Unit 3 AOS 1: How do physicists explain motion in two dimensions?

In this unit students use Newton's laws to investigate motion in one and two dimensions. They explore the concept of the field as a model used by physicists to explain observations of motion of objects not in apparent contact. Students compare and contrast three fundamental fields – gravitational, magnetic and electric – and how they relate to one another. They consider the importance of the field to the motion of particles within the field. Students examine the production of electricity and its delivery to homes. They explore fields in relation to the transmission of electricity over large distances and in the design and operation of particle accelerators.

Lesson	Edrolo lesson	Study design dot point	Key knowledge
Chapter 1 – Force and motion			
1A	Kinematics recap		• Quantities of motion • Constant acceleration equations
1B	Forces recap	• investigate and apply theoretically and practically Newton's three laws of motion in situations where two or more coplanar forces act along a straight line and in two dimensions	• Force vectors • The net force • Newton's laws • The gravitational force • The normal force
1C	Inclined planes	• investigate and apply theoretically and practically Newton's three laws of motion in situations where two or more coplanar forces act along a straight line and in two dimensions	• Forces on an inclined plane
1D	Connected bodies	• investigate and apply theoretically and practically Newton's three laws of motion in situations where two or more coplanar forces act along a straight line and in two dimensions	• Connected bodies in tension • Connected bodies in contact
1E	Basic circular motion	• investigate and analyse theoretically and practically the uniform circular motion of an object moving in a horizontal plane: ($F_{net} = \frac{mv^2}{r}$), including: ○ a vehicle moving around a circular road ○ a vehicle moving around a banked track	• Circular speed • Centripetal acceleration • Centripetal force

		○ an object on the end of a string	
1F	Banked circular motion	• investigate and analyse theoretically and practically the uniform circular motion of an object moving in a horizontal plane: ($F_{net} = \frac{mv^2}{r}$), including: ○ a vehicle moving around a circular road ○ a vehicle moving around a banked track ○ an object on the end of a string	• Banked tracks • Conical pendulums
1G	Vertical circular motion	• investigate and apply theoretically Newton's second law to circular motion in a vertical plane (forces at the highest and lowest positions only)	• Forces in vertical circular motion • Zero normal force in vertical circular motion
1H	Projectile motion	• investigate and analyse theoretically and practically the motion of projectiles near Earth's surface, including a qualitative description of the effects of air resistance	• Vertical motion of projectiles • Horizontal motion of projectiles • Linking vertical and horizontal motion of projectiles • Effect of air resistance on projectiles
1I	Momentum and impulse	• investigate and apply theoretically and practically the laws of energy and momentum conservation in isolated systems in one dimension • investigate and analyse theoretically and practically impulse in an isolated system for collisions between objects moving in a straight line: $F\Delta t = m\Delta v$	• Momentum • Impulse and the conservation of momentum
Chapter 1 review			
Chapter 2 – Energy and collisions			
2A	Kinetic energy, work and power	• investigate and apply theoretically and practically the concept of work done by a force using: ○ work done = force × displacement ○ work done = area under force vs distance graph (one dimensional only)	• Work done • Power as the rate of change in energy • Kinetic energy

