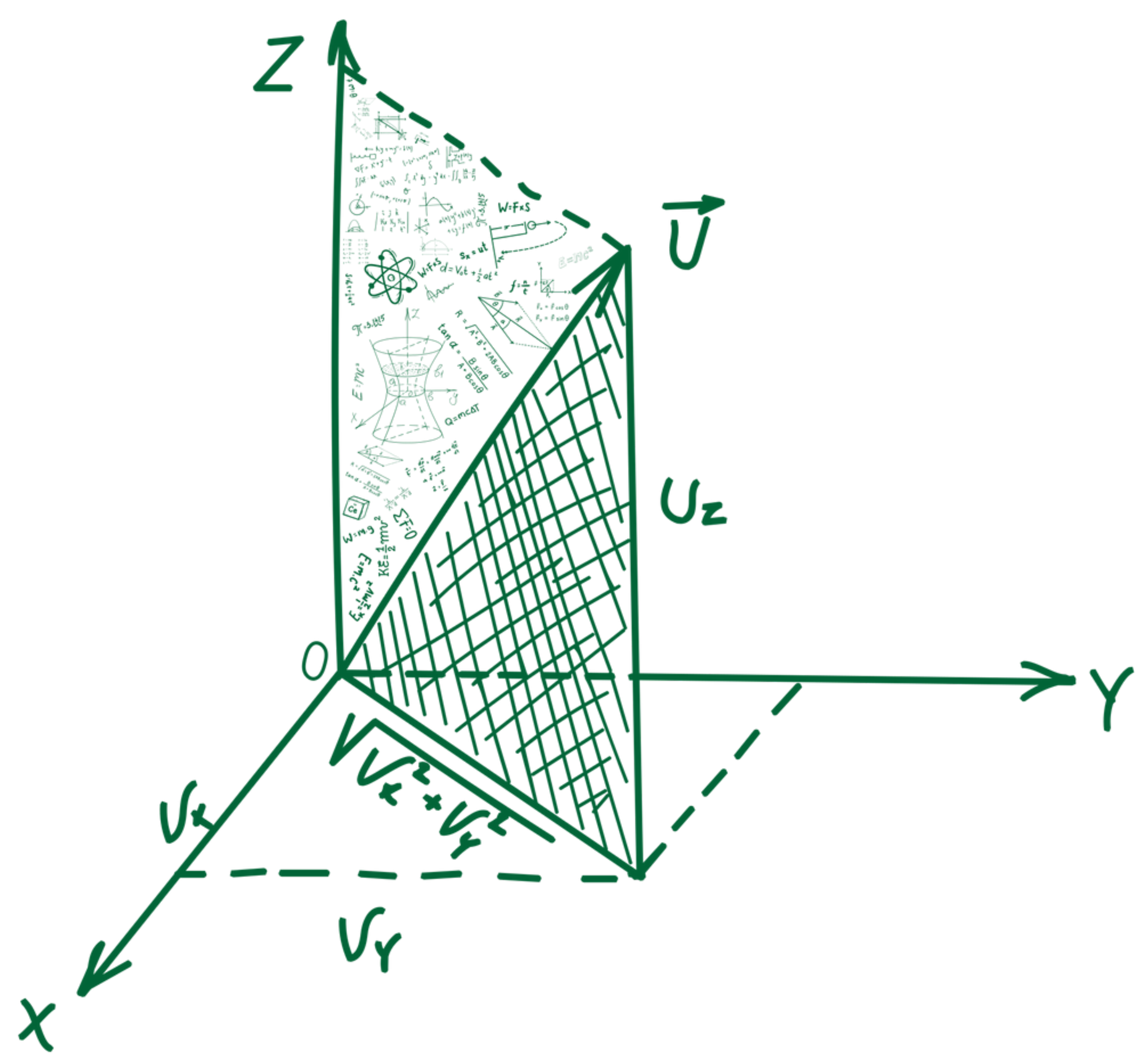
ZIAUDDIN UNIVERSITY
EXAMINATION BOARD

SSC A
Physics Syllabus



For exams in 2026 & onwards

INTRODUCTION TO ZUEB

The Ziauddin University Examination Board (ZUEB) is not only an awarding body but also a solution-driven educational organization dedicated to upholding the highest standards of academic excellence. ZUEB believes in Excellence, Integrity, and Innovation in Education. Established with a vision to foster a robust educational environment, ZUEB is committed to nurturing intellectual growth and development that meets international standards in an effective manner. The Ziauddin University Examination Board (ZUEB) was established through Government Gazette No. XLI on June 6th, 2018. Its purpose is to ensure a high quality, maintain global standards, and align the syllibi with national integrity within the examination system of Pakistan. ZUEB manages student appeals, regulates assessments, and reviews policies to maintain high standards.

WHY CHOOSE SSC-A AT ZUEB?

Ziauddin University Examination Board (ZUEB) offers the SSC-A (Secondary School Certificate advance) program, designed for students from international educational backgrounds. This program provides a structured, affordable, and academically strong pathway for learners to align with Pakistan's education system. It allows students to fulfill national curriculum requirements, including Urdu, Islamiyat, Pakistan Studies, or Sindhi, with academic integrity and flexible learning options. ZUEB believes no student should be left behind due to financial limitations or cross-system transitions, and SSC-A serves as a bridge between past efforts and future ambitions. It is the trusted choice for higher education in Pakistan.

SSC-ADVANCE PHYSICS

Physics in the SSC-advance qualification at ZUEB is a cornerstone subject for students aspiring to pursue careers in engineering, applied sciences, and technology. It provides the essential foundation for analytical reasoning, problem-solving, and scientific exploration — skills that are critical for academic excellence and intellectual growth. This subject not only strengthens conceptual understanding but also equips students with the prerequisites required for success in competitive university entrance examinations across Pakistan.

Aligned with both national educational frameworks and the needs of students from international qualification backgrounds, our SSC-A Physics offers bridges to global understanding with local academic standards. Students gain a firm grasp of fundamental concepts in mechanics, electricity, waves, and thermodynamics, delivered through a structured, flexible, and supportive learning model.

Whether your goal is to enter a top engineering universities, study natural sciences, or simply build a strong foundation in logical reasoning and quantitative thinking, SSC-A Physics ensures you're academicaly prepared and nationaly aligned. Explore more on what SSC-A offers: ZUEB SSC-A Official Page.

Syllabus Overview

No.	Content	AO	Exam
1	Physical Quantities and Measuring Techniques	1,2,3	Combination of written exam papers (externally set and marked) and a practical demonstration of skills. **Paper 1:** Multiple Choice, Theory and Practical Component. Duration: 2 hours **Paper 2:** Multiple Choice, Theory and Practical Component. Duration: 2 hours
2	Kinematics	1,2,3	
3	Dynamics	1,2,3	
4	Work, Power and Energy	1,2,3	
5	Waves	1,2,3	
6	Electricity	1,2,3	
7	Magnetism and Electromagnetic Induction	1,2,3	
8	Thermal Physics	1,2,3	
9	Atomic Structure and Nuclear Physics	1,2,3	
10	The Universe and Cosmology	1,2,3	

DESCRIPTION OF ASSESSMENT OBJECTIVES

AO1 – Show knowledge and understanding of:

- scientific concepts and principles
- relevant methods, techniques, and procedures

AO2 – Apply knowledge and understanding to:

- use scientific ideas in various contexts
- perform and explain investigations, techniques, and procedures

AO3 – Analyse and interpret to:

- evaluate information and data
- draw reasoned conclusions and judgements
- suggest improvements to experimental methods

