



L-Università
ta' Malta

MATSEC
Examinations Board



SEC 24 Syllabus

Physics

2029

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Introduction

This syllabus is based on the curriculum principles outlined in *The National Curriculum Framework for All* (NCF) which was translated into law in 2012 and designed using the *Learning Outcomes Framework* that identify what students should know and be able to achieve by the end of their compulsory education.

As a learning outcomes-based syllabus, it addresses the holistic development of all learners and advocates a quality education for all as part of a coherent strategy for lifelong learning. It ensures that all children can obtain the necessary skills and attitudes to be future active citizens and to succeed at work and in society irrespective of socio-economic, cultural, racial, ethnic, religious, gender and sexual status. This syllabus provides equitable opportunities for all learners to achieve educational outcomes at the end of their schooling which will enable them to participate in lifelong and adult learning, reduce the high incidence of early school leaving and ensure that all learners attain key twenty-first century competences.

This programme also embeds learning outcomes related to cross-curricular themes, namely digital literacy; diversity; entrepreneurship creativity and innovation; sustainable development; learning to learn and cooperative learning and literacy. In this way students will be fully equipped with the skills, knowledge, attitudes and values needed to further learning, work, life and citizenship.

What is Physics?

One way of defining Physics is in terms of the study of the most fundamental measurable quantities in the universe (e.g. velocity, electric field, kinetic energy), the study of relationships between those fundamental measured quantities (e.g. Newton's Laws, conservation of energy, special relativity) and the study of patterns and correlations as expressed when using words, equations, graphs, charts, diagrams, models, and any other means that can be used to demonstrate a relationship in an understandable way. Physics is the study of matter and the movement of that matter through the space and time of the universe. It's one of the fundamental sciences and covers a huge range of subjects.

Physicists ask big questions like:

- How did the universe begin? How will the universe change in the future?
- How does the Sun keep on shining?
- What are the basic building blocks of matter?

Many physicists work in 'pure' research, trying to find answers to these types of question. The answers they come up with often lead to unexpected technological applications. For example, all of the technology we take for granted today, including games consoles and mobile phones, is based on a theoretical understanding of electrons that was developed around the turn of the 20th Century.

Physics is applied in every sphere of human activity, including:

- Development of sustainable forms of energy production;
- Treating cancer, through radiotherapy, and diagnosing illness through various types of imaging;
- Developing computer games;
- Design and manufacture of sports equipment;
- Understanding and predicting earthquakes;

... in fact, pretty much every sector you can think of needs people with Physics knowledge.

What does a study of Physics entail?

The study of Physics is a natural science based on experiments, measurements and mathematical analysis with the purpose of finding quantitative physical laws for everything from the nanoworld of the micro cosmos to the planets, solar systems and galaxies that occupy the macro cosmos.

The laws of nature can be used to predict the behaviour of the world and all kinds of machinery. Many of the everyday technological inventions that we now take for granted resulted from discoveries in Physics.

The early Greeks established the first quantitative physical laws, such as Archimedes' descriptions of the principle of levers and the buoyancy of bodies in water. By the 17th Century, however, Galileo Galilei and later Isaac Newton helped pioneer the use of mathematics as a fundamental tool in physics, which led to advances in describing the motion of heavenly bodies, the laws of gravity and the three laws of motion.

The laws of electricity, magnetism and electromechanical waves were developed in the 1800s by Faraday and Maxwell while many others contributed to our understanding of optics and thermodynamics.

Modern physics can be said to have started around the turn of the 20th century, with the discovery of X-rays, radioactivity, the quantum hypothesis, relativity and atomic theory.

Quantum mechanics (Heisenberg and Schrödinger), beginning in 1926, also gave scientists a better understanding of chemistry and solid-state physics, which in turn has led to new materials and better electronic and optical components. Nuclear and elementary particle physics have become important fields, and particle physics is now the basis for astrophysics and cosmology

How is Physics related to candidates' lives, to Malta, and/or to the world?

Physics extends well into your everyday life, describing the motion, forces and energy of ordinary experience. In actions such as walking, cooking, seeing, driving a car or using a phone, physics is at work. The use of sustainable energy, the caring for the environment and the love for nature are also aspects of how Physics relates to our daily lives, in Malta and globally. The applications of Physics are deeply rooted in our lives, using principles of Physics to provide insight, reference and relevance.

The Physics topics at Level 3, 2 and 1 deal with mechanics, energy and fields. Applications to everyday life is a continuous exercise in the whole Physics syllabus. All topics are closely related to the candidates' lives, now and in the future.

The aspirational programme learning outcomes for this subject are:

At the end of the programme, I can:

- recall facts and ideas;
- show an understanding of facts, terminology, principles and concepts;
- use units correctly;
- demonstrate an understanding of the application of Physics in everyday life;
- understand that scientific concepts are developed within a contemporary and historical context;
- recognise the importance of the work of key scientists;
- understand the outcomes of the applications of science;
- use Physics principles and concepts to describe and explain everyday or unfamiliar situations;
- interpret data presented in tables, diagrams or graphs;
- carry out relevant calculations;
- plan and carry out investigations;
- use safe and accurate practical techniques;
- record data accurately;
- interpret data and draw conclusions;
- communicate the data in a clear and accurate manner;
- evaluate the implications of science and how it affects the quality of one's life, that of others and the quality of the environment.

List of Subject Foci

- Waves
- Motion, Forces and Energy
- Thermal Physics
- Electricity and Electromagnetism
- Radioactivity
- The Earth and the Universe
- The Science of the Physical World

List of Learning Outcomes

At the end of the programme, I can:

- LO 1. Show an understanding of the nature and application of different types of waves.
- LO 2. Relate forces and energy to motion.
- LO 3. Show an understanding of the properties of states of matter and of thermal processes.
- LO 4. Show an understanding of static and moving charges.
- LO 5. Show an understanding of magnetism and electromagnetism.
- LO 6. Show an understanding of nuclear phenomena.
- LO 7. Show an awareness of some features of the Earth and the Universe.
- LO 8. Demonstrate an understanding of how Physics works and is communicated.

Programme Level Descriptors

This syllabus sets out the content and assessment arrangements for the award of Secondary Education Certificate in Physics at Level 1, 2 or 3. First teaching of this programme begins in September 2022. First award certificates will be issued in 2025.

The following levels refer to the qualification levels that can be obtained by candidates sitting for SEC examinations. These are generic statements that describe the depth and complexity of each level of study required to achieve an award at Level 1, 2 or 3 in Physics. (Level 1 being the lowest and level 3 the highest).

Level 1: At the end of the programme the candidate will have obtained basic knowledge, skills and competences in the subject such as basic repetitive communication skills and the ability to follow basic, simple instructions to complete tasks. Support is embedded within the task.

Level 2: At the end of the programme the candidate will have obtained good knowledge, skills and competence in the subject such as the interpretation of given information and ideas. The candidate will have developed the ability to carry out complex tasks. Limited support may be embedded within the task.

Level 3: At the end of the programme the candidate will autonomously apply knowledge and skills to a variety of complex tasks. Candidates will utilise critical thinking skills to analyse, evaluate and reflect upon their own work and that of others. Problem solving tasks may be part of the assessment process.

Learning Outcomes and Assessment Criteria

Subject Focus:	Waves		
Learning Outcome 1:	At the end of the programme, I can show an understanding of the nature and application of different types of waves.		
Paper I and Paper II	- Features of different types of waves. - Waves and ray diagrams to show the path taken by waves in media. - Calculations to work out measurable features of waves.		
Assessment Criteria (LEVEL 1)		Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
1.1a Demonstrate that waves are caused by vibrations and that they carry energy as they travel without carrying matter.		1.2a State that waves are caused by vibrations and that they carry energy as they travel, without carrying matter.	
1.1b Identify amplitude, wavelength, longitudinal and transverse waves in diagrams as applied to mechanical waves.		1.2b Define amplitude, periodic time, frequency, wavelength, longitudinal and transverse waves as applied to mechanical waves.	1.3b Explain what is meant by a mechanical wave.
1.1c Identify crest, trough, compression and rarefaction as applied to mechanical waves.		1.2c Describe crest, trough, compression and rarefaction as applied to mechanical waves.	1.3c Describe the length of a wavelength as applied to mechanical waves.
1.1d Identify hertz, Hz, as the SI unit of frequency, f , and seconds, s , as the SI unit of periodic time, T .		1.2d Use the equation $T=1/f$ to solve simple problems by substitution, where T is the periodic time and f is the frequency.	1.3d Use the equation $T=1/f$ to solve problems requiring the use of subject of the formula.
1.1e Identify m/s as the SI unit of wave speed, v , and m as the SI unit of wavelength, λ .		1.2e Use the equation $v=f\lambda$ to solve simple problems by substitution, where v is the speed of propagation and λ is the wavelength.	1.3e Use the equation $v=f\lambda$ to solve problems requiring the use of subject of the formula.
1.1f Read wavelength and amplitude from a displacement-distance graph.		1.2f Sketch the displacement-distance graph for a travelling wave.	1.3f Compare the displacement-distance and the displacement-time graphs for a travelling wave. <i>Show that correspondence between the two graphs which are similar in shape but the quantity on the x-axis varies (distance or time).</i>

