NCCA

An Chomhairle Náisiúnta Curaclaim agus Measúnachta
National Council for Curriculum and Assessment

LEAVING CERTIFICATE

PHYSICS

DRAFT SYLLABUS FOR CONSULTATION

SENIOR CYCLE

THE EXPERIENCE OF SENIOR CYCLE

Senior cycle

Introduction

Learners in senior cycle are approaching the end of their time in school and are focusing on the directions they would like to take in their future lives. Senior cycle plays a vital role in helping learners to address their current needs as young adults and in preparing them for life in a changing economic and social context.

Senior cycle is founded on a commitment to educational achievement of the highest standard for all learners, commensurate with their individual abilities. To support learners as they shape their own future there is an emphasis on the development of knowledge and deep understanding; on learners taking responsibility for their own learning; on the acquisition of key skills; and on the processes of learning.
The broad curriculum, with some opportunities for specialisation, supports continuity from junior cycle and sets out to meet the needs of learners, some of whom have special educational needs, but who all share a wide range of learning interests, aptitudes and talents.

The range and scope of the curriculum components offered at senior cycle—subjects, short courses, transition units and curriculum frameworks—have been developed to allow for choice and flexibility, for a balance between knowledge and skills, and for the promotion of the kinds of learning strategies relevant to participation in and contribution to a changing world where the future is uncertain.

Assessment in senior cycle involves gathering, interpreting and using information about the processes and outcomes of learning. It takes different forms and can be used for a variety of purposes. It can be used to determine the appropriate route for learners through a differentiated curriculum, to identify specific areas of difficulty or strength for a given student and to test and certify achievement. Assessment can support and improve learning by helping learners and teachers to identify next steps in the teaching and learning process.

The experience of senior cycle

The vision of senior cycle sees the learner at the centre of the educational experience. That experience will enable learners to be resourceful, to be confident, to participate actively in society, and to build an interest in and ability to learn throughout their future lives.

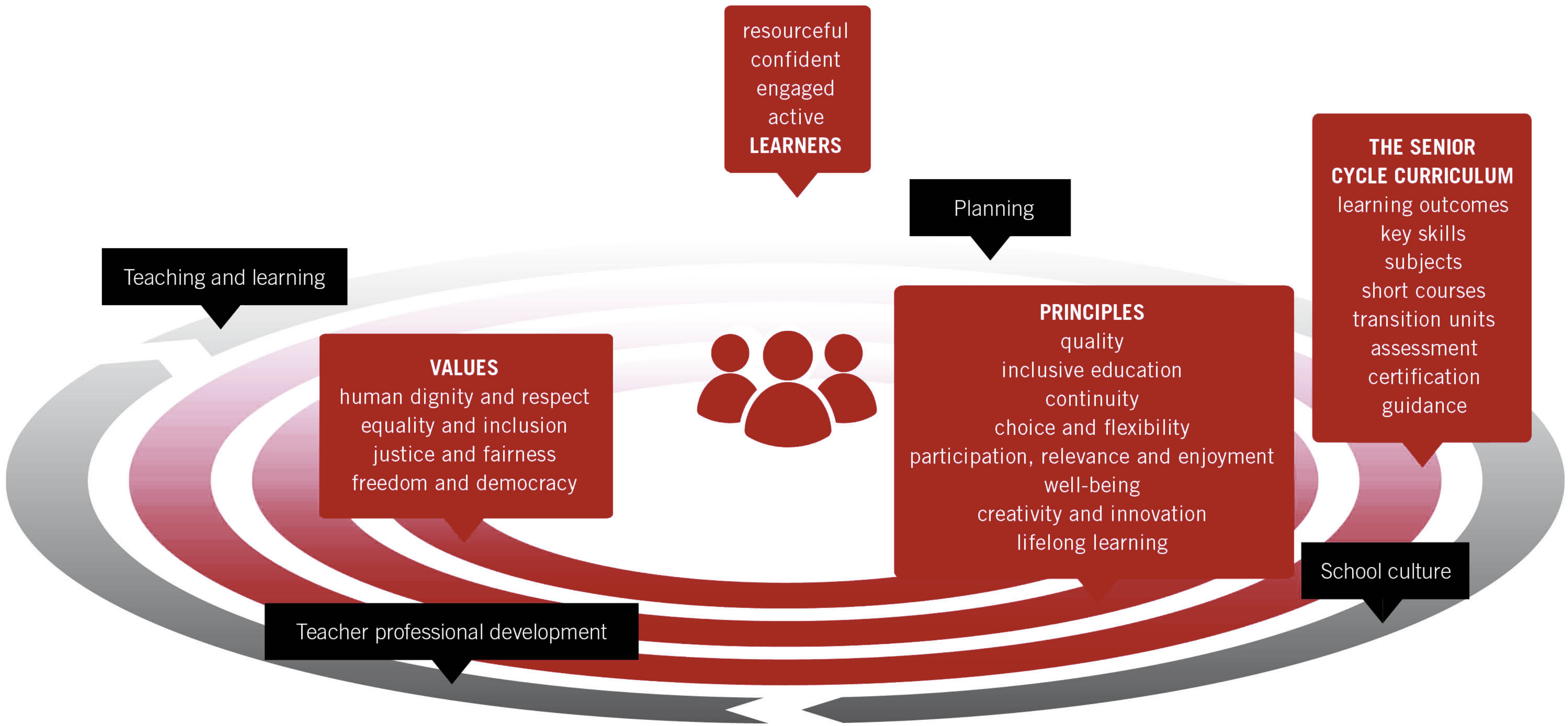
This vision of the learner is underpinned by the values on which senior cycle is based and it is realised through the principles that inform the curriculum as it is experienced by learners in schools. The curriculum, made up of subjects and courses, embedded key skills, clearly expressed learning outcomes, and supported by a range of approaches to assessment, is the vehicle through which the vision becomes a reality for the learner.