WEIGHTING OF ASSESSMENT OBJECTIVES

Assesement Objectives	P1 (%)	P2 (%)
A01	30	30
A02	40	40
A03	30	30

Physical Quantities and Measuring Techniques				
Aim: To strengthen learners' command of core scientific skills, , which will be assessed across all units of the syllabus.				
	The learner will:	**SLO #**	**Assessment Criteria - The learner can:**	**Cognitive levels**
1	Understand the use of SI units, prefixes, and precision in accordance with scientific standards.	1.1.1	**Identify** and name standard SI units along with their correct symbols for physical quantities.	AO1
		1.1.2	**Recall** and correctly apply SI prefixes such as nano [n], micro [μ], milli [m], kilo [k], mega [M], giga [G].	AO1
		1.1.3	**Convert** between different units during calculations.	AO2
		1.1.4	**State** numerical answers to a suitable number of significant figures, typically 2 or 3, as required.	AO1
		1.1.5	**Recognize** and **use** correct symbols for commonly used physical quantities.	AO2
2	Understand Graph Plotting Techniques	1.2.1	**Construct** graph axes precisely using a ruler to ensure clarity and accuracy.	AO2
		1.2.2	**Label** graph axes with descriptive titles and relevant units.	AO2
		1.2.3	**Apply** correct scaling to axes using continuous, evenly spaced increments (factors of 1, 2, 5, or 10); ensure labels are clear, even if not starting at zero.	AO2
		1.2.4	**Plot** data points accurately using crosses, ensuring the center is within half a grid square of the true value.	AO2
		1.2.5	**Draw** a line of best fit that balances data above and below, using a ruler, not connecting individual points.	AO3
		1.2.6	**Distinguish** multiple data sets on shared axes using clear and consistent labeling.	AO2
		1.2.7	**Draw** a proportionally sized triangle (≥½ graph dimension) to determine gradient from a line.	AO2
		1.2.8	**Identify** and **shade** the area under a curve or line on a graph when calculating numerical values (e.g. displacement, work).	AO2
		1.2.9	**Draw** axes for a sketch graph using a ruler, ensuring appropriate spacing and alignment.	AO2

		1.2.10	**Label** the axes of a sketch graph using descriptive terms only, omitting units.	AO2
		1.2.11	**Illustrate** the general shape of a sketch graph based on qualitative relationships between variables.	AO3
3	Understand Measuring Techniqes	1.3.1	**Calculate** the average (mean) from a given set of measured values.	AO2
		1.3.2	**Select** and **use** appropriate instruments for measuring length across different scales (e.g. micrometer, metre rule, tape measure, trundle wheel).	AO2
		1.3.3	**Measure** the diameter or volume of a cylinder using multiple readings and **calculate** the average to improve accuracy. [E.g. Measure a wire by taking diameter readings (usually with a micrometer) at different points along its length and in various orientations, then calculate the average]	AO3
		1.3.4	**Determine** small dimensions by measuring a group of identical objects and **calculating** the average value. [E.g. Measure the thickness of paper by stacking a large number of identical sheets, measuring the total thickness and then calculating the average]	AO3
		1.3.5	**Measure** vertical distances accurately and **verify** vertical alignment using tools like set squares or plumb-lines.	AO2
		1.3.6	**Use** suitable timing devices (e.g. stopwatch, timer) to measure short durations; understand limitations of clocks/watches for short intervals.	AO2
		1.3.7	**Measure** brief time intervals by timing multiple events and computing their average (e.g. multiple pendulum swings).	AO3
		1.3.8	**Measure** mass accurately using a suitable device such as an electronic balance; **describe** the limitations of less precise scales.	AO2
		1.3.9	**Describe** how to measure a small mass by weighing a batch of identical objects and **calculating** the average mass per item.	AO2
		1.3.10	**Measure** volume using suitable equipments: measuring cylinder for liquids, displacement can for irregular objects, measurements and calculations for regular ones.	AO2
		1.3.11	**Use** ammeters and voltmeters correctly to measure current and potential difference in a circuit.	AO2
		1.3.12	**Measure** temperature reliably by ensuring good thermal contact, avoiding container contact, stirring fluids, and allowing equilibration.	AO2
		1.3.13	**Measure** angles accurately using an appropriate device (e.g. protractor or angle gauge).	AO2
		1.3.14	**Describe** an anomaly as a data point significantly different from others, relative to the measurement uncertainty.	AO2
4	Understand Variables and Experimental Design for Scientific Enquiry and Planning	1.4.1	**Distinguish** between independent, dependent, and control variables within a scientific investigation.	AO2

		1.4.2	**Explain** the techniques used to control or quantify variables during an experiment.	AO2
		1.4.3	**Construct** a well-labelled scientific diagram representing the experimental setup or circuit layout.	AO3
		1.4.4	**List** essential safety measures to reduce risks during practical work.	AO1
		1.4.5	**Outline** a step-by-step experimental procedure in a way that beginners can follow to achieve reliable results.	AO2
		1.4.6	**Justify** which parts of the procedure need repetition for reliability, how anomalies are handled, and how to process data using averages.	AO2
		1.4.7	**Suggest** appropriate adjustments to the independent variable for conducting multiple experimental trials.	AO2
		1.4.8	**Recall** relevant equations for processing the collected experimental data.	AO1
		1.4.9	**Describe** how to present data in a graph and extract information such as trends or gradients from it.	AO2

Kinematics				
Aim: To develop students' understanding of motion in one and two dimensions through the analysis of displacement, velocity, acceleration, and time.				
	The learner will:	**SLO #**	**Assessment Criteria - The learner can:**	**Cognitive levels**
1	Understand Scalars and Vectors	2.1.1	**Identify** examples of scalar quantities such as distance, speed, energy, and mass.	AO1
		2.1.2	**Identify** examples of vector quantities including displacement, velocity, acceleration, and force.	AO1
		2.1.3	**Specify** both the magnitude and direction when describing vector quantities.	AO2
		2.1.4	**Construct** vector diagrams to visually represent quantities with direction.	AO2
		2.1.5	**Determine** the resultant of two vectors using vector diagrams.	AO2
2	Understand Speed, Velocity, Acceleration and Motion Experiments	2.2.1	**Define** displacement as distance moved in a specific direction, and distinguish it from distance in descriptions.	AO1
		2.2.2	**Define** speed as the the distance travelled per unit time.	AO1
		2.2.3	**Solve** problems using the equations $v = \frac{s}{t}$ and Average Speed = Total distance ÷ Total time	AO2
		2.2.4	**Define** velocity as speed in a particular direction, and **distinguish** it from speed in descriptions.	AO1
		2.2.5	**Describe** an experiment to measure the average speed of an object moving in a straight line using measured distance and time.	AO3
		2.2.6	**Define** acceleration as the rate of change of velocity over time.	AO1
		2.2.7	**State** that acceleration can cause the velocity to increase or decrease, and/or change direction. $a = \frac{\Delta v}{\Delta t}$	AO1
		2.2.8	**Recognize** deceleration as the rate at which velocity decreases.	AO1

		2.2.9	**Solve** problems using the equations $\text{Average Acceleration} = \frac{\text{Change in Velocity}}{\text{Time Taken}}$ and	AO2
		2.2.10	**Describe** an experiment to determine the average acceleration of a straight-moving object using velocity and time measurements.	AO3
3	Analyze and interpret motion using distance–time and velocity–time graphs	2.3.1	**Sketch** and **label** distance–time and velocity–time graphs to represent different types of motion.	AO2
		2.3.2	**Interpret** the shape and features of distance–time and velocity–time graphs to describe object motion.	AO2
		2.3.3	**Calculate** speed from the gradient of a distance-time graph.	AO2
		2.3.4	**Calculate** acceleration from the gradient of a velocity-time graph.	AO2
		2.3.5	**Compute** total distance travelled by finding the area under a velocity–time graph.	AO2
		2.3.6	**Identify** key points such as rest, constant speed, acceleration, and deceleration on motion graphs.	AO3
4	Understand SUVAT Equations and Accelerated Motion	2.4.1	**State** that the SUVAT equations describe motion under constant acceleration.	AO1
		2.4.2	**Identify** situations with constant velocity or acceleration, and distinguish cases where acceleration varies using descriptions, data, or graphs.	AO2
		2.4.3	**Solve** motion problems using the equation $s = ut + \frac{1}{2}at^2$.	AO2
		2.4.4	**Solve** motion problems using the equation $v = u + at$.	AO2
		2.4.5	**Solve** motion problems using the equation $s = \frac{u+v}{2}t$.	AO2
		2.4.6	**Solve** motion problems using the equation $v^2 = u^2 + 2as$	AO2
		2.4.7	**Calculate** average velocity using the formula $\text{Average Velocity} = \frac{u+v}{2}$.	AO2
		2.4.8	**Estimate** realistic values for typical speeds and accelerations encountered in everyday contexts.	AO3
5	Understand Momentum, Conservation and Collision Analysis, Linear Momentum and Newtonian Dynamics	2.5.1	**Define** momentum as the product of an object's mass and velocity	AO1
		2.5.2	Solve problems using the equation p=mv to calculate momentum of moving objects.	AO2