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
1.1g Demonstrate how to create transverse and longitudinal waves on a slinky spring.	1.2g Draw a diagram to show how to generate transverse and longitudinal waves on a slinky spring.	1.3g Describe how to generate transverse and longitudinal waves on a slinky spring.
1.1h Give examples of transverse waves, including water surface waves and waves on slinky springs.		
1.1i Demonstrate plane and circular water waves in a ripple tank.	1.2i Identify the wavelength as the distance between two successive and similar points in plane and circular waves.	1.3i Explain why the stroboscope is helpful to view the wave pattern in the ripple tank.
1.1j Demonstrate reflection of plane water waves in a ripple tank.	1.2j Draw reflection of plane water waves in a ripple tank.	1.3j Perform a simple experiment to investigate the reflection of plane water waves in a ripple tank. <i>This includes providing a diagram, the procedure, adequate measurements and precautions.</i>
1.1k State that wavelength changes when a plane water wave passes from one medium to another.	1.2k Draw refraction of plane water waves in a ripple tank.	1.3k Perform a simple experiment to investigate the refraction of plane water waves in a ripple tank. <i>This includes providing a diagram, the procedure, adequate measurements and precautions.</i>
1.1l Demonstrate diffraction of plane water waves in a ripple tank.	1.2l Draw diffraction of plane water waves in a ripple tank.	1.3l Perform an experiment to investigate how the diffraction pattern of plane water waves change as the width of a gap and the wavelength are varied. <i>This includes providing a diagram, the procedure, adequate measurements and precautions.</i>
1.1m Give examples of longitudinal waves, including sound waves and waves along slinky springs.	1.2m Describe an experiment that demonstrates how a medium is required for sound to travel from a source to a detector (bell jar experiment).	1.3m Explain how sound is produced from vibrating objects that compress and rarefy the particles of the carrying medium.

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
1.1n Interpret readings from an experimental setup to determine the speed of sound in air.	1.2n Describe an experiment to determine a rough estimate for the speed of sound in air.	1.3n Carry out an experiment to determine an accurate value for the speed of sound in air. <i>This includes providing a diagram, the procedure, adequate measurements and precautions.</i>
1.1o State that an echo is the reflection of sound.	1.2o Identify examples of the uses of reflection of sound (echo) in nature and in industrial applications.	1.3o Describe examples of reflection of sound (echo) in nature and in industrial applications.
1.1p State the meaning of v , s and t in the equation $v = s/t$ is velocity, displacement and time respectively.	1.2p Use the equation $v=s/t$ in situations where sound is reflected from a surface. <i>Equation is used only by simple substitution.</i>	1.3p Apply the equation $v=s/t$ in situations where sound is reflected from a surface including the use of subject of the formula.
1.1q Recognise m/s as the SI unit of speed; metre, m as the SI unit of distance and second, s, as the SI unit of time.		
1.1r Produce sounds of different frequencies using for example tuning forks, digital tuner or other instruments.	1.2r Relate frequency to the pitch of the sound and amplitude to the loudness.	
1.1s Give examples on the uses of ultrasound.	1.2s Explain that ultrasound consists of sound waves that have a frequency above the audible range of human beings, which is 20000 Hz.	1.3s Describe examples related to the use of ultrasound. <i>Examples include: sonar, medical ultrasound, dog's whistle.</i>
1.1t List the properties which are common to all electromagnetic waves.		1.3t Explain the relationship between frequency and wavelength as applied to the electromagnetic spectrum. <i>High frequency electromagnetic waves have a short wavelength; low frequency electromagnetic waves have a long wavelength.</i>

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
1.1u List the various regions of the electromagnetic spectrum. <i>In order of increasing wavelength.</i>	1.2u Give uses of each region of the electromagnetic spectrum.	1.3u Describe the source and mode of detection of each region of the electromagnetic spectrum.
1.1v List the colours in the visible spectrum in increasing or decreasing wavelength.		
1.1w Draw a ray of light representing direction of travel of a wave. <i>Limited to plane wavefronts.</i>		
1.1x Identify the incident ray and the reflected ray for a light ray hitting a reflective surface.	1.2x Draw the incident ray and the reflected ray for a light ray hitting a reflecting surface.	
1.1y Identify the normal to the boundary in a given diagram.	1.2y Draw the normal to a boundary in a given diagram.	
1.1z Identify the angle of incidence and the angle of reflection.	1.2z State the laws of reflection based upon the identification of the angle of incidence and the angle of reflection.	1.3z Draw ray diagrams to show the use of more than one reflecting surface placed in the path of the ray such as in periscopes.
1.1aa List the properties of images in plane mirrors.	1.2aa Represent, using a ray diagram, the properties of images in plane mirrors.	
1.1ab Demonstrate an experiment that proves the laws of reflection of light hitting a plane mirror.	1.2ab Measure the angle of incidence and the angle of reflection for the experiment that proves the laws of reflection of light.	1.3ab Carry out an experiment that proves the laws of reflection for light hitting a plane mirror. <i>This includes providing a diagram, the procedure, adequate precautions and observations made.</i>

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
1.1ac Identify the ray and angle of incidence and the ray and angle of refraction as light passes from one medium to another.	1.2ac Describe refraction in terms of speed in different media.	
	1.2ad Define the refractive index, n , of a medium for light travelling from air into the medium.	1.3ad Use the equation $n = \frac{\text{speed of light in air}}{\text{speed of light in medium}}$.
1.1ae Identify everyday situations where refraction occurs. <i>Examples should include everyday real life applications – e.g. depth of water, bent pencil.</i>		1.3ae Use $n = \frac{\text{real depth}}{\text{apparent depth}}$.
1.1af Demonstrate an experiment that shows refraction of light as it passes through a transparent medium.	1.2af Draw diagrams to show what happens to light rays travelling in an optically denser medium when they meet a boundary at different angles of incidence.	1.3af Carry out an experiment that shows refraction of light as it passes through a transparent medium. <i>This includes providing a diagram, the procedure, adequate precautions and observations made.</i>
1.1ag Demonstrate critical angle and total internal reflection.	1.2ag Define the term critical angle and total internal reflection.	1.3ag Explain the conditions for total internal reflection.
1.1ah Identify situations where total internal reflection occurs. <i>Examples should include everyday life applications - fibre optic, reflectors, etc.</i>	1.2ah Draw rays of light passing through an isosceles right angle prisms to bend light by 90° and 180° .	1.3ah Discuss how isosceles right angle prisms can be used in everyday life to deflect light by 90° and 180° .
	1.2ai Discuss advantages of using fibre optics (light guides) over traditional methods.	1.3ai Carry out an experiment that demonstrates critical angle and total internal reflection of light (using either semi-circular glass block, reflecting prisms, light guides). <i>This includes providing a diagram, the procedure, adequate measurements, precautions and observations made.</i>

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
1.1aj Draw diagrams showing how white light is dispersed as it passes through a dispersive medium such as a prism.	1.2aj Describe the dispersion of white light into its constituent colours. <i>Distinction between pure and impure spectra is not required.</i>	1.3aj Explain what causes the dispersion of white light made when it is incident at an angle on an optically denser medium.
		1.3ak Describe an experiment that demonstrates dispersion of white light.
	1.2al Identify principal axis, principal focus, optical centre and focal length for converging and diverging lenses in a given diagram.	1.3al Draw ray diagrams at 1:1 scale to show how an image is formed by a given single converging lens for different object distances. <i>Limited to object beyond 2F, at 2F, between 2F and F, between F and lens.</i>
1.1am State the properties of images formed by single, thin, converging lenses.	1.2am Distinguish between real and virtual images.	
1.1an State that the meaning of m is the magnification, h_i is the image height, h_o is the object height, v is the image distance and u is the object distance in diagrams involving thin converging lenses.	1.2an Use the equations for linear magnification $m = \frac{h_i}{h_o} = \frac{v}{u}$ to find magnification.	1.3an Use the equations for linear magnification $m = \frac{h_i}{h_o} = \frac{v}{u}$ to solve problems involving thin converging lenses, including subject of the formula.
1.1ao State applications of converging lenses for different object distances. <i>Limited to object beyond 2F, at 2F, between 2F and F, between F and lens.</i>		1.3ao Describe applications of converging lenses for different object distances. <i>Limited to object beyond 2F, at 2F, between 2F and F, between F and lens.</i>
	1.2ap Set up a simple experiment to carry out a rough method experiment to determine the focal length of a thin converging lens. <i>This includes providing a diagram, the procedure, adequate measurements and precautions.</i>	1.3ap Carry out an experiment to determine the focal length of a thin converging lens using the rough and the accurate method experiment. <i>This includes providing a diagram, the procedure, adequate precautions, measurements made and how to determine the focal length.</i>