At a practical level, the provision of a high quality educational experience in senior cycle is supported by

- effective curriculum planning, development, organisation and evaluation
- teaching and learning approaches that motivate and interest learners, that enable them to progress, deepen and apply their learning, and that develop their capacity to reflect on their learning
- professional development for teachers and school management that enables them to lead curriculum development and change in their schools
- a school culture that respects learners, that encourages them to take responsibility for their own learning over time, and that promotes a love of learning.

Senior cycle education is situated in the context of a broader education policy that focuses on the contribution that education can make to the development of the learner as a person and as a citizen. It is an education policy that emphasises the promotion of social cohesion, the growth of society and the economy, and the principle of sustainability in all aspects of development.

Overview of senior cycle



Vision

LEARNERS COMPLETING SENIOR CYCLE ARE

RESOURCEFUL

they show their imagination, intelligence, intuition and other talents through

- curiosity
- enquiry
- open-mindedness
- reflection
- connecting learning
- innovation
- problem solving
- creativity

CONFIDENT

they develop their physical and mental well-being and

- become self-aware
- have high self-efficacy
- engage with ethics, values and beliefs
- welcome opportunities
- can cope with setbacks
- can effect positive change

ENGAGED

they participate in the social, community, national and international dimensions of their lives by

- showing respect for others
- forming and sustaining caring relationships
- making informed decisions
- building practical know-how
- taking interest in and responsibility for their social and physical environment
- developing moral/ethical and political understanding
- making lifestyle choices that are sustainable
- contributing to their own material well-being and the material well-being of society

ACTIVE LEARNERS

they pursue excellence in learning to the best of their ability and develop a love of learning by

- seeking and using knowledge, and understanding how knowledge is created
- experiencing passion for, rigour in and commitment to learning
- developing intellectual and critical thinking skills
- exercising autonomy and independence in learning
- managing their learning and making learning choices
- setting and achieving learning goals
- pursuing learning qualifications

PHYSICS

INTRODUCTION

AIM

OBJECTIVES

RELATED LEARNING

Physics

Introduction

Science education provides a means by which learners can interact with the world around them and understand how scientific concepts can be used to make sense of the physical world. As learners' scientific literacy grows they will be able to make sense of the various ways in which scientific knowledge is communicated. Science is a human construct; scientific knowledge is constructed by the sharing of ideas and by developing, refining, and rejecting or accepting of these ideas. Through engagement with science, learners will acquire the knowledge, skills, attitudes and values that will allow them to take informed positions on scientific issues. As well as constructing knowledge of science they will construct knowledge about science and the nature of science including its moral and ethical dimensions.

Physics is the scientific study of matter and energy and attempts to develop a unified description of how they behave and interact with each other. Nature is complex and beautiful and physics attempts to describe natural phenomena in terms of all-embracing fundamental concepts. In its search for basic laws and general principles, physics attempts to satisfy queries arising from observed events occurring in the world around us and to provide the basis for explanations for, and solutions to, everyday technological issues and problems.

This syllabus endeavours to equip learners for a fast-changing technological world where they are able to recognise both the positive and negative aspects of the application of science and its limits, enabling them to respond to future challenges. In challenging students to learn at a deeper level, the syllabus is designed to help them engage with physics principles, concepts, facts and laws in order to encourage skills development while facilitating teachers to be innovative and flexible in meeting individual learners' needs.

By studying physics laws in the context of issues that impact on their everyday lives, learners will develop an appreciation of real world applications of physics concepts.

In planning for physics, teachers should recognise that some learners may require additional instruction and practice in the use of equipment. Issues relating to safety in the laboratory must be addressed before learners can be expected to participate effectively. Some learners may require a variety of modifications to the learning environment including facilities that allow for the mobility of learners with physical impairment, including adequate provisions for their safety.

To complete the physics syllabus successfully learners will have to demonstrate mathematical competency by being able to tackle physical problems using fundamental mathematical skills. Learners will be expected to understand abstract concepts and transfer them to new contexts; they will also be expected to apply skills and strategies of scientific enquiry to solve physical problems. In participating in practical activities, learners will be required to manipulate and use tools, equipment and material with due regard for their own safety and the safety of others

Aim

Leaving Certificate Physics aims to stimulate and sustain learners' interest in and enjoyment of physics, whilst developing an understanding of the fundamental principles underlying physical phenomena and illustrating how humanity has benefited from the study and practice of physics.