		2.5.3	**State** that the total momentum of a system remains constant unless acted upon by an external force.	AO1
		2.5.4	**Explain** how momentum can be lost from a system through the action of external forces such as friction or impact.	AO3
		2.5.5	**Apply** law of conservation of momentum (total momentum initially = total momentum finally) to solve one-dimensional collision problems where no external forces are present.	AO2
		2.5.6	**Explain** the conservation of momentum in collisions using Newton's Third Law and absence of external forces.	AO3
		2.5.7	**Describe** an experiment using track and trolleys (or similar apparatus) to verify momentum conservation before and after collision.	AO3

Dynamics				
Aim: To understand how forces govern interactions between objects, and how their combination leads to motion or equilibrium in physical systems.				
	The learner will:	**SLO #**	**Assessment Criteria - The learner can:**	**Cognitive levels**
1	Understand Forces Interactions, Resultant Forces and Equilibrium	3.1.1	**Define** force as an interaction that causes a change in an object's momentum.	AO1
		3.1.2	**Identify** common examples of forces such as friction, tension, normal contact force, air resistance, magnetic force, and gravitational force.	AO1
		3.1.3	**Represent** forces using arrows, where length indicates magnitude and direction shows the line of action.	AO2
		3.1.4	**Describe** how multiple forces acting on a body can be simplified to a single resultant force.	AO1
		3.1.5	**Calculate** the net force resulting from several parallel forces acting in the same or opposite directions.	AO2
		3.1.6	**Use** vector diagrams to find the resultant force in an unbalanced system or to determine missing forces in equilibrium conditions.	AO3
		3.1.7	**Draw** free-body diagrams showing all forces acting on an object, including magnitude and direction.	AO2
		3.1.8	**Explain** that deformation (stretching, compressing, bending) requires two or more opposing forces acting on the object.	AO3
		3.1.9	**Differentiate** between internal forces (within the system) and external forces (acting from outside the system).	AO1
		3.1.10	**Describe** resistance forces as forces that act against motion, such as friction and air resistance.	AO1
		3.1.11	**State** that frictional and air resistance forces increase with the speed of a moving object.	AO1
		3.1.12	**State** that the gravitational force near Earth's surface is approximately constant and directed toward Earth's center.	AO1

		3.1.13	**Describe** how the forces acting on a falling object change over time in a constant gravitational field (e.g. increasing air resistance, decreasing acceleration).	AO3
		3.1.14	**Define** terminal velocity as the constant speed reached when upward resistance balances downward gravitational force, resulting in zero acceleration.	AO3
2	Understand Newton's Laws	3.2.1	**State** and **apply** Newton's First Law to describe how an object maintains its motion unless acted upon by an external resultant force.	AO2
		3.2.2	**State** and **apply** Newton's Second Law to explain how objects accelerate due to an unbalanced external force.	AO2
		3.2.3	**Solve** problems using the equation F=ma, where m represents inertial mass.	AO2
		3.2.4	**Define** inertial mass as a measure of how strongly an object resists changes in its velocity.	AO1
		3.2.5	**Define** weight as the force exerted on a mass by a gravitational field.	AO1
		3.2.6	**Recall** that the gravitational field strength, g, is 10 m/s at the Earth's surface, and that it will be different on other planets/moons/etc.	AO1
		3.2.7	**Solve** problems using the equation W=mg, applying the appropriate gravitational field strength when outside Earth.	AO2
		3.2.8	**Explain** why circular motion at constant speed requires a continual inward force to maintain the object's direction.	AO3
		3.2.9	**State** and **apply** Newton's Third Law: For every action, there is an equal and opposite reaction.	AO2
		3.2.10	**Identify** pairs of forces that exemplify Newton's Third Law in real-world interactions.	AO2
		3.2.11	**Justify** whether two interacting forces form a Newton's Third Law pair based on magnitude, direction, and object interaction.	AO3
		3.2.12	**Describe** a method to estimate human reaction time (e.g. using a falling ruler experiment).	AO3
		3.2.13	**Recall** that average human reaction time typically ranges between 0.1 and 0.2 seconds.	AO1
		3.2.14	**Explain** how both thinking distance and braking distance contribute to a car's total stopping distance.	AO3

		3.2.15	**Describe** the dangers associated with rapid deceleration, and estimate forces in typical and emergency driving situations.	AO3
		3.2.16	**Explain** how car safety features (e.g. seatbelts, airbags, crumple zones) reduce the force on passengers using Newton's Laws and motion equations.	AO3
3	Understand Elastic Deformation and Hooke's Law	3.3.1	**State** that a force applied to an object can cause a change in its shape.	AO1
		3.3.2	**Explain** that if an object returns to its original shape after deformation, the change is elastic; otherwise, it is inelastic.	AO1
		3.3.3	**State** Hooke's Law: The extension of a spring is directly proportional to the force applied, within the elastic region.	AO1
		3.3.4	**Solve** problems using the formula F=kx, where F is force, k is spring constant, and x is extension.	AO2
		3.3.5	**Describe** a practical method to determine the spring constant of a metal spring using force and extension measurements.	AO3
		3.3.6	**Define** the limit of proportionality as the point beyond which Hooke's Law no longer holds true.	AO1
		3.3.7	**Define** the elastic limit as the point beyond which a stretched object cannot return to its original length after the force is removed.	AO1
		3.3.8	**Identify** the limit of proportionality and elastic limit from a force-extension graph.	AO3
		3.3.9	**Use** a force-extension graph to determine the spring constant and calculate the elastic energy stored below the limit of proportionality.	AO3
4	Understand Pressure, Density and Buoyancy Forces	3.4.1	**Define** pressure as the force exerted per unit area.	AO1
		3.4.2	**State** that pressure acts perpendicular (normal) to the surface it is applied on.	AO1
		3.4.3	A. **Solve** problems using the formula $P = \frac{F}{A}$ where P is pressure, F is force, and A is area.	AO2

			B. **Describe** atmospheric pressure and relate the concept to understand the working and readings of manometers and barometers.	AO2
		3.4.4	**Explain** how fluid pressure changes with depth or height due to the weight of the overlying fluid.	AO3
		3.4.5	**State** that pressure at a point in a fluid is exerted equally in all directions.	AO1
		3.4.6	**Define** density as mass divided by volume of a material.	AO1
		3.4.7	**Solve** problems using the formula $\rho = \frac{m}{V}$ where ρ is density, m is mass, and V is volume.	AO2
		3.4.8	**Explain** how fluid pressure depends on fluid density, depth, and gravitational field strength.	AO3
		3.4.9	A. **Solve** problems using the formula $P = \rho g h$ where ρ is density, g is gravity, and h is depth.	AO2
			B. **State** Archimedes principle; "the buoyant force on an object submerged in a fluid is equal to the weight of the fluid displaced by the object."	AO1
		3.4.10	**Explain** how the pressure difference between the top and bottom of a submerged object results in an upward buoyant force.	AO3
		3.4.11	**Describe** the conditions that determine whether an object sinks or floats, such as its weight and the fluid's density.	AO3
		3.4.12	**Justify** why two objects of equal mass and material can behave differently in water due to shape or volume differences affecting buoyancy.	AO3
5	Understand moments	3.5.1	**Define** a moment as the rotational effect produced when a force acts at a distance from a pivot or fulcrum.	AO1
		3.5.2	**Describe** real-life examples of rotational forces, such as opening doors, using spanners, or turning taps.	AO1
		3.5.3	**Solve** problems using the formula Moment=Force ×Perpendicular Distance.	AO2
		3.5.4	**State** the Principle of Moments: In equilibrium, the sum of clockwise moments equals the sum of anti-clockwise moments about a pivot.	AO1
		3.5.5	**Describe** an experiment to verify the Principle of Moments using a metre rule, pivot, known weights, and balanced configurations.	AO3

		3.5.6	**Use** the Principle of Moments to solve problems involving balanced or unbalanced systems.	AO2
		3.5.7	**Explain** how levers multiply force by increasing the distance from the pivot, allowing heavy loads to be lifted with less effort.	AO3
		3.5.8	**Describe** how gears transfer rotational force between components, and how changing gear size affects torque and speed.	AO3
		3.5.9	**Define** the centre of mass as the point at which all the mass of an object can be considered to act.	AO1
		3.5.10	**Explain** that an object remains balanced and doesn't rotate if its centre of mass lies directly above its fulcrum or base.	AO3
		3.5.11	**Analyze** how the position of the centre of mass affects stability, with lower and wider positions increasing resistance to tipping.	AO3
		3.5.12	**Outline** a method to locate the centre of mass of an irregular object by suspension and plumb-line alignment.	AO3