Subject Focus:	Motion, Forces and Energy
Learning Outcome 2:	At the end of the programme, I can relate forces and energy to motion.
Paper I and Paper II	<i>Motion related to different parts of a journey.</i> <i>Relate forces in a system to different physical concepts and laws, including Hooke's law, Moments and Pressure.</i> <i>Newton's laws and momentum to typical applications.</i> <i>Quantify different forms of energy in a system in relation to Power and Efficiency.</i>

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
2.1a Distinguish between distance and displacement.	2.2a Distinguish between speed and velocity.	2.3a Distinguish between vectors and scalars.
	2.2b Use (total distance travelled)/(total time taken) to calculate the average speed.	2.3b Apply the equation in Level 2 to solve problems including use of subject of the formula.
	2.2c Use (total displacement)/(total time) to calculate the average velocity.	2.3c Apply the equation in Level 2 to solve problems including use of subject of the formula.
2.1d Explain the meaning of acceleration as (change in velocity)/(time taken).	2.2d Use the equation of acceleration to solve simple problems.	2.3d Apply the equation of acceleration to solve problems including use of subject of the formula.
2.1e Recognise the symbols s, u, v, a and t as referring to the displacement, initial velocity, final velocity, acceleration and time respectively.	2.2e Distinguish between the SI unit for velocity, m/s and the SI unit for acceleration m/s ² .	
2.1f Identify which section(s) in a distance-time graph indicate(s): i. a state of rest; ii. constant speed.		2.3f Sketch a distance-time graph to represent different sections of a journey: at rest and constant speed.

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
	2.2g Determine the speed from a distance-time graph.	2.3g Determine the average speed from a distance-time graph.
2.1h Identify which section(s) in a velocity-time graph indicate(s) an object: - at rest; - moving with constant velocity; - moving with a constant acceleration.		2.3h Sketch a velocity-time graph to represent different sections of a journey: constant velocity and constant acceleration/ deceleration.
2.1i Identify acceleration and deceleration from a velocity-time graph.		2.3i Relate a negative gradient from a velocity-time graphs to deceleration.
	2.2j Calculate acceleration from a velocity-time graph. <i>No calculation of deceleration is required.</i>	2.3j Determine the displacement and the acceleration/deceleration from a velocity-time graph using a graphical method.
	2.2k Use the equations of rectilinear motion $v=u+at$, $s=ut+\frac{1}{2}at^2$, $v^2=u^2+2as$, $s=(u+v)t/2$ to solve simple problems.	2.3k Apply the equations of rectilinear motion $v=u+at$, $s=ut+\frac{1}{2}at^2$, $v^2=u^2+2as$, $s=(u+v)t/2$ to solve problems including use of subject of the formula.
2.1l Define the thinking distance as the distance travelled by an object moving at constant speed during the driver's reaction time.		
	2.2m Identify the factors that affect the thinking distance.	2.3m Describe how the thinking distance is affected by these factors.
2.1n Define the braking distance as the distance travelled by an object during deceleration.		

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
	2.2o Identify the factors that affect the braking distance.	2.3o Describe how the braking distance is affected by these factors.
2.1p Identify between the thinking, braking and stopping distances represented in real-life situations.	2.2p Calculate total stopping distance as the addition of the thinking and braking distance.	2.3p Calculate the thinking, the braking and the stopping distances represented in real-life situations.
2.1q State what is meant by human reaction time.	2.2q Compare human reaction time using a simple experiment in terms of distance fallen by a meter ruler.	2.3q Calculate human reaction time using the experiment of a metre ruler that falls through a measured distance.
2.1r Describe the motion of a falling object on Earth.	2.2r Compare the motion of a falling object on Earth and on the Moon.	2.3r Carry out an experiment to measure the acceleration of free fall. <i>This includes providing a diagram, the procedure, adequate precautions, measurements made and how to determine the acceleration of free fall.</i>
		2.3s Explain how objects of different mass fall equal distances in equal time neglecting air resistance. <i>In a situation of no air resistance, two objects fall with the same acceleration and touch the ground at the same time, irrespective of their mass.</i>
2.1t Demonstrate a situation showing Newton's first law of motion.	2.2t Identify Newton's first law of motion in various situations.	2.3t Link inertia with Newton's first law of motion.
2.1u Label forces acting on an object.	2.2u Draw diagrams of an object which has forces acting on it.	2.3u Describe force as a vector quantity measured in newtons, N.
2.1v Define centre of mass.	2.2v Find the centre of mass of a regularly and an irregularly shaped lamina.	2.3v Describe features that affect stability.

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
2.1w Demonstrate the effect of an unbalanced force acting on an object initially at rest.	2.2w Identify examples where Newton's first law of motion applies.	2.3w State Newton's first law of motion.
	2.2x Determine the resultant (indicating both the magnitude and direction) of forces acting in the same straight line.	
2.1y Represent, using a simple diagram, the acceleration of an object due to an unbalanced force acting on a fixed mass.	2.2y Carry out an experiment that shows the relationship between resultant force and acceleration for a system with constant mass.	2.3y Describe in detail an experiment that shows the relationship between resultant force and acceleration for a system with constant mass. <i>This includes providing a diagram, the procedure, adequate precautions, measurements made and how to determine the magnitude of the resultant force from the graph.</i>
2.1z Represent, using a simple diagram, the acceleration of an object due to a constant force acting on different masses.	2.2z Demonstrate the relationship between the acceleration and the mass of a system when acted upon by a constant resultant force.	2.3z Describe qualitatively the relationship between the acceleration and the mass of a system when acted upon by a constant resultant force.
	2.2aa Use Newton's second law of motion, as $F=ma$, to solve simple problems.	2.3aa State Newton's second law of motion as acceleration is directly proportional to resultant force and inversely proportional to mass ($a \propto F/m$) where m is the mass, F is the resultant force and a is the acceleration
		2.3ab Apply the equation for Newton's second law of motion to solve problems including use of subject of the formula.
2.1ac Define linear momentum as the product of the mass of the object and its velocity, that is $p=mv$ with the SI unit being kg m/s.	2.2ac Use $p=mv$ to solve simple problems.	2.3ac Apply the principle of conservation of momentum in everyday situations. <i>No calculations are required.</i>
	2.2ad State Newton's second law of motion in terms of momentum.	2.3ad Apply the equation for Newton's second law of motion as $F = (\text{change in momentum}) / (\text{change in time})$ to solve simple problems including use of subject of the formula.

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
2.1ae State the meaning of time of impact.	2.2ae Explain how the time of impact is affected when various safety features are applied. <i>Examples to include: Seat belts, crumple zones, air bag, protective foam padding round poles.</i>	2.3ae Discuss how the time of impact and the force affect the change in momentum experienced by an object.
2.1af State Newton's third law of motion in terms of a pair of identical forces which must act on different bodies.	2.2af Give examples of Newton's third law pairs of forces, including contact forces and non-contact forces.	
2.1ag Identify a force as any interaction that can change any of: the state of motion of a body, size, shape.	2.2ag Identify the following contact and non-contact forces in a diagram: friction, tension, drag/ air resistance, reaction, gravitational (weight), electric and magnetic.	2.3ag Identify the different types of forces occurring in a given situation.
2.1ah Use different measuring instruments to measure mass (balance) and weight (Newton meter).	2.2ah Calculate the weight of an object given its mass and the gravitational field strength (expressed in N/kg) and state its direction.	2.3ah Describe the difference between mass and weight.
2.1ai Investigate which factors affect friction between two surfaces in contact.		
2.1aj Describe the behaviour of a helical spring when subjected to an increasing force.	2.2aj State Hooke's law as follows: The stretching force is directly proportional to the extension provided that the elastic limit is not exceeded.	2.3aj Apply Hooke's law in simple situations. <i>(Use of equation $F=k.\Delta x$ not required.)</i>
	2.2ak Define the term elastic limit as the point up to which a spring can be loaded and when unloaded goes back to its original length.	2.3ak Describe what happens to a helical spring when loaded beyond its elastic limit.
	2.2al Identify the elastic limit in force-extension graphs.	2.3al Explain how stiffness is related to the steepness of a force-extension graph.
	2.2am Carry out an experiment that demonstrates Hooke's Law.	2.3am Describe in detail an experiment that demonstrates Hooke's Law. <i>This includes providing a diagram, the procedure, adequate precautions, measurements made as well as the calculations and the representation of data in a graph.</i>

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
2.1an Demonstrate that moment (turning effect) depends on the force and the perpendicular distance from the pivot.	2.2an Identify clockwise and anticlockwise moments using simple diagrams.	
2.1ao Identify newton metre, Nm, as the SI unit of moment of a force.	2.2ao Use the equation for the moment of a force to solve simple problems.	2.3ao Apply the equation for the moment of a force to solve problems including use of subject of the formula.
2.1ap Demonstrate when a system is in equilibrium.	2.2ap State the law of moments.	2.3ap Apply the law of moments to solve problems involving systems in equilibrium having only one pivot including use of subject of the formula.
2.1aq Carry out an experiment to show moments about a pivot. <i>No calculation is required.</i>	2.2aq Carry out an experiment to prove the law of moments using only one clockwise force and one anticlockwise force.	2.3aq Describe in detail an experiment to prove the law of moments. <i>This includes providing a diagram, the procedure, adequate precautions, the measurements made as well as the calculations.</i>
	2.2ar State the two conditions for the equilibrium of a body. <i>Upward forces = Downward forces; Clockwise moments = Anticlockwise moments</i>	
2.1as Identify that an increase in force or a decrease in area, increases pressure on an object.	2.2as Use the equation for Pressure, $P=F/A$ where A is the area of contact and F is the applied normal force, to solve simple problems.	2.3as Apply the equation $P=F/A$ to solve problems including use of subject of the formula.
2.1at Identify pascal, Pa, as the SI unit of pressure, P.		
	2.2au Carry out an experiment to find the pressure exerted by a body on a surface.	2.3au Describe in detail an experiment to find the pressure exerted by a body on a surface. <i>This includes providing a diagram, the procedure, adequate precautions, the measurements made as well as the calculations.</i>
	2.2av Use the equation for pressure in a liquid, $P=pgh$ to solve simple problems.	2.3av Apply the equation for pressure in a liquid, $P=pgh$ to solve problems including use of subject of the formula.