		• analyse transformations of energy between kinetic energy, elastic potential energy, gravitational potential energy and energy dissipated to the environment (considered as a combination of heat, sound and deformation of material): ○ kinetic energy at low speeds: $E_k = \frac{1}{2}mv^2$; elastic and inelastic collisions with reference to conservation of kinetic energy ○ strain potential energy: area under force-distance graph including ideal springs obeying Hooke's Law: $E_s = \frac{1}{2}k\Delta x^2$ ○ gravitational potential energy: $E_g = mg\Delta h$ or from area under a force-distance graph and area under a field-distance graph multiplied by mass	
2B	Elastic and inelastic collisions	• analyse transformations of energy between kinetic energy, elastic potential energy, gravitational potential energy and energy dissipated to the environment (considered as a combination of heat, sound and deformation of material): ○ kinetic energy at low speeds: $E_k = \frac{1}{2}mv^2$; elastic and inelastic collisions with reference to conservation of kinetic energy ○ strain potential energy: area under force-distance graph including ideal springs obeying Hooke's Law: $E_s = \frac{1}{2}k\Delta x^2$ ○ gravitational potential energy: $E_g = mg\Delta h$ or from area under a force-distance graph and area under a field-distance graph multiplied by mass • investigate and apply theoretically and practically the laws of energy and momentum conservation in isolated systems in one dimension	• Energy dissipation • Elastic and inelastic collisions • Gravitational potential energy
2C	Gravitational potential energy	• analyse transformations of energy between kinetic energy, elastic potential energy, gravitational potential energy and energy dissipated to the environment (considered as a combination of heat, sound and deformation of material): ○ kinetic energy at low speeds: $E_k = \frac{1}{2}mv^2$; elastic and inelastic collisions with reference to conservation of kinetic energy ○ strain potential energy: area under force-distance graph including ideal springs obeying Hooke's Law: $E_s = \frac{1}{2}k\Delta x^2$ ○ gravitational potential energy: $E_g = mg\Delta h$ or from area under a force-distance graph and area under a field-distance graph multiplied by mass	• Gravitational potential energy • Conservation of energy

2D	Strain potential energy	• analyse transformations of energy between kinetic energy, elastic potential energy, gravitational potential energy and energy dissipated to the environment (considered as a combination of heat, sound and deformation of material): ○ kinetic energy at low speeds: $E_k = \frac{1}{2}mv^2$; elastic and inelastic collisions with reference to conservation of kinetic energy ○ strain potential energy: area under force-distance graph including ideal springs obeying Hooke's Law: $E_s = \frac{1}{2}k\Delta x^2$ ○ gravitational potential energy: $E_g = mg\Delta h$ or from area under a force-distance graph and area under a field-distance graph multiplied by mass	• Hooke's law • Strain potential energy
2E	Vertical spring-mass systems	• analyse transformations of energy between kinetic energy, elastic potential energy, gravitational potential energy and energy dissipated to the environment (considered as a combination of heat, sound and deformation of material): ○ kinetic energy at low speeds: $E_k = \frac{1}{2}mv^2$; elastic and inelastic collisions with reference to conservation of kinetic energy ○ strain potential energy: area under force-distance graph including ideal springs obeying Hooke's Law: $E_s = \frac{1}{2}k\Delta x^2$ ○ gravitational potential energy: $E_g = mg\Delta h$ or from area under a force-distance graph and area under a field-distance graph multiplied by mass	• Vertical spring-mass system
Chapter 2 review			
Unit 3 Area of Study 1 review			

Unit 3 AOS 2: How do things move without contact

Field models are used to explain the behaviour of objects when there is no apparent contact. In this area of study, students examine the similarities and differences between three fields: gravitational, electric and magnetic. Students explore how positions in fields determine the potential energy of, and the force on, an object. They investigate how concepts related to field models can be applied to construct motors, maintain satellite orbits and to accelerate particles including in a synchrotron.