Objectives

The objectives of Leaving Certificate Physics are to

- enable learners to build on their existing knowledge and understanding of physics terminology, facts, principles and methods and to develop the skills needed to apply this knowledge and understanding to familiar and unfamiliar situations
- to develop an understanding of the quantitative nature of physics and how mathematical expressions relate to physics principles
- develop skills in scientific enquiry including the ability to interpret and analyse qualitative and quantitative data from different sources and to consider the validity and reliability of data in presenting and justifying conclusions
- develop skills in laboratory procedures and techniques, including the use of ICT, carried out with due regard for safety, together with the ability to assess the uses and limitations of these procedures through engagement in a wide variety of practical activities
- develop the ability to explain, evaluate and communicate the results of their experimental and investigative activities in verbal, graphical and mathematical form, using ICT where appropriate
- encourage learners to develop a deeper understanding of the ethical, historical, environmental, and technological aspects of physics, and how physics contributes to the social and economic development of society
- develop in learners qualities that enable them to make informed conclusions about contemporary physical and environmental issues, including those that raise ethical questions.

Related learning

Early Childhood

Aistear, the early childhood curriculum framework, celebrates early childhood as a time of well-being and enjoyment where children learn from experiences as they unfold.
The theme of Exploring and Thinking is about children making sense of the things, places and people in their world by interacting with others, playing, investigating, questioning, and forming, testing and refining ideas.

Children use their senses, their minds and their bodies to find out about and make sense of what they see, feel and experience in the world around them. They gather information and develop new skills, including thinking skills. They form ideas and theories and test these out. They refine their ideas through exploring their environment actively and through interacting and communicating with adults and with other children. Much of this happens through play and other experiences that allow children to be creative, to take risks, and to make discoveries. As they learn, they retest their theories adjusting them to take on board new discoveries and new experiences.

Primary School

Social, environmental and scientific education (SESE) provides opportunities for the child to explore and investigate the world around them from a human, social and cultural perspective. Objects and events in science are experienced in reality before being the subject of mental manipulation.

Junior Cycle

Junior cycle science places student learning in the context of science activities, emphasising hands-on engagement through which learners develop their understanding of the scientific concepts and principles involved together with appropriate science process skills. This approach provides coherence with science in the Primary School Curriculum. There is an emphasis on an investigative approach, through which learners develop an understanding and appreciation of activities and processes that are fundamental to all science together with the ability to apply science principles to their everyday lives. Many junior cycle subjects have close links with science, particularly: geography, CSPE, PE, SPHE and religious education.

Senior Cycle

Learners build on their science process skills and use them to develop deeper understanding of scientific concepts. Many senior cycle subjects have close links with physics, including: Agricultural science, chemistry, biology, geography, religious education, mathematics working with data and graphical analysis, basic statistics and probability, applied mathematics, engineering and technical graphics.

Further Study

A physics qualification can lead to many exciting and rewarding careers. Apart from pure physics, there are a diverse range of opportunities in related areas.

Physics encompasses the study of the universe from the largest galaxies to the smallest subatomic particles. Moreover, it's the basis of many other sciences, including chemistry, oceanography, seismology, and astronomy. All are easily accessible with a undergraduate degree in physics.

Physics is fundamental to many new technologies. Mobile phones, and the Internet, are only two examples of the physics-based technological developments that have revolutionized our world. Many theoretical and experimental physicists work as engineers, and many electrical and mechanical engineers have physics degrees. The importance of physics isn't limited to the "hard sciences." Increasingly, physicists are employed as molecular biologists and medical physicists.

Community and Society

Learners will develop an appreciation of the social and cultural perspectives of physics and of the impact of science and technology on people and on the environment. Physics plays a key role in the technological advances that will continue to drive economies it extends and enhances our understanding of other disciplines, such as chemical, biological, and environmental sciences, astronomy and cosmology - subjects of substantial global importance.