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
2.1aw Identify situations where pressure changes with height or depth.	2.2aw Demonstrate the relationship between liquid pressure and depth.	2.3aw Investigate the relationship between liquid pressure and depth. <i>This includes providing a diagram, the procedure, adequate precautions, measurements made and how to determine the density of the liquid from the graph.</i>
2.1ax State that pressure is transmitted equally in all directions in fluids.	2.2ax Identify simple hydraulic systems.	2.3ax Describe how a simple hydraulic machine uses pressure transmitted in a liquid to magnify forces and use the equation for $P=F/A$ to solve simple problems related to hydraulic machines.
	2.2ay Describe atmospheric pressure as the force per unit area exerted against a surface by the weight of the air above that surface.	2.3ay Explain why atmospheric pressure decreases with increasing height above Earth's surface.
	2.2az Describe how the pressure of a gas is affected by a change in volume or a change in temperature of a fixed mass of gas.	2.3az Describe in terms of the kinetic theory the relationship between two of the following variables: pressure, volume and temperature of a fixed mass of gas.
2.1ba Identify situations where Work is being done.	2.2ba Use the equation for the work done, $W=Fs$ where F is the force and s is the displacement in the direction of the force, to solve simple problems.	2.3ba Apply the equation $W=Fs$ to calculate the mechanical work done by a force in a number of situations including use of subject of the formula. <i>Limited only to the work done by constant forces that are in the direction of motion.</i>
2.1bb Recognise the joule, J, as the SI unit of work, W, and energy, E.	2.2bb Define energy as the ability to do work.	
2.1bc Identify between different forms of energy.	2.2bc Recognise energy transformations in everyday life situations.	
2.2bd State the law of conservation of energy	2.2bd Identify examples of conservation of energy.	2.3bd Apply the law of conservation of energy qualitatively in everyday life situations.
		2.3be Apply the law of conservation of energy to solve problems.

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
2.2bf Recall that an object placed at an altitude above the Earth's surface has gravitational potential energy.	2.2bf Use the equation for gravitational potential energy changes (mgh) near the Earth's surface where m is the mass, g is the gravitational field strength and h is the change in height.	2.3bf Apply the equation for the gravitational potential energy changes, mgh near the Earth's surface including use of subject of the formula.
2.1bg Recall that a moving object has kinetic energy.	2.2bg Use the equation for kinetic energy, $\frac{1}{2}mv^2$, to solve simple problems by substitution.	2.3bg Apply the equation for the kinetic energy, $\frac{1}{2}mv^2$, to solve problems including use of subject of the formula.
2.1bh Write down the equation for Power as $P=E/t$.	2.2bh Define power as the rate of doing work.	
2.1bi Recognise the watt, W , as the SI unit of Power, P . <i>Note that 1 J/s is equivalent to 1 watt.</i>	2.2bi Use the equation for Power, $P=E/t$ to solve simple problems.	2.3bi Apply the equation for Power to solve problems including use of subject of the formula.
	2.2bj Carry out an experiment to find the personal power.	2.3bj Describe in detail an experiment to find the personal power. <i>This includes providing a diagram, the procedure, adequate precautions, the measurements made as well as the calculations.</i>
2.1bk Describe efficiency in terms of useful energy output in relation to total energy input.	2.2bk Compare the efficiency of two simple mechanical systems.	2.3bk Apply the equation of efficiency to solve problems including use of subject of the formula.

Subject Focus:	Thermal Physics
Learning Outcome 3:	At the end of the programme, I can show an understanding of the properties of states of matter and of thermal processes.
Paper I and Paper II	• <i>Relate the three states of matter to density and temperature.</i> • <i>Different thermal processes and their link to their everyday applications.</i> • <i>Specific heat capacity in everyday applications.</i>

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
3.1a Identify kilogram, kg, as the SI unit of mass, m and cubic metre, m ³ , as the SI unit of volume, V.	3.2a Define density as the mass per unit volume.	
3.1b Identify kg/m ³ as the SI unit of density, ρ .	3.2b Use the equation for density $\rho = m/V$ in simple problems.	3.3b Use the equation for density to solve problems requiring the use of the subject of the formula.
3.1c List different materials according to their given densities in terms of whether they sink or float on water.	3.2c Explain why objects float or sink when immersed in a fluid by considering the density of the object and the fluid.	
3.1d Compare the density of a mix of liquids and solids.	3.2d Carry out an experiment to find the density of regular objects.	3.3d Perform an experiment to find the density of a liquid and an irregular object. <i>This includes providing a diagram, the procedure, adequate precautions, the measurements taken as well as the calculations.</i>
3.1e Identify substances in their different states from a given representation of their particle arrangement.	3.2e Describe, using the Kinetic Theory of Matter, the different properties of solids, liquids and gases, including particle arrangement and their motion.	
3.1f List factors which affect the rate of evaporation. <i>(To include: surface area, temperature, air currents and humidity)</i>	3.2f Link the changes of state of matter to the addition or removal of energy to/from the atoms or molecules of the material. <i>Reference to latent heat is not required.</i>	3.3f Interpret evaporation as the change of state in which the more energetic particles leave the surface of the liquid and cause cooling.

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
	3.3g Describe the motion of particles in solids, liquids and gases in relation to temperature and their internal energy.	3.2g Relate temperature change to the change in the average speed of particles in matter.
3.1h Identify the degrees Celsius, °C, as a unit of temperature.	3.2h Identify the Kelvin (K) as the SI unit of temperature. <i>No conversion from degrees Celsius to Kelvin is required.</i>	
	3.2i Identify the freezing point and boiling point of pure water at normal atmospheric pressure as 0 °C and 100 °C respectively.	
3.1j Demonstrate how objects expand on heating.	3.2j Identify practical situations where expansion and contraction occur due to changes in thermal energy.	3.3j Describe how changes in thermal energy result in expansion and contraction. <i>The unusual expansion of water is not required.</i>
3.1k Draw the particles of a gas in a closed container.	3.2k Describe how particles of a gas exert pressure in a closed container due to the continuous bombardment of the particles of the gas on the container. <i>Brownian motion is not required.</i>	3.3k Explain how the increase in the kinetic energy of the particles of a gas increases the pressure of the gas.
3.1l Demonstrate how the direction of heat flow depends on temperature difference.	3.2l Describe heating as an energy transfer due to a temperature difference (from a high temperature to a lower temperature).	
3.1m Identify situations where the three types of heat transfer occur	3.2m Define conduction as heat flow through solids, convection as heat flow through fluids and radiation as heat flow through gases or a vacuum.	3.3m Describe qualitatively conduction, convection and radiation as the fundamental modes of heat transfer.
3.1n Carry out a simple experiment that differentiates between conductors and insulators of heat.	3.2n Classify materials as conductors or insulators of heat.	3.3n Describe the difference between good, poor and bad thermal conductors and give examples of each.