Work, Power and Energy				
Aim: Learners will explore how energy enables motion, transforms between forms, and transfers between systems to produce measurable and useful effects.				
	The learner will:	**SLO #**	**Assessment Criteria - The learner can:**	**Cognitive levels**
1	Understand Energy Transfers and Quantitative Relationships	4.1.1	**Define** work as the energy transferred when a force moves an object through a distance.	AO1
		4.1.2	**Solve** problems using the formula W=Fd, where W is work done, F is force, and d is distance moved.	AO2
		4.1.3	**Define** energy as the capacity to perform work.	AO1
		4.1.4	**Identify** and **list** examples of energy stores such as kinetic, gravitational, thermal, chemical, elastic, and nuclear.	AO1
		4.1.5	**Describe** energy transfers and transformations in everyday systems (e.g. electrical to thermal in kettles, chemical to kinetic in cars).	AO3
		4.1.6	**Define** power as the rate at which energy is transferred or work is done.	AO1
		4.1.7	**Solve** problems using the formula $P = \frac{W}{t}$ where P is power, E is energy transferred, and t is time taken.	AO2
2	Understand Energy Conservation and Efficiency	4.2.1	**State** that energy cannot be created or destroyed, only transferred or transformed.	AO1
		4.2.2	**Define** useful energy as the intended output of a device, and wasted energy as unintended forms lost to surroundings.	AO1

		4.2.3	**Identify** and **classify** useful and wasted energy outputs in everyday devices and systems.	AO2
		4.2.4	**Calculate** missing energy values using appropriate energy transfer equations (e.g. input = useful + wasted).	AO2
		4.2.5	**Explain** how energy tends to dissipate through transfer to less useful stores in the system and its environment.	AO3
		4.2.6	**Construct** Sankey diagrams using energy data to visually represent input, useful output, and wasted energy flows.	AO2
		4.2.7	**Calculate** efficiency of a system using the formula $\text{efficiency} = \frac{\text{useful energy}}{\text{total energy}}$	AO2
		4.2.8	**Explain** methods to improve system efficiency, such as reducing friction, insulation, and technological design improvements.	AO3
		4.2.9	**Explain** how building features like insulation, double glazing, and draught-proofing reduce heat loss to the environment.	AO3
3	Understand Energy Calculations	4.3.1	**Solve** problems using the kinetic energy equation $\text{K.E.} = \frac{1}{2}mv^2$	AO2
		4.3.2	**Solve** problems using the gravitational potential energy equation $\text{G.P.E.} = mgh$	AO2
		4.3.3	**Solve** problems using the elastic potential energy equation $\text{Energy Stored in a Spring (E.P.E.)} = \frac{1}{2}kx^2$	AO2
		4.3.4	**Calculate** energy transfers between kinetic, gravitational, and elastic energy stores in systems (e.g. falling, bouncing, compressing).	AO2
		4.3.5	**Describe** an experiment to demonstrate conservation of energy, such as tracking the motion of a falling object and measuring speed and height.	AO3
		4.3.6	**Solve** problems involving total work done on a system and the corresponding energy gained in kinetic, gravitational, or elastic stores.	AO2

		4.3.7	**Solve** problems involving power input and resulting energy gains in different energy stores (K.E., G.P.E., E.P.E.).	AO2
4	Be able to evaluate different energy resources and select appropriate ones for practical use.	4.4.1	**Describe** how major energy sources on Earth (e.g. fossil fuels, nuclear, solar, wind, geothermal, hydroelectric) are used to generate electricity.	AO1
		4.4.2	**Define** renewable energy sources as those that replenish naturally at a faster rate than they are consumed.	AO1
		4.4.3	**Compare** key energy sources based on factors including renewability, reliability, setup cost, operational cost, environmental impact, and limitations.	AO3
		4.4.4	**Justify** the suitability or unsuitability of an energy source for a specific application based on contextual factors (e.g. location, scale, availability).	AO3

Waves				
Aim: Learners will explore how wave properties govern interactions with different materials, and how these principles can be harnessed for practical applications.				
	The learner will:	**SLO #**	**Assessment Criteria - The learner can:**	**Cognitive levels**
1	Understand Wave Properties and Classification	5.1.1	**Describe** waves as oscillations that transfer energy through a medium or space without carrying matter along.	AO1
		5.1.2	**Define** amplitude as the maximum displacement from the equilibrium position during a wave cycle.	AO1
		5.1.3	**Define** wavelength as the distance between two consecutive crests or troughs in a wave.	AO1
		5.1.4	**Define** frequency as the number of complete wave cycles passing a point per second.	AO1
		5.1.5	**Define** period as the time it takes for one full wavelength to pass a fixed point.	AO1
		5.1.6	**Identify** and **label** key wave features on a diagram: amplitude, wavelength, period, crest, and trough.	AO2
		5.1.7	**Solve** problems using the wave speed formula $v = f\lambda$, where v is wave speed, f is frequency, and λ is wavelength.	AO2
		5.1.8	**Compare** transverse and longitudinal waves based on particle motion relative to wave direction; provide examples of each (e.g. light, sound).	AO3
2	Understand wave interactions and their effects at boundaries and during propagation	5.2.1	**Define** reflection as a sudden change in wave direction at a boundary, where the wave remains within the original medium.	AO1

		5.2.2	**Define** refraction as the change in wave direction as it passes across a boundary into a different medium.	AO1
		5.2.3	**Define** diffraction as the spreading out of a wave when it moves through a narrow gap or around an obstacle.	AO1
		5.2.4	**Defin**e transmission as the process by which a wave passes fully or partially through a material or region.	AO1
		5.2.5	**Define** absorption as the transfer of wave energy into the medium through which it travels, often reducing wave amplitude.	AO1
		5.2.6	**Identify** and **label** the angles of incidence, reflection, and refraction on wave diagrams and practical setups.	AO2
		5.2.7	**Describe** how smooth surfaces produce specular reflection and rough surfaces cause diffuse reflection of waves.	AO2
		5.2.8	**State** and **apply** the law of reflection: the angle of incidence is equal to the angle of reflection.	AO2
		5.2.9	**Describe** an experiment to verify the law of reflection using a ray box, mirror, and protractor to measure incident and reflected angles.	AO3
		5.2.10	**Explain** refraction at a boundary in terms of changes in wave speed and wavelength, while frequency remains constant.	AO3
		5.2.11	**Solve** problems using $n_1 \sin\theta_1 = n_2 \sin\theta_2$ where light transitions between air and a transparent material.	AO2
		5.2.12	**Outline** a method to determine the refractive index of a material by measuring angles of incidence and refraction using a rectangular block.	AO3
		5.2.13	**Describe** how diffraction is minimal through wide gaps compared to wavelength, and more significant when gap size is similar to the wavelength.	AO1
		5.2.14	**Provide** real-world examples of reflection (e.g. mirrors), refraction (e.g. lenses), and diffraction (e.g. sound bending through a doorway).	AO1

3	Understand Electromagnetic waves and Electromagnetic Spectrum	5.3.1	**State** that light is a type of electromagnetic wave.	AO1
		5.3.2	**Recall** that the speed of light in a vacuum is approximately 3×10^8 m/s, and that the speed is nearly the same in air.	AO1
		5.3.3	**State** the general properties of electromagnetic waves: they are transverse, travel at the same speed in vacuum, can travel through empty space, and exhibit wave behavior (e.g. refraction).	AO1
		5.3.4	**List** the components of the electromagnetic spectrum in order of increasing or decreasing wavelength and frequency.	AO1
		5.3.5	**Describe** how each type of EM wave can be produced and detected using appropriate sources and detectors.	AO2
		5.3.6	**Explain** the practical uses and potential health hazards associated with each part of the electromagnetic spectrum.	AO3
		5.3.7	**List** the visible spectrum colors in order of increasing or decreasing wavelength/frequency (e.g. red to violet).	AO1
		5.3.8	**Describe** how a substance's absorption, transmission, and reflection of light depend on the wavelength of the light.	AO2
		5.3.9	**Explain** how an object's color appearance results from wavelength-dependent processes: absorption, transmission, specular reflection, and scattering.	AO3
5.4	Understand Ray Diagrams and Light Behaviour	5.4.1	**Draw** a ray diagram showing the reflection of light from a plane mirror, clearly indicating incident and reflected rays and their angles.	AO2
		5.4.2	**Construct** a ray diagram to demonstrate the refraction of light as it passes through a rectangular glass block, showing directional changes.	AO2
		5.4.3	**Sketch** a ray diagram illustrating the dispersion of white light into its constituent colors using a prism.	AO2
		5.4.4	**Define** the terms 'Converging', 'Diverging', and 'Focal point'.	AO1