SYLLABUS OVERVIEW

STRUCTURE

TIME ALLOCATION

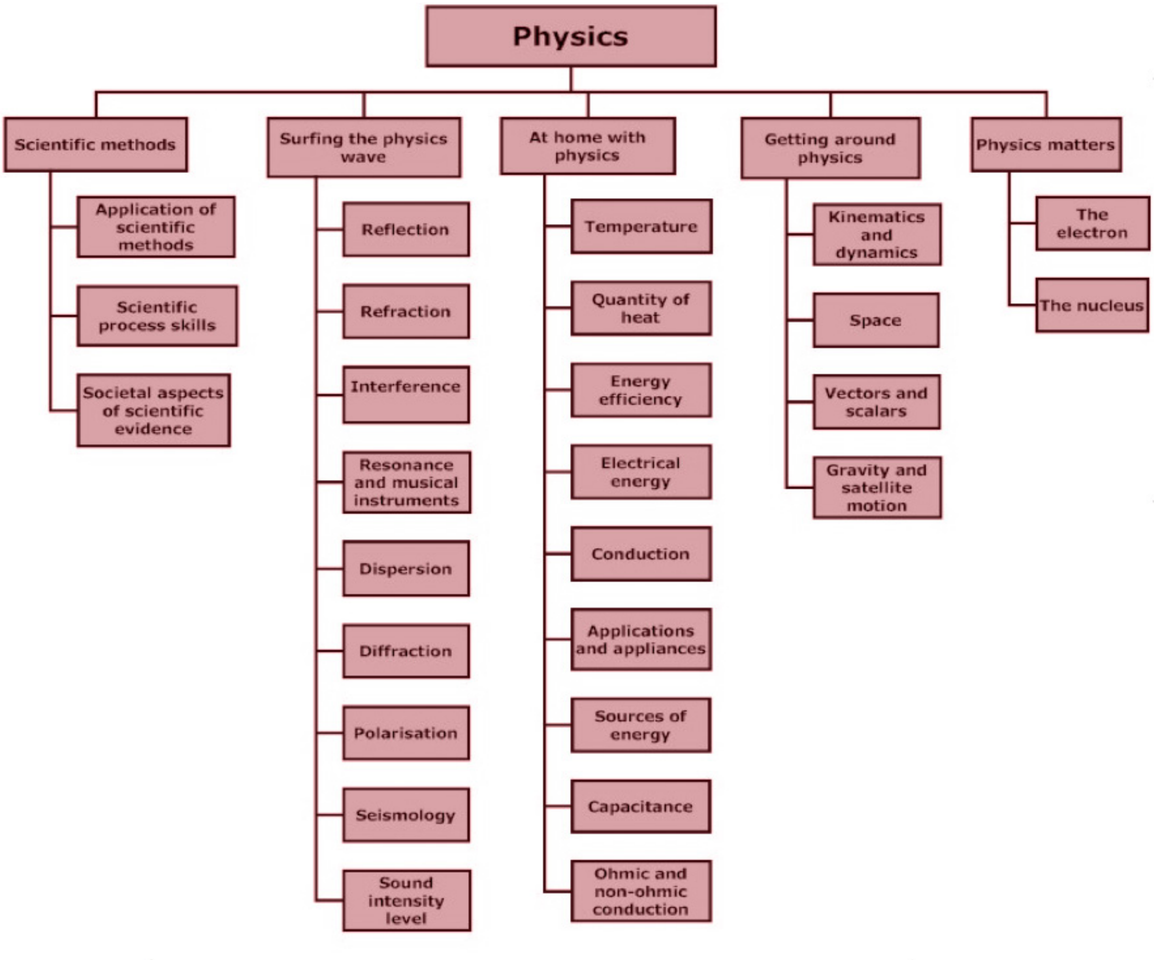
KEY SKILLS

TEACHING AND LEARNING

DIFFERENTIATION

Syllabus overview

Structure



The physics syllabus is divided into five sections reflecting major branches of physics. The first section of the syllabus, scientific methods, sets the context for the four units of content that follow. The course content is gathered into topics on waves, energy, motion, and matter.

The syllabus is presented as learning outcomes. The outcomes are statements of what the learner should be able to do having completed the course. The sequence in which the syllabus learning outcomes are presented does not imply any particular order of teaching and/or learning.