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
	3.2o Carry out a simple experiment that compares rates of thermal conduction in different types of solids.	3.3o Describe conduction in terms of particle vibration and free electrons in the case of metals.
	3.2p Describe a thermal insulator as a bad thermal conductor.	3.3p Describe an experiment to show how a thermal insulator reduces heat transfer.
3.1q Draw arrows on a diagram to show how convection of heat takes place in a fluid.	3.2q Describe convection as a method of heat transfer through fluids with hot less dense fluid rising on top of cold denser fluid.	3.3q Identify convection currents in everyday life situations such as the formation of land/sea breeze.
	3.2r Carry out a simple experiment that shows convection currents in fluids.	
3.1s Identify radiant heat as an electromagnetic wave.		3.3s State that objects radiate/emit or absorb heat energy (infra-red radiation) in the form of waves.
3.1t Demonstrate that matt/dark objects are best absorbers/radiators of heat.	3.2t Compare the different rates of heat emission/absorption for dark and light coloured body surfaces.	3.3t Describe the different rates of heat emission/absorption for dark and light coloured body surfaces in everyday life situations.
3.1u Demonstrate that shiny/ white objects are best reflectors of heat.	3.2u Compare the different rates of heat emission/absorption for matt/dark and shiny/white surfaces.	3.3u Describe the different rates of heat emission/absorption for matt and shiny surfaces in everyday life situations.
	3.2v Carry out an experiment to show how the colour of the surface affects the absorption or emission of heat.	3.3v Describe an experiment to show how the colour of the surface affects the absorption and emission of heat. <i>This includes providing a diagram, the procedure, precautions necessary, observations made and representation of data in graphical form.</i>

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
3.1w List a number of ways of limiting energy costs at home or other buildings.		3.3w Explain a number of ways of limiting energy costs at home and other buildings including a typical Maltese house.
3.1x Identify J/kgK and J/kg°C as the units of Specific Heat Capacity, c.	3.2x Demonstrate that the final temperature of different materials is different when heated by the same amount of heat.	3.3x Define the specific heat capacity c as the heat energy required to increase the temperature of 1 kg of substance by 1 K or 1 °C.
		3.3y Apply the equation $Q = mc\Delta\theta$ to get the unknown quantity c or m or $\Delta\theta$, where Q represents the quantity of heat transferred, m is the mass and $\Delta\theta$ is the change in temperature.
		3.3z Work out problems related to the specific heat capacity of a heated metal/liquid using an electric heater.
		3.3aa Describe in detail an experiment to measure the specific heat capacity of a solid metal or a liquid using a heater of known power and/or a joulemeter. <i>This includes providing a diagram, the procedure, precautions, the measurements taken as well as any calculations.</i>
	3.2ab Identify everyday life situations where the final temperature of various materials is different when heated or cooled by the same amount of heat transfer such as the difference in temperature of sea and sand after receiving the same amount of heat.	3.3ab Interpret how the specific heat capacity of different materials relates to practical situations where they are used.

Subject Focus:	Electricity
Learning Outcome 4:	At the end of the programme, I can show an understanding of static and moving charges.
Paper I and Paper II	• <i>Link static charge with forces of attraction and repulsion in different situations.</i> • <i>Describe the energy changes in circuits both qualitatively and quantitatively.</i> • <i>Relate current, voltage and resistance in series, parallel and combination circuits.</i>

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
	4.2a Label the structure of an atom in terms of protons, neutrons and electrons.	4.3a Describe the structure of an atom in terms of protons, neutrons and electrons.
	4.2b State the charges on protons, neutrons and electrons and that electrons and protons have equal charge.	
4.1c Demonstrate that friction charges an insulator by using lab and everyday examples.	4.2c Describe how to charge an insulator by friction.	
4.1d Recall that after charging, polythene acquires a negative charge while acetate acquires a positive charge.	4.2d Explain how charging an insulator involves the movement of charges between two materials to leave one positively charged and one negatively charged.	4.3d Explain how charging an insulator involves the movement of negative charges between two materials. <i>The material that loses electrons becomes positively charged and the material that gains electrons becomes negatively charged.</i>
4.1e Carry out a simple experiment that demonstrates repulsion and attraction between charged objects.	4.2e State the conditions for electrical attraction and repulsion between charges. <i>Like charges repel; unlike charges attract.</i>	
		4.3f Explain how a charged object attracts a neutral object. <i>No reference to induction is required.</i>

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
4.1g Show that a charged object can attract an uncharged object.	4.2g Explain that when a charged object A attracts another object B, then object B either has an opposite charge to A or is neutral.	4.3g Explain why electrostatic repulsion is the only way to identify an unknown type of charge.
		4.3h Describe earthing as a process by which a charged object becomes neutral due to a flow of electrons to or from earth. <i>No reference to induction is required.</i>
4.1i List uses of static electricity. - <i>spray painting of charged objects;</i> - <i>lightning conductor for earthing;</i> - <i>electrostatic precipitator.</i> <i>No reference to induction required.</i>	4.2i Describe the uses of static electricity listed in level 1. <i>No reference to ionisation required.</i>	4.3i Apply the principles of electrostatics to other everyday life situations.
4.1j Name suitable examples of conductors and insulators.	4.2j Distinguish between electric conductors and insulators in terms of conductivity of electricity.	4.3j Distinguish between electric conductors and insulators in terms of conductivity and relative numbers in free electrons.
4.1k Carry out an experiment that distinguishes between conductors and insulators.	4.2k Describe an experiment that distinguishes between conductors and insulators.	
4.1l Identify the ampere, A, as the SI unit of electric current, I and the coulomb, C, as the SI unit of quantity of electric charge, Q.		
4.1m Describe current as the rate of flow of charge.	4.2m Use $I=Q/t$ to define current I, as the rate of flow of charge past a point in a circuit, where Q is the quantity of charge and t is the time.	4.3m Use the equation $I=Q/t$ to solve problems requiring the use of subject of the formula.
4.1n Draw the direction of flow of conventional current.		4.3n Distinguish between the direction of conventional current and the direction of motion of the negative charge (electrons).
4.1o Demonstrate that a voltage can create a current.	4.2o State that a voltage / potential difference creates a current.	4.3o Define voltage as the energy that 1 Coulomb of charge uses up between two points in a circuit.

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
4.1p Identify volt, V, as the SI unit of voltage / potential difference, V.		4.3p Apply the equation $E=QV$, where E is the electrical energy, V is the potential difference and Q is quantity of charge, to solve problems requiring the use of subject of the formula.
4.1q Demonstrate that electrical energy is being converted to different types of energies according to the specific type of circuit.		4.3q Apply the equation $E=IVt$, where E is the electrical energy, V is the potential difference and I is the current flow during time t, to solve problems requiring subject of the formula.
4.1r Identify ohm, Ω , as the SI unit of resistance, R.	4.2r Describe electrical resistance as an opposition to the flow of charge or current.	4.3r Demonstrate that current and resistance are inversely proportional.
4.1s Demonstrate how the brightness of a bulb varies with the length of a wire. (E.g. Simple experiment of brightness of a bulb and different lengths of nichrome wire)	4.2s Interpret results from a simple experiment investigating how the brightness of a bulb varies with the length of a wire.	4.3s Describe in detail an experiment that demonstrates how the resistance of a wire depends on its length.
	4.2t Relate qualitatively the resistance of a wire to its length, diameter, the type of material and temperature.	
4.1u State that current can be doubled if voltage is doubled.	4.2u State Ohm's law - current is directly proportional to the voltage across a resistance if the temperature remains constant.	
	4.2v Use $V=IR$ to find V, where V is the voltage, R is the resistance and I is current.	4.3v Apply the equation $V=IR$ to solve problems requiring subject of the formula.

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
4.1w Demonstrate that the voltage is directly proportional to current for an ohmic conductor.	4.2w Carry out an experiment to prove Ohm's Law for a metallic conductor (ohmic conductor).	4.3w Describe in detail an experiment that proves Ohm's law for a metallic conductor. <i>This includes providing a circuit diagram, the procedure, adequate precautions, measurements made and how to determine the resistance of the metallic conductor from the graph.</i>
4.1x Recognise the V-I graph of a metallic conductor at constant temperature.	4.2x Sketch the V-I graph of a metallic conductor at constant temperature and a filament lamp.	4.3x Discuss the V-I graph of a metallic conductor at constant temperature and a filament lamp.
	4.2y Carry out an experiment to investigate how current varies with voltage for a filament lamp. <i>This includes any measurements made and a graphical representation of the data.</i>	4.3y Describe in detail an experiment to investigate how current varies with voltage for a filament lamp. <i>This includes providing a circuit diagram, the procedure, adequate precautions, measurements made and a graphical representation of the data.</i>
4.1z Draw the standard electronic symbols of: a wire, a cell, a battery, an alternating current supply, a direct current power supply, an earthed point, a switch, a fixed resistor, a variable resistor, a fuse, a voltmeter, an ammeter, and a filament lamp.	4.2z Recognise the standard electronic symbol of a centre-zero galvanometer.	
4.1aa Use the correct circuit symbols to draw circuit diagrams of simple circuits.		
4.1ab Assemble a simple circuit that can include: a wire, a cell or battery, a direct current power supply, a switch, a fixed resistor, a variable resistor, a voltmeter, an ammeter, and a light bulb. <i>A circuit diagram is required.</i>		4.3ab Design a simple circuit that can include: a wire, a cell or battery, an alternating current supply, a direct current power supply, an earthed point, a switch, a fixed resistor, a variable resistor, a voltmeter, an ammeter and a light bulb.