Lesson	Edrolo lesson	Study design dot point	Key knowledge

Chapter 4 – Gravitational fields			
3A	Gravitational fields and forces	• describe gravitation, magnetism and electricity using a field model • investigate and compare theoretically and practically gravitational fields and electrical fields about a point mass or charge (positive or negative) with reference to: ○ the direction of the field ○ the shape of the field ○ the use of the inverse square law to determine the magnitude of the field ○ potential energy changes (qualitative) associated with a point mass or charge moving in the field • analyse the use of gravitational fields to accelerate mass, including: gravitational field and gravitational force concepts: $g = G\frac{M}{r^2}$ and $F_g = G\frac{m_1 m_2}{r^2}$ ○ potential energy changes in a uniform gravitational field: $E_g = mg\Delta h$ • describe the interaction of two fields, allowing that electric charges, magnetic poles and current carrying conductors can either attract or repel, whereas masses only attract each other	• Field model of gravity • Inverse square law • Gravitational force and field strength • Interactions between two gravitational fields
3B	Gravitational potential energy in uniform and non-uniform fields	• investigate and compare theoretically and practically gravitational fields and electrical fields about a point mass or charge (positive or negative) with reference to: ○ the direction of the field ○ the shape of the field ○ the use of the inverse square law to determine the magnitude of the field ○ potential energy changes (qualitative) associated with a point mass or charge moving in the field • analyse the use of gravitational fields to accelerate mass, including: ○ gravitational field and gravitational force concepts: $g = G\frac{M}{r^2}$ and $F_g = G\frac{m_1 m_2}{r^2}$ ○ potential energy changes in a uniform gravitational field: $E_g = mg\Delta h$	• Potential energy change in non-uniform fields • Gravitational potential energy in uniform fields

		• analyse the change in gravitational potential energy from area under a force vs distance graph and area under a field vs distance graph multiplied by mass	
3C	Orbital motion	• apply the concepts of force due to gravity and normal force including in relation to satellites in orbit where the orbits are assumed to be uniform and circular • model satellite motion (artificial, Moon, planet) as uniform circular orbital motion: $a = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$	• The force on an object in orbit • The normal force in gravitational fields • Orbital radius, period, and speed • Satellite motion
Chapter 3 review			
Chapter 4 – Electric and magnetic fields			

4A	Electric fields	• describe gravitation, magnetism and electricity using a field model
		• investigate and compare theoretically and practically gravitational, magnetic and electric fields, including directions and shapes of fields, attractive and repulsive effects, and the existence of dipoles and monopoles
		• investigate and compare theoretically and practically gravitational fields and electrical fields about a point mass or charge (positive or negative) with reference to:
		  ○ the direction of the field
		  ○ the shape of the field
		  ○ the use of the inverse square law to determine the magnitude of the field
		  ○ potential energy changes (qualitative) associated with a point mass or charge moving in the field
		• investigate and compare theoretically and practically gravitational, magnetic and electric fields, including directions and shapes of fields, attractive and repulsive effects, and the existence of dipoles and monopoles
		• identify fields as static or changing, and as uniform or non-uniform
		• analyse the use of an electric field to accelerate a charge, including:
		  ○ electric field and electric force concepts: $E = k\frac{Q}{r^2}$ and $F = k\frac{q_1 q_2}{r^2}$
			• Electric fields around point charges
			• Electric fields between charged plates

		○ potential energy changes in a uniform electric field: $W = qV$, $E = \frac{V}{d}$ ○ the magnitude of the force on a charged particle due to a uniform electric field: $F = qE$ • describe the interaction of two fields, allowing that electric charges, magnetic poles and current carrying conductors can either attract or repel, whereas masses only attract each other • model the acceleration of particles in a particle accelerator (including synchrotrons) as uniform circular motion (limited to linear acceleration by a uniform electric field and direction change by a uniform magnetic field).	
4B	Magnetic fields	• describe gravitation, magnetism and electricity using a field model • investigate and compare theoretically and practically gravitational, magnetic and electric fields, including directions and shapes of fields, attractive and repulsive effects, and the existence of dipoles and monopoles • describe the interaction of two fields, allowing that electric charges, magnetic poles and current carrying conductors can either attract or repel, whereas masses only attract each other • investigate and apply theoretically and practically a field model to magnetic phenomena, including shapes and directions of fields produced by bar magnets, and by current-carrying wires, loops and solenoids • identify fields as static or changing, and as uniform or non-uniform	• Magnetic fields • Magnetic field patterns
4C	Magnetic forces on charged particles	• analyse the use of a magnetic field to change the path of a charged particle, including: ○ the magnitude and direction of the force applied to an electron beam by a magnetic field: $F = qvB$, in cases where the directions of *v* and *B* are perpendicular or parallel ○ the radius of the path followed by an electron in a magnetic field: $qvB = \frac{mv}{r}^2$, where $v \ll c$ • investigate and analyse theoretically and practically the force on a current carrying conductor due to an external magnetic field, $F = nILB$, where the	• Magnetic forces on charged particles • Circular motion in magnetic fields • Magnetic forces on current-carrying wires