		5.4.5	**Draw** ray diagrams to show how convex (converging) and concave (diverging) lenses form images, indicating focal points and principal rays.	AO2
5.5	Understand Sound Propagation and Auditory Range	5.5.1	**State** that sound is a longitudinal wave, where oscillations occur parallel to the direction of energy transfer.	AO1
		5.5.2	**Define** loudness as related to amplitude, pitch to frequency, and echo as the reflection of sound waves from surfaces.	AO1
		5.5.3	**Describe** sound waves as a series of compressions and rarefactions traveling through a medium.	AO1
		5.5.4	**Explain** how sound travels by vibrating particles in air and solids, transferring energy without transferring matter.	AO2
		5.5.5	**Justify** why sound travels faster and more efficiently through solids than gases due to particle density and bonding.	AO3
		5.5.6	**State** that humans can hear sounds in the frequency range of approximately 20 Hz to 20 kHz.	AO1
		5.5.7	**Identify** and **classify** sound waves as: • Infrasound (<20 Hz) • Audible sound (20 Hz – 20 kHz) • Ultrasound (>20 kHz)	AO1
		5.5.8	**Describe** how the absorption and reflection of sound by solids depends on frequency, affecting a device's detection range.	AO3
		5.5.9	**Explain** why human hearing range is limited due to the structural and functional properties of the ear and its sensory cells.	AO3
		5.5.10	**Outline** an experiment to measure the speed of sound in air, such as using visual-auditory timing or resonance tube methods.	AO3
6	Understand Wave Applications, Diagnostic Techniques and Practical Effects	5.6.1	**Describe** how wave interactions with different materials (e.g. reflection, refraction, transmission) are used to investigate hidden or internal structures.	AO1
		5.6.2	**Explain** how ultrasound, seismic waves (earthquakes), and sonar are used to image the body, Earth's interior, and underwater environments respectively.	AO3

		5.6.3	**Explain** how light refracting from glass into air can undergo total internal reflection when the angle of incidence exceeds the critical angle.	AO3
		5.6.4	**Solve** problems using the formula $n = \frac{1}{\sin c}$ where c is the critical angle and n is the refractive index. **Define** the critical angle.	AO2
		5.6.5	**Explain** how total internal reflection allows optical fibres to transmit signals over long distances and in medical instruments like endoscopes.	AO3
		5.6.6	**Describe** how relative motion between a wave source and observer causes a change in observed frequency, known as the Doppler Effect.	AO3

Electricity				
Aim: To distinguish between static and current electricity, demonstrate how each produces useful effects, and explain how their associated risks can be safely managed.				
	The learner will:	**SLO #**	**Assessment Criteria - The learner can:**	**Cognitive levels**
1	Understand Electric Current, Potential Difference and Resistance	6.1.1	**Define** electric current as the rate at which electric charge flows through a point in a circuit.	AO1
		6.1.2	**Solve** problems using the formula $I = \frac{Q}{t}$ where I is current, Q is charge, and t is time.	AO2
		6.1.3	**State** that electric current in metals is caused by the movement of electrons.	AO1
		6.1.4	**Recall** that electrons flow in the opposite direction to conventional current.	AO1
		6.1.5	**Define** potential difference as the energy transferred per unit charge as it moves across a component in a circuit.	AO1
		6.1.6	Solve problems using the formula $V = \frac{W}{Q}$ where V is potential difference, W is work done, and Q is charge.	AO2
		6.1.7	**State** that for current to flow, a closed circuit and a source of potential difference are required.	AO1
		6.1.8	**Define** resistance as the ratio of potential difference across a component to the current flowing through it.	AO1

		6.1.9	**Solve** problems using the formula $R = \frac{V}{I}$ where R is resistance, V is potential difference, and I is current.	AO2
		6.1.10	**State** that a component with constant resistance is known as an ohmic conductor.	AO1
		6.1.11	**Identify** an ohmic conductor from a straight-line I–V graph or a proportional data table.	AO2
		6.1.12	**Calculate** the resistance of an ohmic conductor using values from an I–V graph or numerical table.	AO2
		6.1.13	**Sketch** and **interpret** I–V graphs for components such as fixed resistors, filament lamps, and diodes/LEDs.	AO3
		6.1.14	**Sketch** I–V graphs for a thermistor or light-dependent resistor (LDR) showing how the curve changes with temperature or light intensity.	AO2
		6.1.15	**Explain** the shape of I–V graphs for fixed resistors (linear), filament lamps (curved due to heating), and diodes/LEDs (non-linear with threshold behavior).	AO3
		6.1.16	**Explain** how changing conditions (e.g. temperature or light level) affect the resistance and I–V graph shape for thermistors and LDRs.	AO3
		6.1.17	**Calculate** the resistance of a component at a specific point using its I–V graph and values for current and potential difference.	AO2
		6.1.18	Solve problems using $P = IV$ (components and devices).	AO2
2	Understand Circuit Diagrams, Circuit Components and Resistance in Series and Parallel Circuits	6.2.1	**Identify** and **draw** standard circuit symbols for key components: wire, cell, battery, switch, fixed resistor, variable resistor, LDR, thermistor, lamp, diode, ammeter, voltmeter.	AO1
		6.2.2	**Describe** the structural and functional differences between series circuits and parallel circuits.	AO1

		6.2.3	**Interpret** and **construct** basic circuit diagrams using recognized symbols for standard components.	AO2
		6.2.4	**Explain** qualitatively why the resistance of two identical resistors connected in series is greater than the resistance of a single resistor.	AO3
		6.2.5	**Calculate** total resistance in a series circuit using the formula $R_T = R_1 + R_2$	AO2
		6.2.6	**Explain** qualitatively why the resistance of two identical resistors connected in parallel is lower than that of a single resistor.	AO3
		6.2.7	**Calculate** total resistance in a parallel circuit using the formula $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$	AO2
		6.2.8	**Use** circuit rules to calculate current, potential difference, and resistance in series and parallel circuits.	AO2
		6.2.9	**Describe** an experiment to measure the resistance of a fixed resistor using an ammeter and voltmeter.	AO3
		6.2.10	**Outline** a method to investigate how the resistance of an LDR or thermistor varies with light intensity or temperature, using ammeter and voltmeter readings.	AO3
		6.2.11	**Evaluate** the advantages and disadvantages of series and parallel circuits in terms of current flow, component behavior, and system reliability.	AO3
3	Understand Mains Electricity and Safety Features	6.3.1	**Recall** that the UK domestic electricity supply is alternating current (AC) at 50 Hz, with an effective voltage equivalent to 230 V DC.	AO1
		6.3.2	**Describe** the roles of the live wire (carries voltage from the mains), neutral wire (returns current to the power source), and earth wire (safety discharge path).	AO1

		6.3.3	**Identify** the live, neutral, and earth wires in UK mains cables by their color codes:• Live – brown • Neutral – blue • Earth – green/yellow	AO1
		6.3.4	**Describe** safety precautions when wiring a mains plug, including proper insulation handling, secure terminal connections, and cable clamping.	AO2
		6.3.5	**Identify** wiring faults in plug diagrams, such as exposed wires, incorrect placement, reversed polarity, or missing components.	AO2
		6.3.6	**Explain** household electrical hazards such as damaged cables, wet environments near sockets, overloaded circuits, and faulty appliances.	AO3
		6.3.7	**Explain** how safety devices, earth wires, fuses, and circuit breakers prevent electric shocks and protect against excessive current flow.	AO3
		6.3.8	**Evaluate** the benefits and limitations of earth wires, fuses, and circuit breakers based on cost, reliability, reset capabilities, and protection mechanisms.	AO3
		6.3.9	**Explain** why a live wire can still present a shock hazard even when the plug socket switch is off, due to residual potential difference.	AO3
4	Understand Static Electricity	6.4.1	**State** that electric charges can be either positive or negative.	AO1
		6.4.2	**Describe** that like charges repel each other while opposite charges attract.	AO1
		6.4.3	**State** that an electric field is a region where a charged particle experiences a force, with the field direction defined by the force on a positive charge.	AO1
		6.4.4	**Sketch** electric field patterns for different configurations: a point charge, two point charges, a conducting sphere, and between parallel plates.	AO2
		6.4.5	**State** that an object becomes electrically charged when electrons are added to or removed from it.	AO1