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
4.1ac Distinguish between open and closed circuits.	4.2ac Describe a short circuit as an alternative route for current to flow through.	
4.1ad Identify the correct wiring of ammeters and voltmeters in a circuit.		
		4.3ae Explain why an ideal ammeter has negligible resistance.
		4.3af Explain why an ideal voltmeter has an infinitely high resistance.
4.1ag Recognise resistors connected in series and resistors connected in parallel in a circuit.	4.2ag Use the equation for total resistance for resistors connected in series: $R_{\text{total}} = R_1 + R_2 + R_3$.	4.3ag Use the equation for total resistance for two resistors connected in parallel: $1/R_{\text{total}} = 1/R_1 + 1/R_2$.
4.1ah Assemble a circuit that uses resistors connected in series or in parallel to demonstrate how the total current in the circuit varies. <i>This can be represented visually by the change of brightness of a bulb connected to the same circuit.</i>		
4.1ai Measure the voltage across electrical components in a series circuit by connecting the voltmeter in a suitable position.	4.2ai State that for electrical components in series, current is the same, voltage is shared: ($V_{\text{total}} = V_1 + V_2 + \dots$).	4.3ai Solve problems involving electrical components in series, where current is the same and voltage is shared: ($V_{\text{total}} = V_1 + V_2 + \dots$).
4.1aj Measure the current through electrical components in a series and parallel circuits by connecting the ammeter in a suitable position.	4.2aj State that for electrical components in parallel, voltage is the same, current is shared: ($I_{\text{total}} = I_1 + I_2 + \dots$).	4.3aj Solve problems involving electrical components in parallel, where voltage is the same and current is shared: ($I_{\text{total}} = I_1 + I_2 + \dots$).

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
		4.3ak Solve problems involving a combination of series and parallel electrical components in a circuit.
	4.2al Define electrical power as the rate at which electrical energy is transferred in an electric circuit.	
	4.2am Use the equation $P = IV$ to find Power in simple problems.	4.3am Use the equation $P = IV$ to solve problems requiring the use of the subject of the formula.
4.1an Mention the sources of alternating current and direct current.	4.2an Recognise each type of current from the display of a cathode ray oscilloscope.	4.3an Distinguish between the properties of direct and alternating currents.
4.1ao Identify the live, neutral and earth wires from the colour of their insulation.	4.2ao Explain the function of the live, neutral and earth wires in domestic mains electricity.	
4.1ap Identify the live, neutral and earth wires from their position in a standard three pin plug.	4.2ap Draw connections from the live, neutral and earth wires in a ring circuit to the corresponding points in a wall socket.	
4.1aq Carry out the wiring of a three pin plug observing safe procedures.	4.2aq Distinguish between correctly and incorrectly wired three pin plugs.	
4.1ar Demonstrate how a fuse works.	4.2ar Explain why fuses have various ratings.	4.3ar Solve problems to identify the appropriate fuse rating from given values.
4.1as Identify the earth wire and the circuit breaker in a house.	4.2as Explain the function of the earth wire in a household circuit.	4.3as Describe the electrical safety features in a house. <i>Including earthing and circuit breakers</i>

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
4.1at Identify household appliances that are double insulated.	4.2at Explain why double insulated appliances do not need an earth wire while appliances with a metal case need to be earthed.	
4.1au Identify dangerous practices in the use of mains electricity.		4.3au Recognise and explain dangerous practices in the use of mains electricity.
4.1av Relate kilowatt-hour to one unit of electrical energy.	4.2av Define the kilowatt-hour as a unit of energy.	4.3av Calculate the cost of domestic electricity using the number of units consumed and the cost per unit.
		4.3aw Convert energy from joules to kilowatt-hour and vice versa.

Subject Focus:	Magnetism and Electromagnetism
Learning Outcome 5:	At the end of the programme, I can show an understanding of magnetism and electromagnetism.
Paper I and Paper II	• <i>Explain the processes leading to magnetism.</i> • <i>Relate electricity to electromagnetism as applied in a variety of uses.</i>

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
5.1a Show that magnetic materials are attracted to a permanent magnet.	5.2a Distinguish between magnetic and non-magnetic materials.	
5.1b Demonstrate attraction and repulsion between magnets.	5.2b Describe that permanent magnets have two poles.	5.3b Explain how the alignment of dipoles leads to the poles of a magnet.
5.1c Use a plotting compass to demonstrate the presence of a magnetic field.	5.2c Explain how a plotting compass works in terms of the Earth's magnetic field.	5.3c State that the Earth has its own magnetic field and that the magnetic north pole and geographical North Pole are not on the same place on Earth.
5.1d Carry out an experiment that uses iron filings to show the magnetic field around a permanent bar magnet.	5.2d Describe an experiment that uses iron filings to show the magnetic field lines around a permanent magnet. <i>The resulting field diagrams are expected.</i>	5.3d Link the closeness of the magnetic field lines to the strength of the magnetic field.
5.1e Describe a magnetic field as a 3D space around a permanent magnet where another magnet or magnetic material experiences a force.		
5.1f Demonstrate the making of a magnet using both the stroking method and the direct current electrical method.	5.2f Describe how to create a permanent magnet using both the stroking method and the direct current electrical method.	5.3f Explain why permanent magnets are created by the stroking method and direct current electrical method.

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
5.1g Identify simple everyday practices that cause a demagnetising effect. <i>E.g. leaving credit card in car/sun in summer, banging fridge door, etc...</i>	5.2g Describe how demagnetisation can be achieved using hammering, heating or the electrical method using alternating current.	5.3g Explain why demagnetisation can be achieved using hammering, heating or the electrical method using alternating current.
		5.3h Explain magnetic induction using a permanent magnet.
5.1i Demonstrate how like poles repel and unlike poles attract.	5.2i Deduce the type of magnetic pole on another magnet depending on the magnetic forces that can exist between it and another known magnetic pole.	5.3i Deduce the type of magnetic pole on a material depending on the magnetic forces that can exist between it and another known magnetic pole.
	5.2j Explain why magnetic repulsion is the only way to identify an unknown type of magnetic pole.	
5.1k Draw the magnetic field lines around two bar magnets to show the magnetic field between different pole combinations.	5.2k Indicate the direction of the magnetic field lines between different pole combinations.	
5.1l Demonstrate the direction of the field around a single long straight current-carrying conductor.	5.2l Draw the magnetic field lines around a single long straight current-carrying conductor. <i>No reference to direction of magnetic field lines required.</i>	5.3l Draw the magnetic field lines around a single long straight current-carrying conductor and a solenoid using the right hand grip rule.
5.1m Demonstrate the presence of a magnetic field around an electromagnet.	5.2m Describe how a field is setup around an electromagnet when current flows through the wire.	5.3m Identify the magnetic polarities of an electromagnet using the right hand grip rule.

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
5.1n Draw a labelled diagram of an electromagnet.	5.2n Carry out experiments to observe how the strength of an electromagnet depends on the number of turns in the coil or strength of the current. <i>This includes taking and comparing measurements.</i>	5.3n Describe in detail an experiment to show how the strength of an electromagnet depends on the number of turns in the coil or strength of the current. <i>This includes providing a diagram, the procedure, adequate precautions, measurements made and a graphical representation of the data.</i>
5.1o List the factors (the number of turns, the size of current flow and the use of an iron core) that affect the strength of the magnetic field around an electromagnet.	5.2o Compare the properties of permanent magnets and electromagnets.	5.3o Explain how the factors (the number of turns, the size of current flow and the use of an iron core) affect the strength of the magnetic field around an electromagnet.
5.1p List applications where electromagnets are used.		5.3p Describe applications where electromagnets are used.
5.1q Demonstrate how a force acts on a current carrying conductor placed in a magnetic field.	5.2q State that a current carrying conductor placed at right angles to a magnetic field will experience a force.	5.3q Explain with reference to a diagram, how the magnetic fields interact when a current carrying conductor is placed at right angles to a magnetic field, causing a perpendicular catapult force to act on the conductor.
	5.2r List the factors (the current and the magnetic field strength) that affect the magnitude of the force acting on the conductor.	5.3r Describe how the factors (the current and the magnetic field strength) affect the magnitude of the force acting on the conductor.
5.1s Demonstrate how the force acting on a current carrying conductor is affected by: - the amount of current flowing in the conductor; - the strength of the magnetic field.	5.2s Demonstrate how the force acting on a current carrying conductor is affected by: - changing the direction of the current; - changing the direction of the magnetic field. <i>No reference to Fleming's Left Hand Rule required.</i>	5.3s Use Fleming's Left Hand Rule for a current carrying conductor in a magnetic field to give the relative directions of the catapult force, magnetic field and current.

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
		5.3t Recognise that no catapult force can act on the current carrying conductor if it is placed parallel to the direction of the magnetic field.
5.1u Outline practical situations where a simple motor is used. <i>E.g. Food mixer, washing machine, drill, electric toy car, etc.</i>	5.2u Demonstrate that a current carrying rectangular coil placed in a magnetic field experiences a turning effect.	5.3u Explain that a current carrying rectangular coil placed in a magnetic field experiences a turning effect including the action of an electric dc motor. <i>No reference to split ring commutators required.</i>
	5.2v List the factors (current through coil, magnetic field strength and number of turns) that increase the turning effect of the rectangular coil in the magnetic field.	5.2v Explain why increasing current through coil, magnetic field strength and number of turns in a simple dc motor increase the turning effect of the rectangular coil in the magnetic field.
5.1w Identify that a current is induced when a magnet is moved back and forth close to a stationary conductor.	5.2w State that when a magnet is moved back and forth close to a stationary conductor, an emf is induced across the conductor as observed on a centre zero galvanometer.	5.3w Explain, in terms of the cutting of magnetic field lines, that when a magnet is moved back and forth close to a stationary conductor, an emf is induced across the conductor as observed on a centre zero galvanometer.
	5.2x State Faraday's law.	5.3x Explain how the current induced in a conductor depends on the rate of cutting of the magnetic flux, and the number of turns of the coil using Faraday's law of electromagnetic induction.
	5.2y List the factors that affect the size of the induced current: the number of turns of coil, and the rate of cutting of magnetic flux.	5.3y Relate the size of the induced current with the number of turns in a coil, and the rate of cutting of magnetic flux.
		5.3z State Lenz's law.