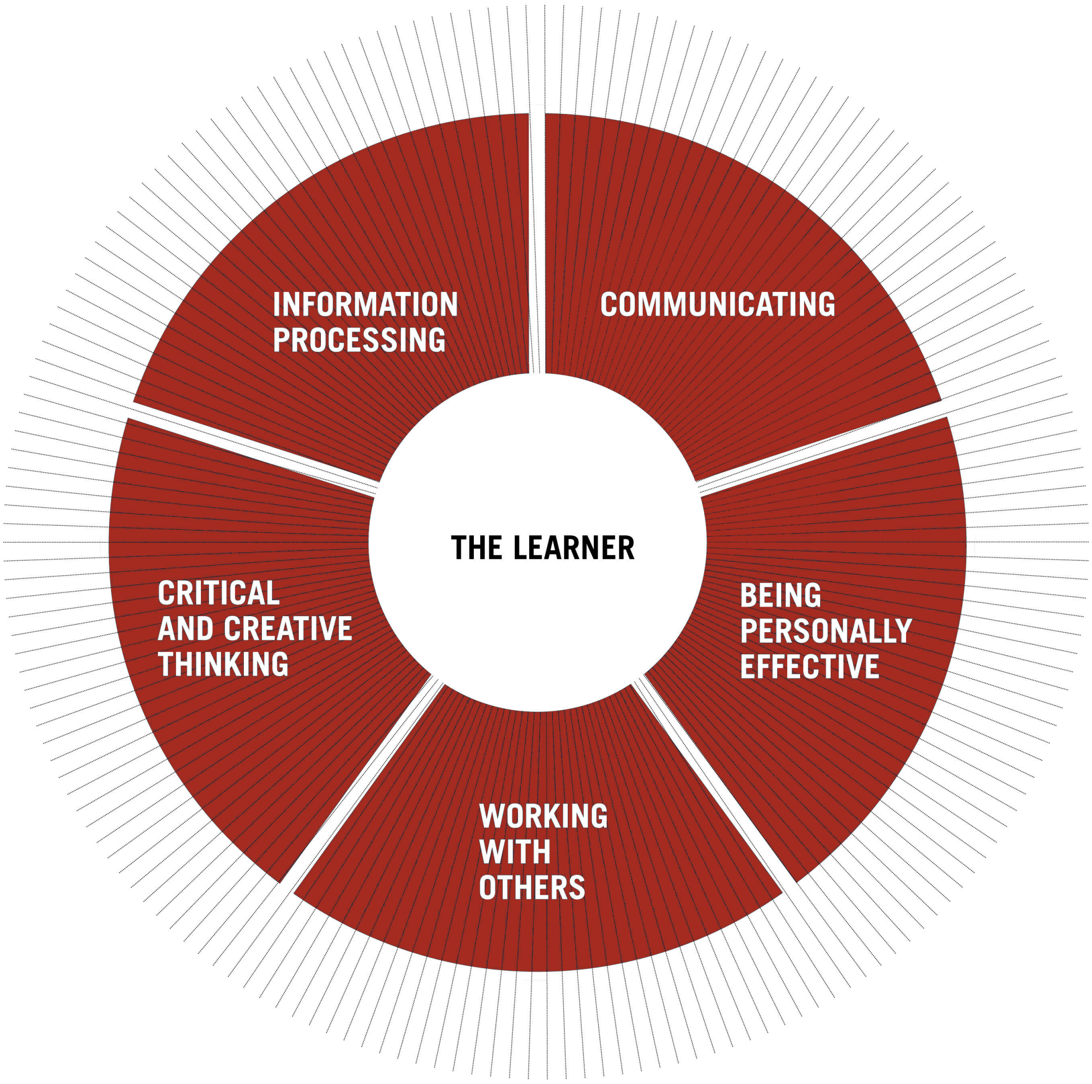
Time Allocation

The Physics syllabus is designed for 180 hours of class contact time. It is recommended that some class periods be timetabled together to facilitate meaningful learner engagement in practical activities

Practical Activities

Learners must complete the practical activities specified in the syllabus. Over the two years of the course each learner is required to maintain a record of these activities according to specified criteria.

Key skills



There are five skills identified as central to teaching and learning across the curriculum at senior cycle. These are information processing, being personally effective, communicating, critical and creative thinking and working with others. These key skills are important for all learners to achieve their full potential, both during their time in school and into the future and to participate fully in society, including family life, the world of work and lifelong learning. Learners develop key skills which enhance their abilities to learn, broaden the scope of their learning and increase their capacity for learning. The syllabus is designed to help learners develop skills as they build on their knowledge and understanding of physics, form positive attitudes to learning and acquire good values through their learning experiences. The key skills are embedded within the learning outcomes of the syllabus and will be assessed in the context of the assessment of the learning outcomes.

Learners will engage with the fundamental principles and concepts of physics through participation in a wide range of skills-based activities. They will build on their knowledge of physics constructed initially through their exploration in science in the Primary School Curriculum and through their investigations in Junior Certificate Science. They will develop information processing and critical and creative thinking skills by examining patterns and relationships, analysing hypotheses, exploring options, solving problems and applying those solutions to new contexts. The Leaving Certificate Physics syllabus offers the opportunity for learners to work together to research, design, plan and conduct investigations and to research and present their findings.

In solving physics problems learners will use careful observation, thoughtful analysis and clarity of expression to evaluate evidence, give their own interpretation of that evidence and make a clear presentation of their proposed solution. Students will learn how to research up-to-date and balanced information to develop a critical approach to accepted physics theories and beliefs and in so doing come to understand the limitations of science.

A wide range of activities is appropriate for physics, including among others, experimental and investigative activities, poster presentations, research activities and debates. Participation in these activities will mirror the work of scientists and enable learners to connect their experience with the theoretical concepts of physics.

In working with others to achieve shared goals, learners develop skills of communication as they share their ideas and present their work using a variety of media. The syllabus learning outcomes encourage learners to make reasoned arguments and to express and justify their position.

Practical Activities

Included in the syllabus learning outcomes are a number of practical activities which are categorised under three headings

- **prescribed activities** develop skills in science process, laboratory techniques and safety procedures. These skills include: following experimental procedure, identifying controls and variables, collecting and recording data, observing and measuring, analysing data for patterns and meaning, and communicating conclusions
- **open-ended, investigative activities** develop skills in application of the strategies of scientific inquiry. These skills include identifying and refining good inquiry questions, developing testable hypotheses, initiating and planning, performing and recording, analysing and interpreting, problem solving and assessing results
- **research activities** develop skills in accessing information that has been gathered previously, selecting the relevant details, analysing that information for patterns and meaning, identifying bias and communicating findings or conclusions.

All forms of practical activities throughout the course develop communication skills. Although the traditional written report is one form of communication, learners will describe what they do and what they learn in other formats as well – such as poster presentations, computer presentations or video. Through various formats of co-operative learning, they will discuss, debate, and reflect on their own thinking and learning. As well as reinforcing the understanding of concepts, principles, laws, and theories the practical activities will support the development of key skills in a variety of contexts. The scientific approach, interpretation of data and use of evidence and argument in evaluating biological information are central to both the practical activities and the theoretical concepts.

Teaching and Learning

Senior cycle learners are encouraged to develop the knowledge, skills, attitudes and values that will enable them to become independent learners and to develop a lifelong commitment to improving their learning.

Leaving Certificate Physics supports the use of a wide variety of teaching and learning approaches. As learners progress they will develop learning strategies that will be transferable across different tasks and different subjects enabling them to make connections between physics, other subjects and everyday experiences. Through engaging in self-directed activities and reflection, learners will assume much of the responsibility for planning, monitoring and evaluating their own learning and in so doing will develop a positive sense of their own capacity to learn.

Learners will integrate their knowledge and understanding of physics with the ethical, social, economic and environmental implications and applications of physics. Increasingly, arguments between scientists extend into the public domain. By critically evaluating scientific texts and debating public statements about science, learners will engage with contemporary issues in physics that affect their everyday lives. They will learn to interrogate and interpret data—a skill which has a value far beyond physics wherever data are used as evidence to support argument. By providing an opportunity to examine and debate reports about contemporary issues in science, Leaving Certificate Physics will enable learners to develop an appreciation of the social context of science.

The variety of activities that learners engage in enables them to take charge of their own learning by setting goals, developing action plans and receiving and responding to assessment feedback. As well as varied teaching strategies, varied assessment strategies will provide information that can be used as feedback so that teaching and learning activities can be modified in ways which best suit individual learners. ethical, and available.