		directions of *I* and *B* are either perpendicular or parallel to each other	
4D	DC motors	• investigate and analyse theoretically and practically the operation of simple DC motors consisting of one coil, containing a number of loops of wire, which is free to rotate about an axis in a uniform magnetic field and including the use of a split ring commutator • investigate, qualitatively, the effect of current, external magnetic field and the number of loops of wire on the torque of a simple motor	• DC motor operation • Split ring commutators in DC motors • Variation in torque of a DC motor
Chapter 4 review			
Unit 3 Area of Study 2 review			

Unit 3 AOS 3: How are fields used in electricity generation?

The production, distribution and use of electricity has had a major impact on the way that humans live. In this area of study, students use empirical evidence and models of electric, magnetic and electromagnetic effects to explain how electricity is produced and delivered to homes. They explore the transformer as critical to the performance of electrical distribution systems in minimising power loss.

Lesson	Edrolo lesson	Study design dot point	Key knowledge
Chapter 5 – Generating electricity			

5A	EMF and Faraday's law	• calculate magnetic flux when the magnetic field is perpendicular to the area, and describe the qualitative effect of differing angles between the area and the field: $\Phi_B = B_\perp A$
		• investigate and analyse theoretically and practically the generation of electromotive force (emf) including AC voltage and calculations using induced emf: $\varepsilon = -N\frac{\Delta\Phi_B}{\Delta t}$, with reference to:
		  ○ rate of change of magnetic flux
		  ○ number of loops through which the flux passes
			• Magnetic flux
			• Faraday's law

		○ direction of induced emf in a coil	
5B	Direction of induced current and Lenz's law	● investigate and analyse theoretically and practically the generation of electromotive force (emf) including AC voltage and calculations using induced emf: $\varepsilon = -N\frac{\Delta\Phi_B}{\Delta t}$, with reference to: ○ rate of change of magnetic flux ○ number of loops through which the flux passes ○ direction of induced emf in a coil	● Lenz's law
5C	Generators and alternators	● explain the production of DC voltage in DC generators and AC voltage in alternators, including the use of split ring commutators and slip rings respectively ● compare sinusoidal AC voltages produced as a result of the uniform rotation of a loop in a constant magnetic field with reference to frequency, period, amplitude, peak-to-peak voltage (V_{p-p}) and peak-to-peak current (I_{p-p})	● Alternators ● DC generators ● AC power quantifies
5D	Photovoltaic cells	● describe the production of electricity using photovoltaic cells and the need for an inverter to convert power from DC to AC for use in the home (not including details of semiconductors action or inverter circuitry)	● Producing electricity with photovoltaic cells ● Inverters for power use in the home
Chapter 5 review			
Chapter 6 – Transmitting electricity			
6A	Electricity recap		● Electrical quantities ● Ohm's law ● Series circuits ● Power in circuits
6B	Transformer and comparing AC and DC power	● compare sinusoidal AC voltages produced as a result of the uniform rotation of a loop in a constant magnetic field with reference to frequency, period, amplitude, peak-to-peak voltage (V_{p-p}) and peak-to-peak current (I_{p-p})	● RMS, peak and peak-to-peak values of an AC supply ● Comparing RMS and DC power ● Transformers

		• compare alternating voltage expressed as the root-mean-square (rms) to a constant DC voltage developing the same power in a resistive component • analyse transformer action with reference to electromagnetic induction for an ideal transformer: $\frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{I_2}{I_1}$	
6C	Transmission of power	• analyse the supply of power by considering transmission losses across transmission lines	• Power supply and transmission losses • Transformers in power transmission
Chapter 6 review			
Unit 3 Area of Study 3 review			

Unit 4 AOS 1: How has understanding about the physical world changed?