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
		5.3aa Determine the direction of the induced current in the coil when a magnet is moved back and forth by applying the right hand grip rule.
		5.3ab Apply the concepts of electromagnetic induction in given situations.
		5.3ac Relate generation of electricity to electromagnetic induction.
5.1ad Distinguish between a step-up and a step-down transformer.	5.2ad Draw the construction of a basic iron core transformer, i.e. step-up and step-down.	
	5.2ae Relate the operation of a basic iron core transformer to Faraday's law.	5.3ae Explain that a change in magnetic field lines induces an emf across a conductor.
	5.2af Identify that a transformer has an input from an a.c. source.	5.3af Explain why transformers can only be used with alternating current.
		5.3ag Solve problems using $N_1/N_2 = V_1/V_2$, where N_1 is the number of turns in the primary coil, N_2 is the number of turns in the secondary coil, V_1 is the voltage across the primary coil and V_2 is the voltage across the secondary coil for an ideal transformer.
		5.3ah Distinguish between ideal and practical transformers in terms of heat energy losses.

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
		5.3ai Use the equation $I_1V_1=I_2V_2$ for an ideal transformer to solve problems requiring the use of the subject of the formula.
		5.3aj Explain why transformers are required to adjust voltages to reduce energy losses, when electrical energy is distributed from power stations to consumers. <i>Calculations are required.</i>

Subject Focus:	Radioactivity
Learning Outcome 6:	At the end of the programme, I can show an understanding of nuclear phenomena.
Paper II	• <i>Relate nuclear phenomena to instability, randomness and spontaneity.</i> • <i>Compare the properties of different types of nuclear radiation.</i> • <i>Describe some characteristics and applications of radioactive substances.</i>

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
	6.2a Define the terms: proton (or atomic) number Z, neutron number N and nucleon (or mass) number A.	
6.1b Draw a model of an atom having a nucleus with protons and neutrons surrounded by electrons.	6.2b State the charge of subatomic particles: neutrons and protons and electrons.	6.3b Describe an atom as having a nucleus with most of the mass of the atom, surrounded by orbiting electrons of negligible mass.
	6.2c Represent an element with a given chemical symbol using letter(s) together with the nucleon and proton number. These should be set in the general form A_ZX where X is the symbol for the element.	6.3c Identify isotopes as atoms of the same element that have the same proton number but a different nucleon number.
6.1d State that nuclear radiation is emitted from the nucleus of an unstable atom.	6.2d Explain that nuclear radiation is a random and spontaneous process.	6.3d Describe the terms radioactive decay and ionisation.
	6.2e Describe the nature of alpha particles, beta particles (electrons from nuclei) and gamma radiation (electromagnetic waves).	6.3e Write down nuclear equations to represent alpha (helium nucleus) and beta decay.
6.1f Compare the range in air and penetrating power of alpha, beta and gamma radiation.	6.2f Compare the nature, charge and mass of alpha, beta and gamma radiation.	6.3f Compare properties of alpha, beta and gamma radiation including their ionizing effect. <i>Use of cloud chamber is not expected.</i>

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
6.1g Describe how to detect radioactive radiation using the Geiger Muller tube and a rate meter.	6.2g Describe an experiment using the Geiger Muller tube and a ratemeter to identify the type of radioactive radiation present.	6.3g Explain how a Geiger Muller tube and a ratemeter can be used to determine properties of radioactive radiation.
6.1h List the sources of background radiation.	6.2h Describe a simple experiment to measure the background radiation.	6.3h Describe a simple experiment to determine the corrected count rate of a radioactive source.
6.1i Explain the meaning of the term 'half-life' using a model.	6.2i Determine the half-life of a radioactive substance from a graph. <i>Drawing of a half-life graph is expected.</i>	6.3i Calculate the fraction/percentage of the original isotope left after a period of time.
6.1j Describe how radioactivity can be used to detect a leakage in underground pipes.	6.2j Describe how radioactivity can be used in the thickness control of a material and as tracers to help radiographers see inside a patient's body.	6.3j Apply the properties of the three types of radiation to given practical applications.
6.1k Describe ways of storing and handling radioactive materials in a safe manner.		

Subject Focus:	The Earth and the Universe
Learning Outcome 7:	At the end of the programme, I can show an awareness of some features of the Earth and the Universe.
Paper II	• <i>Earth's motion.</i> • <i>The solar system.</i> • <i>The universe and its component parts.</i>

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
7.1a Draw a labelled diagram of the solar system - the sun and its eight orbiting planets.	7.2a Describe the solar system as consisting of the sun and its eight orbiting planets.	7.3a Describe the solar system as consisting of the sun, the eight planets, the asteroid belt and the moons.
7.1b Identify the eight planets of the solar system according to their distance from the sun.		7.3b Distinguish between rocky and gaseous planets in our solar system.
7.1c Describe three features (atmosphere, water and life) of the earth that distinguishes it from other planets.	7.2c Define a planet as being a celestial body that: is in orbit around the Sun; has a nearly spherical shape; has cleared the neighbourhood around its orbit.	7.3c Recognise a dwarf planet as a celestial object which has not cleared the neighbourhood around its orbit.
7.1d State that the Earth spins about its own axis to create day and night. <i>Example using a bulb and a ball.</i>		7.3d Explain how as the Earth revolves around the sun about its own axis, the spinning of the Earth causes day and night.
7.1e Make a simple model of the orbit of the Earth around the sun.	7.2e State that the Earth takes approximately 365.25 days to orbit once around the sun. <i>Reference to leap year is expected.</i>	7.3e Explain how the tilt of the Earth in relation to the sun gives rise to the seasons.
7.1f Define the term orbit.	7.2f Recognise the gravitational pull acting between the Earth and other objects.	7.3f Explain how the force of gravity between objects increases with mass and decreases with distance.
7.1g Identify that satellites orbit planets.	7.2g Distinguish between artificial satellites and natural satellites.	7.3g Distinguish between geostationary and polar orbit satellites by considering their different orbitals, distance from Earth, duration of an orbit and their uses. <i>No specific values are required.</i>

7.1h Distinguish between stars, planets and galaxies.	7.2h Describe how our solar system is part of the Milky Way galaxy which is a small part of the Universe.	
	7.2i Recognise the telescope as the instrument used to observe celestial bodies. <i>Reference to both optical and radio telescopes is expected.</i>	7.3i Discuss the advantages and disadvantages of using orbiting optical telescopes as opposed to terrestrial telescopes.
7.1j Use the term 'light year' to compare relative distances in space.	7.2j Define one light year as the distance travelled by light in one year.	7.3j Calculate the distance travelled by light in one year.
7.1k State that the sun is a star.	7.2k Explain how the sun is one of billions of stars in the Milky Way.	7.3k Describe how the Milky Way is one of billions of galaxies in the Universe.
	7.2l Relate the origin of the universe to the Big Bang theory.	7.3l Describe the Big Bang theory in relation with the expansion of the Universe.
7.1m List social and economic benefits of space explorations.	7.2m Explain that current observations of the night sky represent events that happened light years ago.	7.3m Research about the role of the International Space Station for space exploration and its benefits to human kind.

Subject Focus:	The Science of the Physical World
Learning Outcome 8:	At the end of the programme, I can demonstrate an understanding of how Physics works and is communicated. <i>The assessment criteria of this learning outcome are to be implemented in combination with learning outcomes and refer to experiments and investigations.</i>

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
8.1a State that scientific knowledge changes with new evidence / observations / experiments	8.2a Distinguish between a fact, a hypothesis and a theory.	8.3a Discuss briefly the meaning of science in terms of its healthy scepticism, aimed objectivity and the value of physical (observable / measurable) evidence.
8.1b Discuss the importance of fair (objective) testing in science.		8.3b Evaluate an experiment in terms of its objectivity.
	8.2c Plan an experiment/investigation to solve a given problem with guidance.	8.3c Plan an experiment/investigation to solve a given problem without guidance.
	8.2d Carry out an investigation/experiment to solve a given problem with guidance.	8.3d Carry out an investigation/experiment to solve a given problem without guidance.
8.1e Carry out, with guidance, a written procedure for an experiment.	8.2e Carry out, with limited guidance, a written procedure for an experiment.	8.3e Carry out, with no guidance, a written procedure for an experiment.
8.1f Identify safety precautions that should be taken during an experiment.	8.2f List precautions related to a particular experiment to obtain reliable results.	8.3f Explain precautions related to a particular experiment to obtain reliable results.