Information and communication technology (ICT)
Computer applications should be included in activities whenever they enhance student learning by enabling them to complete work more efficiently or to complete work that otherwise could not be done. A wide variety of software tools should be used to collect, record, analyse and display information. Examples include reports, spread sheets, graphics, flow charts, concept maps, databases, and electronic presentation. Sensors and other appropriate hardware should be used to collect data where appropriate. The portability of sensor laboratory systems makes them useful for work outside as well as inside the classroom. Software simulations offer access to science experiments that may be difficult to illustrate in other ways; they are easy to relate to and immediately useful. Whilst simulations may substitute for experiences they should not be used to replace direct experiences that are safe, ethical, and available.

Differentiation

Differentiation occurs in three distinct areas: the learning outcomes of the syllabus, the process of teaching and learning, and assessment.

Learning outcomes

Ordinary level	Higher level
Only the learning outcomes that are not presented in bold type Learners engage with a broad range of knowledge, mainly concrete in nature, but with some elements of abstraction or theory. They will be expected to demonstrate and use a moderate range of practical and cognitive skills and tools, select from a range of procedures and apply known solutions to a variety of problems in both familiar and unfamiliar contexts.	All learning outcomes **including those in bold type** Learners engage with a broad range of knowledge including theoretical concepts and abstract thinking with significant depth in some areas. They will be expected to demonstrate and use a broad range of specialised skills and tools to evaluate and use information, to plan and develop investigative strategies and to determine solutions to varied, unfamiliar problems. They will be expected to identify and apply skill and knowledge to a wide variety of both familiar and unfamiliar contexts.

Teaching and Learning
Learners vary in the amount and type of support they need to be successful. Levels of demand in any learning activity will differ as learners bring different ideas and levels of understanding to it. The use of strategies for differentiated learning such as adjusting the level of skills required, varying the amount and the nature of teacher intervention and varying the pace and sequence of learning will allow learners to interact at their own level.

Assessment
In common with other syllabuses for national certification, Physics will be assessed at both Higher and Ordinary Levels. Those sections of the syllabus designated for Higher Level students only appear in **bold type**. Differentiation at the point of assessment will be reflected in the structure of the examination paper and in the style of questioning. Consideration will be given to the language level in the examination questions, the stimulus material provided, the structure of the questions and the amount of scaffolding provided for examination candidates, especially at Ordinary Level.

UNITS OF STUDY

UNIT 1: SCIENTIFIC METHODS

UNIT 2: SURFING THE PHYSICS WAVE

UNIT 3: AT HOME WITH PHYSICS

UNIT 4: GETTING AROUND PHYSICS

UNIT 5: PHYSICS MATTERS

Units of Study

Unit 1: Scientific methods

In addition to the ability to understand and apply the concepts, laws and theories of science, as specified throughout the syllabus, learners should also be able to understand scientific methods and apply them in a variety of contexts. They should be competent in understanding the body of knowledge relating to the pursuit of suitable evidence that underpins scientific practice. Understanding methods of collection, analysis and interpretation of data and being able to evaluate scientific evidence will enable learners to question and engage in debate on the evidence used to defend a scientific claim. This section contains learning outcomes that learners need to achieve so that the syllabus objectives are fully met.

Students learn about	Students should be able to
1.1 Application of scienific method	• apply their knowledge and understanding of science to develop arguments or draw conclusions related to both familiar and unfamiliar situations • use secondary data sources; locate and comprehend relevant information from books, scientific publications, internet, databases and other resources • make judgements and draw informed conclusions pertaining to the reliability and validity of data • use observations as the basis for formulating a hypothesis
1.2 Scientific process skills	• identify variables and select appropriate controls • design, manage and carry out experimental and non-experimental investigations; select appropriate measuring devices; use scales and units accurately, being aware of limitations and errors • collect, organise, interpret, present and analyse primary and secondary data • describe relationships (qualitatively and/or quantitatively) between sets of data; recognising the difference between causation and correlation
1.3 Societal aspects of scientific evidence	• critically examine the scientific process that was used to present a scientific claim • appreciate the limitations of scientific evidence

Unit 2: Surfing the physics wave

This unit describes energy transfer in terms of a wave model. The content deals with the characteristics and properties of electromagnetic, mechanical and sound waves with many opportunities to draw on common and everyday applications and practical demonstrations of these phenomena. Some of these areas include musical instruments, medical imaging and communications technologies. Seismology provides a context for some of the fundamental mathematics and physics laws contained in this section.

Students learn about	Students should be able to
2.1 Reflection	• investigate experimentally the relationship between an object and its image in a plane mirror • investigate experimentally the relationship between object distance, image distance and focal length for a parabolic mirror • investigate experimentally the relationship between object distance, image distance and magnification for a parabolic mirror • construct diagrams which illustrate reflection at plane and regular curved mirrors • use experimental and theoretical techniques to analyse and solve appropriate problems on reflection at plane and curved mirrors • discuss uses of plane and curved mirrors
2.2 Refraction	• construct and interpret ray diagrams for refraction at plane and regular curved surfaces • demonstrate refraction at plane and regular curved surfaces • discuss applications of refraction • investigate the relationship between angles of incidence and refraction and determine experimentally the refractive index and critical angle of translucent materials • discuss applications of mirrors, lenses and optical fibres in optical appliances • describe the optical structure of the eye, including defects and corrections • investigate experimentally the relationship between object distance, image distance and focal length for a converging lens • solve appropriate problems on refractive indices, critical angle, lenses, magnification and power
2.3 Interference	• apply the principle of superposition to explain wave interference • investigate and analyse interference patterns for electromagnetic waves, sound waves and water waves • examine the conditions necessary to produce a standing wave