In this area of study, students learn how understanding of light, matter and motion have changed over time. They explore how major experiments led to the development of theories to describe these fundamental aspects of the physical world.

When light and matter are probed, they appear to have remarkable similarities. Light, previously described as an electromagnetic wave, appears to exhibit both wave-like and particle-like properties. Findings that electrons behave in a wave-like manner challenged thinking about the relationship between light and matter.

Chapter 7 – Properties of a mechanical wave			
7A	Waves recap		• Wave definition • Wave properties
7B	Wave interference and path difference	• explain the results of Young's double slit experiment with reference to:	• Constructive and destructive interference • How path difference affects wave interference

		○ evidence for the wave-like nature of light constructive and destructive interference of coherent waves in terms of path differences: $n\lambda$ and $(n - \frac{1}{2})\lambda$ respectively, where $n = 0, 1, 2, ...$ ○ effect of wavelength, distance of screen and slit separation on interference patterns: $\Delta x = \frac{\lambda L}{d}$ when $L \gg d$	
7C	Standing wave	• explain the formation of a standing wave resulting from the superposition of a travelling wave and its reflection • analyse the formation of standing waves (only those with nodes at both ends is required)	• Wave reflection • Resonance • Standing waves on a string with two fixed ends
7D	Diffraction	• investigate and explain theoretically and practically diffraction as the directional spread of various frequencies with reference to different gap width or obstacle size, including the qualitative effect of changing the ratio $\frac{\lambda}{w}$, and apply this to limitations of imaging using electromagnetic waves	• Describing diffraction • Analysing diffraction
Chapter 7 review			
Chapter 8 – Light behaving as a wave			
8A	Electromagnetic waves	• describe light as a transverse electromagnetic wave which is produced by the acceleration of charges, which in turn produces changing electric fields and associated changing magnetic fields • identify that all electromagnetic waves travel at the same speed, *c*, in a vacuum	• Light as an electromagnetic wave
8B	Young's Double Slit experiment	• explain the results of Young's double slit experiment with reference to: ○ evidence for the wave-like nature of light constructive and destructive interference of coherent waves in terms of path differences: $n\lambda$ and $(n - \frac{1}{2})\lambda$ respectively, where $n = 0, 1, 2, ...$ ○ effect of wavelength, distance of screen and slit separation on interference patterns: $\Delta x = \frac{\lambda L}{d}$ when $L \gg d$	• Evidence for the wave-like nature of light • Fringe spacing
Chapter 8 review			

Chapter 9 – Light behaving as a particle			
9A	Experimental design of the photoelectric effect	• analyse the photoelectric effect with reference to: ○ evidence for the particle-like nature of light ○ experimental data in the form of graphs of photocurrent versus electrode potential, and of kinetic energy of electrons versus frequency ○ kinetic energy of emitted photoelectrons: $E_{k\,max} = hf - \phi$, using energy units of joule and electron-volt ○ effects of intensity of incident irradiation on the emission of photoelectrons	• The electron-volt • Understanding the photoelectric effect experiment • Work function • Dependent and independent variables of the photoelectric effect experiment • Stopping voltage as a way to determine the maximum kinetic energy of electrons
9B	Changing intensity in the photoelectric effect	• analyse the photoelectric effect with reference to: ○ evidence for the particle-like nature of light ○ experimental data in the form of graphs of photocurrent versus electrode potential, and of kinetic energy of electrons versus frequency ○ kinetic energy of emitted photoelectrons: $E_{k\,max} = hf - \phi$, using energy units of joule and electron-volt ○ effects of intensity of incident irradiation on the emission of photoelectrons	• Photoelectric effect graphs • Effect of changing the intensity of light
9C	Changing frequency in the photoelectric effect	• analyse the photoelectric effect with reference to: ○ evidence for the particle-like nature of light ○ experimental data in the form of graphs of photocurrent versus electrode potential, and of kinetic energy of electrons versus frequency ○ kinetic energy of emitted photoelectrons: $E_{k\,max} = hf - \phi$, using energy units of joule and electron-volt	• Effect of changing the frequency of light • The relationship between electron kinetic energy and frequency of light