Assessment Criteria (LEVEL 1)	Assessment Criteria (LEVEL 2)	Assessment Criteria (LEVEL 3)
8.1g Record observations / measurements in a given table.	8.2g Record observations / measurements appropriately.	8.3g Determine which observations / measurements are to be measured for an experiment.
	8.2h Structure a laboratory report in sections.	8.3h Write a scientific report for an experiment carried out.
8.1i Label diagrams of given apparatus.		8.3i Draw labelled diagrams of apparatus used during experiments/investigations.
8.1j Read simple graphical representations.	8.2j Plot simple, linear graphical representations.	8.3j Plot graphical representations from data.
		8.3k Interpret graphical representations.
8.1l Relate conclusions from an experiment to everyday life situations.	8.2l Draw conclusions from an experiment.	8.3l Apply the conclusions from an experiment to everyday life situations.
	8.2m Write sources of error for experiments/investigations.	8.3m Describe improvements to the experiments/investigation.

Scheme of Assessment

School candidates

The assessment consists of Paper I and Paper 2. Paper I consist of unmoderated school-based assessment (SBA) that is to be set and assessed by the school. Paper II consists of a controlled assessment that will take place at the end of the three-year programme.

School-based assessment (SBA): is any type of assessment of a candidate made by the school relevant to the respective SEC syllabus contributing to the final level awarded in the subject.

Controlled assessment: is comprised of a two-hour written exam set at the end of the programme and differentiated between two tiers:

- a. Levels 1 and 2;
- b. Levels 2 and 3.

Candidates are to satisfy the examiner in Paper I and Paper II to obtain a level higher than 1.

Paper I - School Based Assessment (30% of the total mark).

The school-based assessment shall be marked out of 100 each year (9, 10 and 11). The assessment for each year will contribute to 10% of the overall mark and will be reported to MATSEC by the school in Year 11. Therefore, each year will equally contribute to the final mark of the school-based assessment. The school-based assessment shall reflect the MATSEC syllabus covered in Year 9, Year 10 and Year 11.

School-based assessment can be pegged at either of two categories:

- SBA at categories 1-2 must identify assessment criteria from these two levels. It is suggested that ACs are weighted at a ratio of 40% at Level 1 and 60% at Level 2.
- SBA at categories 1-2-3 must identify assessment criteria from each of Levels 1, 2, and 3. It is suggested that ACs are weighted at a ratio of 30% at each of Levels 1 and 2, and 40% at Level 3.

The mark for SBA at level categories 1-2 presented for a qualification at level categories 2-3 will be calculated to 60% of the original mark. The mark stands in all other cases.

Paper II - Controlled Assessment (70% of the total mark).

Written Examination (100 marks; 2 hours)

Learning outcomes with assessment criteria in the psychomotor domain can be assessed by asking questions in pen-and-paper format seeking understanding of the activity.

Controlled Assessment will:

- cover most learning outcomes including all learning outcomes which are not indicated to be covered through SBA;
- have three sections as follows:
 - Section A consisting of 8 – 10 short questions (40 marks);
 - Section B consisting of 1 structured question including graph plotting (15 marks);
 - Section C consisting of 3 long structured questions (45 marks);
 - be marked out of 100 and all questions are compulsory.

Private Candidates

Private candidates will not be expected to carry out any school-based assessment as school candidates. Instead private candidates need to sit for another Controlled paper as an alternative to the school-based assessment. Private candidates will be assessed through the means of **TWO** Controlled papers, one of which is common with school candidates.

Paper I – Controlled Assessment - Private Candidates Only (30% of the total mark).

Written Examination (100 marks; 2 hours)

Paper I for private candidates shall be a controlled assessment assessing levels 1, 2 and 3 as described in the respective syllabus and set and marked by MATSEC. It shall mainly focus on the learning outcomes marked in the respective syllabi as suggested for school-based assessment.

Learning outcomes with assessment criteria in the psychomotor domain can be assessed by asking questions in pen-and-paper format seeking understanding of the activity.

Controlled Assessment will:

- assess all learning outcomes which were indicated as part of school candidates' SBA and some other outcomes;
- have two sections as follows:
 - Section A consisting of 5 long structured questions of 15 marks each (75 marks)
 - Section B consisting of 1 – 2 structured questions which may be based on a local context (25 marks)
- include items which will focus on the practical aspect of the assessed learning outcomes;
- have questions which include graph plotting;
- be marked out of 100 and all questions are compulsory.

Paper II - Controlled Assessment (70% of the total mark).

Paper II is common with school candidates.

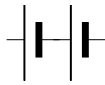
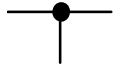
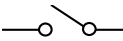
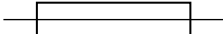
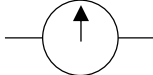
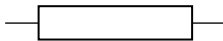
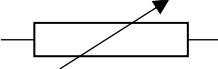
Appendices

Appendix 1: Mathematical Notations

Students should be able to:

- recognise and use expressions in decimal and standard form (scientific) notations;
- recognise and use prefixes indicating multiplication by 10^{-6} , 10^{-3} , 10^3 , 10^6 ;
- make evaluations of numerical expressions and use such approximations to check calculations;
- change the subject of an equation;
- solve simple algebraic equations.

Appendix 2: Table of Circuit Symbols

Name	Circuit symbol	Name	Circuit Symbol
a. c. supply		filament lamp	
voltmeter		ammeter	
cell		battery	
d. c. supply		junction	
switch		earth	
fuse		galvanometer	
fixed resistor		variable resistor	

Appendix 3: SI Units and Symbols

Physical Quantity	Symbol	Name of S.I. Unit	Symbol of S.I. unit
length	l	metre	m
area	A	square metre	m ²
volume	V	cubic metre	m ³
mass	m	kilogram	kg
density	ρ	kilogram per metre cubed	kg/m ³
time	t	second	s
periodic time	T	second	s
frequency	f	hertz [per second]	Hz
wavelength	λ	metre	m

work	W	joule [newton metre]	J
energy	E	joule	J
power	P	watt [joule per second]	W
potential energy	PE	joule	J
kinetic energy	KE	joule	J
heat energy	Q	joule	J
temperature*	θ	kelvin	K
specific heat capacity*	c	joule per kilogram kelvin	J/kg K

force	F	newton [kg m/s ²]	N
weight	W	newton	N
moment of a force	M	newton metre	Nm
pressure	P	pascal [N/m ²]	Pa
distance	s	metres	m
speed	s	metre per second	m/s
initial velocity	u	metre per second	m/s
final velocity	v	metre per second	m/s
acceleration	a	metre per second squared	m/s ²
acc. due to gravity	g	metre per second squared	m/s ²
momentum	p	kilogram metre per second	kg m/s

Quantity of electric charge	Q	coulomb	C
electric current	I	ampere	A
electromotive force	EMF	volt [joule per coulomb]	V
potential difference pd	V	volt [joule per coulomb]	V
voltage	V	volt [joule per coulomb]	V
resistance	R	ohms	Ω
electrical energy	E	joule	J

* Questions in Controlled Papers using these units may be set in degrees celsius(°C).

Appendix 4: Useful information given in Controlled Papers

When necessary, take g , acceleration due to gravity, as 10m/s^2 .

Density	$\rho = \frac{m}{V}$
Pressure	$P = \frac{F}{A}$ $P = h \rho g$
Moments	Moment = $F \times$ perpendicular distance
Energy and Work	$PE = m g h$ $KE = \frac{1}{2} m v^2$ $W = F s$ $P = \frac{E}{t}$
Force and Motion	resultant force = $m a$ $W = m g$ $p = m v$ $F = \frac{(mv - mu)}{t}$
	average speed = $\frac{\text{total distance}}{\text{total time}}$ $v = u + a t$ $s = (u + v) \frac{t}{2}$
	$v^2 = u^2 + 2 a s$ $s = u t + \frac{1}{2} a t^2$
Waves	$n = \frac{\text{speed of light in air}}{\text{speed of light in medium}}$ $n = \frac{\text{real depth}}{\text{apparent depth}}$
	Magnification = $\frac{\text{image height}}{\text{object height}}$ Magnification = $\frac{\text{image distance}}{\text{object distance}}$
	$v = f \lambda$ $T = \frac{1}{f}$
Electricity	$I = \frac{Q}{t}$ $V = I R$ $P = I V$
	$E = Q V$ $E = I V t$
	$R_{\text{total}} = R_1 + R_2 + R_3$ $\frac{1}{R_{\text{total}}} = \frac{1}{R_1} + \frac{1}{R_2}$
Electromagnetism	$\frac{V_p}{V_s} = \frac{N_p}{N_s}$ $V_p I_p = V_s I_s$
Heat	$Q = m c \Delta \theta$
Radioactivity	$A = Z + N$
Other equations	Area of a triangle = $\frac{1}{2} b h$ Area of a trapezium = $\frac{1}{2} (a + b) h$