2.4 Resonance and musical instruments	• use examples to examine resonance in terms of natural frequency and fundamental frequency, including the operation of the vocal cords • analyse stationary waves in stretched strings in terms of resonance, natural frequency and fundamental frequency • analyse the relationship between the frequency of a wave and the tension of the string and use it to solve appropriate problems • design and make a four note musical instrument
2.5 Dispersion	• demonstrate dispersion • link dispersion to dependence of refractive index on frequency • explain the relative positions on the electromagnetic spectrum of radiations in terms of wavelength and frequency and consequent properties • analyse colour combination and filtering • discuss the effect of the atmosphere on ultraviolet and infrared radiations • discuss applications of infrared radiation
2.6 Diffraction	• demonstrate diffraction • compare diffraction of sound waves with diffraction of light waves • demonstrate the wave nature of light using a slit, double slit or grating • investigate the diffraction grating experimentally leading to the grating equation • solve appropriate problems using the grating equation
2.7 Polarisation	• categorise waves using polarisation • discuss applications of polarisation
2.8 Seismology	• interpret relevant seismographic data to determine possible directions of first motion along faults (compare these with reference to GPS data) • interpret relevant seismographic data from a minimum of three recording stations to determine epicentres • interpret relevant seismic data to construct a model of the Earth's cross-section by reference to the reflection and refraction of the seismic waves • outline the uses of P and S waves in the search for oil and gas • analyse information from computer simulations to identify the source of a seismic event
2.9 Sound intensity level	• discuss dB(A) levels of common sounds, the frequency response of the human ear and the threshold of hearing • relate sound intensity level to hearing impairment and the need for ear protection in industry and work situations

2.10 Interference	• Investigate the factors that determine the fundamental frequency of a stretched string • use the formula $f = \frac{1}{2l}\sqrt{\frac{2}{\mu}}$ to solve appropriate problems
2.11 Refraction	• Solve appropriate problems involving refractive index in terms of relative speeds

Unit 3: At home with physics

Issues relating to energy efficiency are explored with an emphasis on the physics of heat and temperature. Energy conversion and transmission are explored in the section on electricity and magnetism. Theories relating to energy conversion, transformation and transmission are grounded in practical applications from familiar contexts as learners analyse the impact and benefits of various energy conservation and transformation technologies that are used around the world.

Students learn about	Students should be able to
3.1 Temperature	• interpret temperature in terms of internal energy • convert temperature values between kelvin and degrees Celsius • investigate variation in the thermometric property of a material with temperature and use it in the design of a thermometer
3.2 Quantity of heat	• explain specific heat capacity and specific latent heat of a substance • determine the specific heat capacity of a liquid by an electrical method • determine the specific latent heat of ice
3.3 Energy efficiency	• interpret given data about the efficiency and performance of systems that use contemporary energy resources, fuels and traditional energy sources • explain the use of heat exchangers to recover heat and to achieve 'thermal comfort' in terms of ventilation and temperature control in the home and in the workplace • use Maximum Average Elemental U-Values and other standards of energy efficiency to make judgements about the quality of a building
3.4 Electrical energy	• analyse the behaviour of electrostatic charges and the properties of the fields associated with them • demonstrate the forces between charges • distinguish between charging an insulator and an isolated conductor by friction and by induction • discuss applications and the effects of static electricity • explain capacitance • demonstrate that a capacitor stores energy • discuss practical applications of capacitors

3.5 Conduction	• explain potential, zero potential and potential difference • collect primary data using sensors; use this data to compare characteristic conduction curves for a metal, an ionic solution with active or inactive electrodes and a gas at low pressure • interpret I-V graphs based on primary and secondary data, and identify charge carriers for a metal, filament bulb, and a semiconductor diode • investigate the factors that determine electrical resistance in a metallic conductor • explain current flow across a p-n junction • demonstrate current flow across an led in forward and reverse bias • investigate simple circuits which illustrate the use of the following components: potential divider, LDR, thermistor, diode, LED, electromagnetic relay and a DPDT switch • solve appropriate problems using Ohm's law • demonstrate the variation in the resistance of a thermistor with temperature • solve appropriate problems on resistors in series and parallel • solve appropriate problems on resistivity • explain the operation of a residual current device and a miniature circuit breaker in circuits • discuss the supply and use of domestic electricity and associated safety issues • calculate appropriate fuse ratings • interpret power ratings for common electrical devices • verify Joule's law by experiment • use appropriate calculations and Joule's law to explain the transmission of electric energy using EHT
3.6 Applications and appliances	• plot the magnetic field due to magnets and due to current in a long straight wire, a loop and a solenoid • discuss the operation and practical applications of an electromagnetic relay • explain the use of the Earth's magnetic field in navigation • demonstrate that a current-carrying conductor in a magnetic field experiences a force • perform appropriate calculations on magnetic flux density • demonstrate the operation of a simple d.c. motor and a moving coil loudspeaker • discuss practical applications of motors