		6.4.6	**Describe** static electricity as the physical effects resulting from separated charges and the electric fields they produce.	AO1
		6.4.7	**Describe** methods of generating charge separation, such as friction, induction, or contact.	AO2
		6.4.8	**Distinguish** between conductors and insulators based on how freely their electrons move.	AO1
		6.4.9	**Explain** the behavior of electrons in situations where a charged insulator is brought near another insulator, a conductor, or a neutral object.	AO3
		6.4.10	**Explain** that charge build-up on an insulator can lead to electric shocks or sparks, presenting potential safety hazards.	AO3

Magnetism and Electromagnetic Induction				
Aim: Learners will examine how magnetic fields are generated, how they are used to produce rotational motion, and how electromagnetic principles underpin electricity generation and transfer in modern technology.				
	The learner will:	**SLO #**	**Assessment Criteria - The learner can:**	**Cognitive levels**
1	Understand Magnets, Poles, and Magnetic Fields	7.1.1	**State** that all magnets have two poles; a North pole and a South pole.	AO1
		7.1.2	**Describe** the force interactions between magnetic poles: • Like poles (North–North or South–South) repel • Unlike poles (North–South) attract • A magnetic material is attracted to either pole	AO1
		7.1.3	**Distinguish** between a permanent magnet, which retains its magnetism, and an induced magnet, which becomes magnetic only in the presence of another magnetic field.	AO1
		7.1.4	**Use** iron as an example of a material suitable for induced magnets, and steel as a material used to produce permanent magnets.	AO1
		7.1.5	**Describe** methods for magnetising (e.g. stroking with a magnet, using an electric current, placing in a magnetic field) and demagnetising (e.g. heating, striking, alternating current) a magnet.	AO2
		7.1.6	**State** that a magnetic field is a region where a magnetic pole experiences a force, and its direction is the direction of the force on a North pole.	AO1
		7.1.7	**Draw** magnetic field lines around a bar magnet or two nearby magnetic poles, showing direction from North to South and relative field strength.	AO2
		7.1.8	**Describe** an experiment to observe magnetic field patterns using tools like a compass or iron filings to determine both field shape and direction.	AO3
		7.1.9	**Explain** that Earth's geographic North Pole acts as a magnetic South Pole because it attracts the North-seeking pole of a compass needle.	AO3
	Understand Electromagnetic Force and Rotating Systems	7.2.1	**State** that a moving electric charge, such as current in a wire, generates a magnetic field around it.	AO1

2		7.2.2	**State** that a solenoid is a coil of conducting wire that produces a stronger magnetic field when current flows through it.	AO1
		7.2.3	**Draw** magnetic field patterns around: ▪ A straight current-carrying wire (circular field lines) • A solenoid (uniform field similar to a bar magnet)	AO2
		7.2.4	**Use** the right-hand grip to determine the direction of the magnetic field around a straight conducting wire or solenoid.	AO2
		7.2.5	**Describe** an experiment showing that a current-carrying wire produces a magnetic field, such as compass deflection near a powered wire.	AO3
		7.2.6	**Explain** that the strength of the magnetic field increases with higher current and decreases with distance from the wire.	AO1
		7.2.7	**Explain** methods for increasing the strength of a magnetic field: increasing current, adding coil turns, or using a ferromagnetic core inside a solenoid.	AO3
		7.2.8	**Apply** Fleming's Left Hand Rule to determine the force direction on a current-carrying wire inside a magnetic field, based on the field and current axes.	AO2
		7.2.9	Solve problems using the equation F=BIL, where F is force (N), B is magnetic field strength (T), I is current (A), and L is wire length (m).	AO2
		7.2.10	**Describe** how an electromagnet is built using a coil of wire around an iron core, and give examples of its use in devices such as cranes and circuit breakers.	AO1
		7.2.11	**Explain** that iron is used instead of steel in electromagnets because it easily magnetises and demagnetises, making it more responsive.	AO3
		7.2.12	**Explain** that an electric motor works due to the turning effect on a coil in a magnetic field, resulting from the interaction of current and magnetic force.	AO3
		7.2.13	**State** that a split-ring commutator in a DC motor reverses the current direction each half-turn to maintain continuous rotation.	AO1
		7.2.14	**Describe** how motor turning force can be increased by raising current, using stronger magnets, or increasing coil turns or size.	AO3
	Understand Electromagnetic Induction and Signal Conversion	7.3.1	**Describe** how a changing magnetic field around a conductor induces a potential difference across it, causing current to flow in a complete circuit.	AO1

3		7.3.2	**State** that electromagnetic induction is the generation of a potential difference in a conductor due to a changing magnetic field.	AO1
		7.3.3	**Outline** an experiment to demonstrate electromagnetic induction, such as moving a magnet through a coil and measuring the induced voltage.	AO3
		7.3.4	**Explain** how a rotating coil in a magnetic field produces an alternating current (AC) due to periodic change in coil orientation relative to the field.	AO3
		7.3.5	**State** that a slip-ring maintains connection with the same coil side during rotation, allowing continuous AC output.	AO1
		7.3.6	**State** that a split-ring commutator switches the coil connection every half turn, resulting in direct current (DC) output.	AO1
		7.3.7	**Explain** that a microphone converts sound waves into electrical signals by inducing current in a coil as pressure moves a diaphragm inside a magnetic field.	AO3

		7.3.8	**Explain** that a loudspeaker transforms electrical signals into sound waves by moving a coil attached to a diaphragm when current flows through it in a magnetic field.	AO3
		7.3.9	**Explain** Lenz ' s Law: the current induced by electromagnetic induction generates a magnetic field that opposes the change causing it.	AO3
4	Understand Transformers and Electrical Transmission	7.4.1	**State** that a transformer is a device used to change the voltage in an alternating current (AC) circuit.	AO1
		7.4.2	**State** that a step-up transformer increases voltage and decreases current, while a step-down transformer decreases voltage and increases current.	AO1
		7.4.3	**Describe** the basic construction of a transformer: two coils (primary and secondary) wound around a soft iron core.	AO1
		7.4.4	**Explain** that a transformer operates by electromagnetic induction, transferring energy between coils via a changing magnetic field in the core.	AO3
		7.4.5	**Solve** problems using the transformer equation $\frac{Vp}{Vs} = \frac{Np}{Ns}$ here V is voltage and N is number of coil turns.	AO2
		7.4.6	**Solve** problems using the power equation for efficiency, *IpVp = IsVs* where V is voltage and I is current.	AO2
		7.4.7	**Describe** how transformers are used in the transmission of electricity over large distances by stepping up voltage for efficient transport and stepping it down for safe domestic use.	AO1
		7.4.8	**Explain** why the power loss along transmission wires is less when the voltage is higher.	AO3

Thermal Physics				
Aim: Learners will explore how thermal energy is transferred, how to reduce energy transfer and how changes in internal energy affect the physical behavior of substances.				
	The learner will:	**SLO #**	**Assessment Criteria - The learner can:**	**Cognitive levels**
1	Understand States of Matter, Density and Physical Change	8.1.1	**Draw** particle arrangement diagrams representing solids (closely packed, fixed structure), liquids (close but irregular), and gases (widely spaced).	AO2
		8.1.2	**Describe** the arrangement and movement of particles in solids, liquids, and gases.	AO1
		8.1.3	**Define** density as mass per unit volume of a substance.	AO1
		8.1.4	**Solve** problems using the formula $p = \frac{m}{v}$	AO2
		8.1.5	**Outline** a method to determine the density of an irregular object.	AO3
		8.1.6	**Explain** the relative densities of solids, liquids, and gases in terms of aprticle arrangements.	AO2
		8.1.7	**Define** state change terms: Melting: solid to liquid Freezing: liquid to solid Evaporation: liquid to gas Condensation: gas to liquid Sublimation: solid to gas Deposition: gas to solid	AO1
		8.1.8	**Explain** why state changes are physical changes and not chemical changes.	AO2
2	Understand Internal Energy, Temperature Change and Latent Heat	8.2.1	**State** that energy stored in a chemical bond is negative, meaning energy must be supplied to break the bond.	AO1
		8.2.2	**State** that internal energy is the total energy stored in a substance, comprising potential energy (from chemical bonds) and kinetic energy (particle motion).	AO1
		8.2.3	**Describe** how heating a system increases its internal energy by increasing the kinetic energy of its particles and potentially changing particle spacing.	AO2
		8.2.4	**State** that the temperature of a gas is directly proportional to the average kinetic energy of its molecules.	AO1
		8.2.5	**Explain** why heating a system either increases its temperature or changes its state.	AO3
		8.2.6	**Define** specific heat capacity as the energy needed to increase the temperature of 1 kg of a substance by 1°C	AO1
		8.2.7	**Define** specific latent heat as the energy required to change the state of 1 kg of a substance without changing its temperature.	AO1
		8.2.8	**Solve** problems using $\Delta E = mc\Delta T$, where c is the specific heat capacity.	AO2
		8.2.9	Solve problems using $\Delta E = mL$, where m is mass, and L is specific latent heat.	AO2