		○ effects of intensity of incident irradiation on the emission of photoelectrons	
9D	Explaining the photoelectric effect	• analyse the photoelectric effect with reference to: ○ evidence for the particle-like nature of light ○ experimental data in the form of graphs of photocurrent versus electrode potential, and of kinetic energy of electrons versus frequency ○ kinetic energy of emitted photoelectrons: $E_{k\,max} = hf - \phi$, using energy units of joule and electron-volt ○ effects of intensity of incident irradiation on the emission of photoelectrons • apply the quantised energy of photons: $E = hf = \frac{hc}{\lambda}$ • describe the limitation of the wave model of light in explaining experimental results related to the photoelectric effect	• Evidence for the particle-like nature of light • The energy of a photon • Why the wave model fails
Chapter 9 review			
Chapter 10 – The wave-particle duality of light and matter			
10A	Comparing light and matter	• investigate and explain theoretically and practically diffraction as the directional spread of various frequencies with reference to different gap width or obstacle size, including the qualitative effect of changing the ratio $\frac{\lambda}{w}$, and apply this to limitations of imaging using electromagnetic waves • interpret electron diffraction patterns as evidence for the wave-like nature of matter • distinguish between the diffraction patterns produced by photons and electrons • calculate the de Broglie wavelength of matter: $\lambda = \frac{h}{p}$	• The limitations of imaging using light • Matter waves: electrons diffract • Comparing the diffraction patterns produced by photons and electrons • Comparing the momentum of photons and matter • Photons and electrons in the double slit experiment

		• compare the momentum of photons and of matter of the same wavelength including calculations using: $p = \frac{h}{\lambda}$ • interpret the single photon and the electron double slit experiment as evidence for the dual nature of light and matter	
10B	Absorption and emission spectra	• apply the quantised energy of photons: $E = hf = \frac{hc}{\lambda}$ • explain the production of atomic absorption and emission line spectra, including those from metal vapour lamps • interpret spectra and calculate the energy of absorbed or emitted photons: $E = hf$ • analyse the emission or absorption of a photon by an atom in terms of a change in the electron energy state of the atom, with the difference in the states' energies being equal to the photon energy: $E = hf = \frac{hc}{\lambda}$ • describe the quantised states of the atom with reference to electrons forming standing waves, and explain this as evidence for the dual nature of matter • discuss the importance of the idea of quantisation in the development of knowledge about light and in explaining the nature of atoms	• Energy level diagrams • Electron standing waves • Atomic absorption and emission spectra • Atomic energy transitions • The importance of quantisation
Chapter 10 review			

Chapter 11 – Special relativity and mass-energy equivalence			

11A	Special relativity concepts	• describe Einstein's two postulates for his special theory of relativity that:
		  ○ describe the limitation of classical mechanics when considering motion approaching the speed of light
		  ○ the laws of physics are the same in all inertial (non-accelerated) frames of reference -the speed of light has a constant value for all observers regardless of their motion or the motion of the source
		• interpret the null result of the Michelson-Morley experiment as evidence in support of Einstein's special theory of relativity
			• Limitations
			• Einstein's first postulate
			• Einstein's second postulate
			• Classical physics and special relativity
			• Limitations of classical mechanics

		• compare Einstein's special theory of relativity with the principles of classical physics • describe the limitation of classical mechanics when considering motion approaching the speed of light	
11B	Length contraction and time dilation	• describe proper time (t_0) as the time interval between two events in a reference frame where the two events occur at the same point in space • describe proper length (L_0) as the length that is measured in the frame of reference in which objects are at rest • model mathematically time dilation and length contraction at speeds approaching *c* using the equations: $t = \gamma t_0$ and $L = \frac{L_0}{\gamma}$ where $\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$	• Time dilation • Length contraction • The Lorentz factor