		8.2.10	**Describe** an experiment to determine the specific heat capacity of a liquid, e.g. using a heater, thermometer, and known mass with measured energy input.	AO3
3	Understand Ideal Gas Behavior and Relationships (Pressure, Temperature and Volume Interactions)	8.3.1	**Recall** that an ideal gas is a simplified model used to describe gas behavior, and that most gases approximate ideal behavior under normal conditions.	AO1
		8.3.2	**Explain** that gas pressure on the walls of a container results from repeated collisions of moving gas molecules with the container surface.	AO1
		8.3.3	**State** that the force exerted by a gas on a surface due to pressure acts perpendicular (normal) to the surface.	AO1
		8.3.4	**Describe** qualitatively that at constant volume, increasing temperature raises the pressure because gas molecules collide more energetically and more frequently.	AO3
		8.3.5	**Describe** qualitatively that at constant temperature, increasing volume decreases pressure because molecules collide with container walls less frequently.	AO3
		8.3.6	**Describe** qualitatively that at constant pressure, increasing temperature increases the volume due to faster particle motion pushing the container outward.	AO3
		8.3.7	**Solve** problems using the equation $pV=\text{constant}$ for fixed temperature, where p is pressure and V is volume.	AO2
		8.3.8	**Explain** that doing work on a gas, such as compression, increases its internal energy and therefore raises its temperature.	AO3
4	Understand Heat, Temperature and Thermal Energy Transfer	8.4.1	**Describe** the difference between heat and temperature.	AO1
		8.4.2	**Explain** that conduction transfers heat through solids as vibrating particles pass energy to neighboring particles by direct contact.	AO1
		8.4.3	**Explain** that convection transfers heat in fluids as warmer, less dense regions rise while cooler, denser regions sink, creating a circulation pattern.	AO1
		8.4.4	**Explain** that radiation transfers heat via electromagnetic waves, enabling thermal energy to travel through a vacuum (e.g. Sun warming Earth).	AO1
		8.4.5	**Explain** that evaporation causes heat transfer when faster-moving particles escape from a liquid’s surface, lowering the average kinetic energy of the remaining particles.	AO1
		8.4.6	**Explain** how each type of heat transfer can be prevented or reduced.	AO1
5	Understand Black Body Radiation and Thermal Equilibrium	8.5.1	**State** the effect of surface colour and texture on the absorption, emission and reflection of radiation.	AO1
		8.5.2	**Define** a black body as an ideal object that absorbs all incident radiation and emits radiation across all wavelengths.	AO1
		8.5.3	**State** that the distribution and intensity of radiation emitted by a black body depends solely on its temperature.	AO1
		8.5.4	**Draw** and **label** the emission spectrum of a black body, showing peak wavelength shift and increasing total emission with rising temperature.	AO2
		8.5.5	**Explain** that when an object is in thermal equilibrium with its surroundings, the rate of energy absorption equals the rate of energy emission.	AO3

Atomic Structure and Nuclear Physics				
Aim: Learners will explore how energy is released through nuclear processes such as fission and fusion, and understand both the practical applications and potential hazards of radiation in science and industry.				
	The learner will:	**SLO #**	**Assessment Criteria - The learner can:**	**Cognitive levels**
1	Understand Atomic Structure, Energy Levels and Ion Formation	9.1.1	**Describe** the structure of an atom as a central nucleus containing protons and neutrons, surrounded by electrons in defined energy levels.	AO1
		9.1.2	**State** the typical sizes of atoms, molecules and nuclei (order of magnitude).	AO1
		9.1.3	**Describe** how the accepted model of the atom has changed over time.	AO2
		9.1.4	**Explain** how Rutherford's Gold Foil experiment, provided evidence for a small, dense, positively charged nucleus.	AO3
		9.1.5	**State** that electrons in atoms occupy fixed energy levels and can only exist in these distinct energy states.	AO1
		9.1.6	**Describe** how electrons absorb energy to move to higher energy levels and emit energy when they fall back to lower levels.	AO2
		9.1.7	**State** that electrons which gain enough energy can leave their atom entirely, forming a positively charged ion through electron loss.	AO1
2	Understand Nuclear Physics and Radiation Terminology	9.2.1	**Define** isotopes as atoms with the same number of protons but different numbers of neutrons in their nuclei.	AO1
		9.2.2	**Define** radiation as energy or particles emitted from a source and radiated outward in all directions.	AO1
		9.2.3	**Define** radioactive decay as a process in which an unstable atomic nucleus changes causing emission of radiation.	AO1
		9.2.4	**Define** a radioactive substance as one that is currently undergoing radioactive decay and emitting radiation.	AO1
		9.2.5	**Define** half-life as the average time required for half of the unstable nuclei in a sample to undergo radioactive decay.	AO1

		9.2.6	**Define** background radiation as the radiation present in the environment that does not originate from the specific radioactive source being studied.	AO1
3	Understand Radioactive Decay, Detection, Quantitative Analysis, Emissions, Calculations and Experimental Techniques	9.3.1	**Explain** that radioactive nuclei are unstable and spontaneously undergo decay, releasing energy or particles as radiation.	AO1
		9.3.2	**State** that unstable nuclei can emit alpha particles, beta particles, neutrons, or electromagnetic waves (gamma radiation).	AO1
		9.3.3	**List** properties of nuclear radiation: • what they exist as • relative charge • relative mass	AO1
		9.3.4	**List** typical sources of background radiation.	AO1
		9.3.5	**Describe** an experiment to measure how gamma radiation intensity varies with distance from the source, using a GM tube and correcting for background radiation.	AO3
		9.3.6	**Explain** how the emission of radiation affects the nucleus.	AO2
		9.3.7	**Use** nuclear notation to write balanced equations for radioactive decay.	AO2
		9.3.8	**Explain** how radiation ionises atoms it comes in contact with.	AO3
		9.3.9	**State** the relative penetration and ionisation powers of alpha, beta and gamma radiation.	AO1
		9.3.10	**Describe** an experiment to identify the type of radiation emitted from a source while subtracting background radiation.	AO3
		9.3.11	**Calculate** the half-life of a radioactive material using simple data tables or decay graphs.	AO2
		9.3.12	**Explain** how to correct for background radiation by measuring ambient counts before testing and subtracting them from all experimental readings.	AO2
		9.3.13	**Calculate** the actual activity of a radioactive source by subtracting background count from the total measured count rate.	AO2
		9.3.14	**Calculate** remaining radioactive material after whole-number half-lives	AO3

4	Understand Nuclear Fission, Fusion & Reactor Control Energy Release and Reaction Management	9.4.1	**Describe** the process of induced nuclear fission.	AO1
		9.4.2	**Explain** that each fission event releases multiple neutrons, which may collide with other fissile nuclei, causing a chain raction.	AO3
		9.4.3	**Describe** the purpose of a moderator and control rods in a nuclear fission reactor.	AO2
		9.4.4	**Describe** nuclear fusion as the process in which two light atomic nuclei, such as hydrogen isotopes, combine under high temperature and pressure to form a heavier nucleus and release energy.	AO1
		9.4.5	**Use** nuclear notation to write balanced equations for nuclear fission and nuclear fusion.	AO2
		9.4.6	**Compare** and **contrast** nuclear fission and fusion.	AO3
5	Understand Radiation Hazards, Applications, Carbon Dating and Safety Considerations	9.5.1	**Explain** that contamination involves radioactive material entering or attaching to surfaces, while irradiation refers to exposure to radiation without direct contact with the source.	AO1
		9.5.2	**Compare** and **contrast** dangers of ionising radiation and radioactive material.	AO3
		9.5.3	**Describe** that ionising radiation can cause harm like biological tissue by breaking molecular bonds, leading to burns, mutations, or cancer.	AO1
		9.5.4	**Explain** that the danger of radioactive material depends on its half-life.	AO3
		9.5.5	**Describe** uses of each types of ionising radiation.	AO1
		9.5.6	**Explain** that source choice depends on: • Penetrating power (e.g. gamma for internal imaging) • Half-life (e.g. short-lived isotopes for medical tracers, long-lived for monitoring equipment)	AO3
		9.5.7	**Outline** that Carbon-14 dating estimates an object’s age by measuring the remaining radioactive carbon in organic remains, using known half-life values	AO2
		9.5.8	**Explain** that Carbon dating is limited to approximately 50,000 years because after many half-lives, the remaining Carbon-14 is too low to detect reliably.	AO3

The Universe and Cosmology				
Aim: Learners will develop an understanding of astronomical phenomena and how scientific knowledge of the universe has changed over time.				
	The learner will:	**SLO #**	**Assessment Criteria - The learner can:**	**Cognitive levels**
1	Understand The Solar System, Orbital Mechanics of Celestial Bodies and Gravitational Motion	10.1.1	**Define** the solar system as a group of planets, moons, asteroids, comets, and artificial satellites that orbit a central star, the Sun.	AO1
		10.1.2	**Define** a galaxy as a vast collection of stars, solar systems, dust, and gas bound together by gravity.	AO1
		10.1.3	**Compare** and **contrast** the main features of the Solar System: • Sun: a star that provides heat and light • Planets: large bodies orbiting the Sun • Moons: natural satellites orbiting planets • Comets: icy bodies with elongated orbits • Asteroids: rocky objects mainly found in the asteroid belt • Artificial Satellites: man-made objects in orbit around Earth or other planets	AO3
		10.1.4	**Explain** that an orbit is a circular or elliptical path around a celestial object, where gravitational force acts as the centripetal force keeping the object in motion.	AO2
		10.1.5	**Explain** that in a stable orbit, a satellite's velocity direction continually changes due to circular motion, while its speed remains constant.	AO2
		10.1.6	**Explain** the reason behind a changed speed of a satellite's speed altering its orbital radius.	AO2
2	Understand Nuclear Reactions Star Formation, Life Cycle of Stars, Fusion, and Stellar Fate	10.2.1	**State** that nuclear fusion requires extremely high temperatures and densities in order to overcome repulsive forces between atomic nuclei.	AO1
		10.2.2	**Describe** the formation of a main sequence star (nebula -> main sequence).	AO1
		10.2.3	**Explain** that a star becomes stable when the outward pressure from energy released by fusion balances the inward gravitational pull.	AO3
		10.2.4	**State** that fusing heavier nuclei such as helium requires significantly higher temperatures than fusing hydrogen nuclei.	AO1

		10.2.5	**Describe** that low-mass stars evolve from: Main sequence → Red giant → Shed outer layers → White dwarf → (eventual cooling into black dwarf)	AO1
		10.2.6	**Describe** that high-mass stars evolve from: Main sequence → Red supergiant → Supernova → **Either** Neutron star (if mass is moderate) **Or** Black hole (if remnant mass is high)	AO1
		10.2.7	**Label** the key stages in a star's life cycle on a Hertzsprung–Russell diagram, including main sequence, red giant/supergiant, white dwarf, and supernova outcomes.	AO2
3	Understand Doppler Effect, Red-Shifts, Cosmic Expansion, Electromagnetic Radiation and Cosmology	10.3.1	**Explain** that the Doppler effect causes the wavelength of electromagnetic radiation from a moving object to stretch (red-shift) if moving away and compress (blue-shift) if moving closer.	AO3
		10.3.2	**Define** red-shift as the increase in wavelength (shift toward red end) when an object moves away from the observer, and blue-shift as the decrease in wavelength (shift toward blue end) when an object moves toward the observer.	AO1
		10.3.3	**State** that light from distant galaxies is red-shifted, and that the degree of red-shift increases with distance from Earth.	AO1
		10.3.4	**Explain** that widespread red-shift indicates all galaxies are moving apart, suggesting that space itself is expanding rather than galaxies simply moving away.	AO3
		10.3.5	**Explain** that an expanding universe implies that all matter originated from a single, extremely dense point known as the Big Bang in the distant past.	AO3

Mathematical Requirements

Candidate may use calculators for all sections.

Candidate should be able to:

1. Work out problems involving addition, subtraction, multiplication, and division.
2. Calculate percentages with accuracy.
3. Determine percentage increases or decreases.
4. Apply different formulas to find missing values.
5. Convert between various units of measurement.
6. Judge suitable orders of magnitude and sense of scale.
7. Find the surface area and volume of common shapes (e.g., circles, squares, rectangles, triangles).
8. Estimate values by identifying patterns or trends.
9. Represent data using standard form.
10. Round numbers correctly.
11. Give answers using the proper number of significant figures.
12. Record results in line with measuring equipment precision (e.g., 1.1 cm^3 for a burette).
13. Work out energy efficiency.
14. Find averages such as mean, mode, and median.
15. Calculate probabilities.
16. Understand and use ratios effectively.

Safety in the laboratory

🧪 Personal Preparation

- Wear a **lab coat/apron**, **safety goggles**, and **closed-toe shoes** at all times.
- Tie back long hair and secure loose clothing or accessories.
- Avoid eating, drinking, chewing gum, or applying cosmetics in the lab.
- Read the experiment instructions fully before starting.

⚠️ General Conduct

- Work only under supervision, never alone in the lab.
- Keep your workspace tidy; store bags and books away from benches.
- Handle all equipment and materials with care; report any damage immediately.
- Follow your teacher's instructions exactly; do not improvise procedures.

🔬 Equipment & Chemical Safety

- Use apparatus only after proper training.
- Check glassware for cracks before use; handle hot glass with tongs or heat-resistant gloves.
- Never touch electrical equipment with wet hands.
- Read chemical labels carefully; know the hazard symbols.
- Use fume cupboards for volatile, toxic, or strong-smelling chemicals.

🧬 Biological Safety

- Wash hands before and after handling biological specimens.
- Wear gloves when dealing with biological materials.
- Dispose of biological waste in designated containers.

🔥 Fire & Heat Safety

- Keep flammable materials away from open flames.
- Light Bunsen burners only when ready to use; turn them off immediately after.
- Know the location of fire extinguishers, fire blankets, and emergency exits.

🗑️ Waste Disposal

- Dispose of chemicals, broken glass, and biological waste in the correct containers — never down the sink unless instructed.
- Follow your school's waste segregation rules.

🚑 Emergency Procedures

- Report all accidents, spills, or injuries to the teacher immediately.
- Know the location of first-aid kits and emergency contact numbers.
- In case of evacuation, follow the designated route calmly.

FORMULAS

$V = U + at$	$p=mv$	$W = mg$
$F = kx$	$W = Fd$	$\Delta E= mc\Delta T$
$\Delta E= mL$	$v = \frac{s}{t}$	$average\ speed = \frac{total\ distance\ travelled}{total\ time\ taken}$
$a = \frac{\Delta v}{\Delta t}$	$s = ut + \frac{1}{2}at^2$	$Average\ Acceleration = \frac{Chnge\ in\ Velocity}{Time\ Taken}$
$s = \frac{u+v}{2}t$	$v^2 = u^2 + 2as$	$average\ velocity = \frac{u+v}{2}$
$m = \frac{F}{a}$	*Pressure* $P = \frac{F}{A}$	$Efficiency = \frac{Useful\ Energy}{Total\ Energy}$ x 100
$\rho = \frac{m}{V}$	*Power* $P = \frac{W}{t}$	$n_1 sin\theta_1 = n_2 sin\theta_2$
$n = \frac{1}{\sin c}$	v = fλ	$E_{P.E} = \frac{1}{2}kx^2$
$E_P = mgh$	$I = \frac{Q}{t}$	$E_k = \frac{1}{2}mv^2$
$V = \frac{W}{Q}$	$R = V/I$	$\frac{Vp}{Vs} = \frac{Np}{Ns}$
$R_T = R_1 + R_2$	$I_pV_p = I_sV_s$	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$