11C	Relativity examples	• explain and analyse examples of special relativity including that:
		  ○ muons can reach Earth even though their half-lives would suggest that they should decay in the upper atmosphere
		  ○ particle accelerator lengths must be designed to take the effects of special relativity into account
		  ○ time signals from GPS satellites must be corrected for the effects of special relativity due to their orbital velocity
			• Muon detection as evidence of the effect of special relativity
			• The effects of special relativity in particle accelerators
			• GPS time signals

11D	Mass-energy	• interpret Einstein's prediction by showing that the total 'mass-energy' of an object is given by: $E_{tot} = E_k + E_0 = \gamma mc^2$ where $E_0 = mc^2$, and where kinetic energy can be calculated by: $E_k = (\gamma - 1)mc^2$ • apply the energy-mass relationship to mass conversion in the Sun, to positron-electron annihilation and to nuclear transformations in particle accelerators (details of the particular nuclear processes are not required).	• Rest energy • Relativistic kinetic energy • Total mass-energy • Conservation of mass-energy
Chapter 11 review			

Unit 4 Area of Study 1 review		

Unit 4 AOS 2: How is scientific inquiry used to investigate fields, motion or light?

Students undertake a student-designed scientific investigation in either Unit 3 or Unit 4, or across both Units 3 and 4. The investigation involves the generation of primary data relating to fields, motion or light. The investigation draws on knowledge and related key science skills developed across Units 3 and 4 and is undertaken by students in the laboratory and/or in the field.

When undertaking the investigation students are required to apply the key science skills to develop a question, state an aim, formulate a hypothesis and plan a course of action to answer the question, while complying with safety and ethical guidelines. Students then undertake an investigation to generate primary quantitative data, analyse and evaluate the data, identify limitations of data and methods, link experimental results to scientific ideas, discuss implications of the results, and draw and evaluate a conclusion in response to the question. Students are expected to design and undertake an investigation involving one continuous independent variable. The presentation format for the investigation is a scientific poster constructed according to the structure outlined on page 13 of the study design. A logbook is maintained by the students for record, assessment and authentication purposes.

Chapter 12 - Scientific Investigations			
12A		• explain the characteristics of the selected scientific methodology and method including: techniques of primary qualitative and quantitative data generation relevant to the selected investigation; and appropriateness of the use of independent, dependent and controlled variables in the selected scientific investigation • discuss the nature of evidence that supports or refutes a hypothesis, model or theory	• The scientific method • Variables, types of data, and characteristics of data • Theories, models and laws
12B	Scientific conventions	• apply the conventions of science communication: scientific terminology and representations; symbols, equations and formulas; standard abbreviations; significant figures; and units of measurement	• Units of measurements • Significant figures

12C	Collecting data	• identify and apply concepts of accuracy, precision, repeatability, reproducibility, resolution and validity of data; and the identification of, and distinction between, error and uncertainty • model the scientific practice of using a logbook to authenticate generated primary data	• Precision, accuracy & resolution • Error & uncertainty • Validity, repeatability & reproducibility
12D	Representing and analysing data	• apply methods of organising, analysing and evaluating primary data to identify patterns and relationships including: the physical significance of the gradient of linearised data; causes of uncertainty; use of uncertainty bars; and assumptions and limitations of data, methodologies and methods	• Plotting data • Drawing straight and curved lines of best fit • Calculating the gradient
12E	Communicating findings	• explain the key findings and implications of the selected investigation • apply the conventions of scientific poster presentation, including succinct communication of the selected scientific investigation, and acknowledgement of references • identify the physics concepts specific to the investigation and explain their significance, including definitions of key terms and physics representations	
Chapter 12 review			

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