3.7 Sources of energy	• demonstrate electromagnetic induction, Faraday's law and Lenz's law • demonstrate the variation in alternating voltages and alternating currents with time • demonstrate mutual induction in two coils • describe the structure of a transformer • solve appropriate problems on the transformer • explain the term percentage efficiency; and solve appropriate problems involving power and percentage efficiency for a transformer
3.8 Capacitance	• **solve appropriate problems using the formula** $W = \frac{1}{2}cv^2$
3.9 Ohmic and non-ohmic conduction	• **explain the principle of operation of an LED and a photodiode** • **discuss common applications of electrical conduction in gases and in semiconductor devices** • **explain rectification of an a.c. supply**
3.10 Motors	• **discuss the structure and operation of a simple d.c. motor and an induction motor**

Unit 4: Getting around physics

At the core of this unit are Newton's laws of motion and gravitation. Linear and circular motion are analysed in terms of planetary motion and space. Learners use live data from the latest space technology to explore the universe.

Students learn about	Students should be able to
4.1 Kinematics and dynamics	• contrast, using examples, vector and scalar quantities • calculate the resultant of two co-planar vectors • explain displacement, instantaneous and average speed, velocity and acceleration • using primary data collected by sensors determine for linear motion the velocity and acceleration of a moving body • use the equations of motion to solve appropriate problems • analyse distance-time and velocity-time graphs • give examples of how new technologies are used to make observations and measurements that increase our knowledge of the Earth and our Universe • solve appropriate problems, where mass is constant, using the principle of conservation of linear momentum in one dimension • explain appropriate applications of conservation of momentum • verify the principle of conservation of linear momentum in one dimension • establish a relationship between force and acceleration experimentally • demonstrate Newton's laws of motion • explain appropriate applications of Newton's laws • solve appropriate problems involving force, mass and acceleration • determine the net force acting on a body • using primary data collected by sensors determine a value for the acceleration due to gravity 'g' • establish a relationship between the acceleration due to gravity 'g' and the universal gravitation constant 'G' • solve appropriate gravitational problems • explain the variation of 'g' with distance from the centre of a planet • estimate the average power developed in everyday activities • compare the kinetic energy with the potential energy of a body • solve appropriate problems involving potential and kinetic energy • solve appropriate problems involving force and displacement in the same direction • use the principle of conservation of energy to solve problems involving gravitational potential and kinetic energies

4.2 Space	• explain weightlessness and artificial gravity • discuss the presence of atmosphere in terms of gravitational force • discuss how a spacecraft enters, remains in and leaves an orbit • discuss the role of satellites in communications and global positioning systems • discuss parallax of stars using measurements taken at six month time intervals • use the Big Bang Theory to explain the formation of galaxies, stars and planets
4.3 Vectors and scalars	• **solve appropriate problems by resolving a co-planar vector into its vertical and horizontal components**
4.4 Gravity and satellite motion	• **demonstrate an understanding of angular velocity and centripetal acceleration** • **demonstrate uniform circular motion** • **describe the forces acting on an object in uniform circular motion** • **derive the formula** $v = r\omega$ **for the linear velocity of an object moving in uniform circular motion in terms of its angular velocity** • **solve appropriate problems for an object moving in circular motion** • **solve appropriate problems based on the motion of natural and artificial satellites including satellites in geostationary orbits**

Unit 5: Physics matters

Conceptual models and theories of matter and energy provide insights into issues such as the origin of the universe and the production of electricity using nuclear energy and its associated benefits, hazards and the likely environmental impact. Major research and large scale projects in physics have concentrated on the interface between matter and energy; the underlying physical concepts and theories contribute to the debate on the associated ethical and moral issues.

Students learn about	Students should be able to
5.1 The electron	• discuss spectroscopy as a tool in science • describe the photoelectric effect • demonstrate the photoelectric effect • discuss the structure and operation of a photocell • use a computer simulation to investigate the effect on the current due to the photoelectric effect of changing the intensity and frequency of the incident radiation in a photocell • explain X-ray production and the principle of operation of a hot-cathode X-ray tube • discuss applications of X-rays and hazards associated with their production and use • explain the process of stimulated emission of radiation • describe the structure of a semiconductor laser • discuss the applications of a semiconductor laser

5.2 The nucleus	• discuss radioactivity and the nature and properties of each type of radiation • describe the experimental evidence for three kinds of radiation • use alpha scattering to explain atomic structure • write and interpret balanced nuclear reactions • discuss radiation dose • explain half-life, decay constant and the Becquerel • use the relationship between half-life and decay constant and the law of radioactive decay to solve appropriate problems on radioactive decay • discuss the uses of radioisotopes • describe the sources of radon gas, its effects and the detection and controls used to minimise risk • evaluate arguments for the use of nuclear energy, based on research into its advantages and disadvantages • describe the health hazards when using ionising radiations • describe conservation of momentum and energy in nuclear reactions with particular reference to the neutrino • use the Cockcroft and Walton experiment, Einstein's equation, mass defect and the law of conservation of energy to discuss mass-energy conservation • outline the life cycle of a star • describe the structure and operation of a fission reactor and the difficulties in producing sustained fusion as a source of energy • discuss the operation and applications of particle accelerators • discuss the environmental impact of fission reactors and the role of fission and fusion in nuclear weapons • use $E = mc^2$ to solve appropriate problems • discuss how forces at the nanoscale differ from those observed in macroscopic systems
5.3 The electron	• **solve appropriate problems on electron behaviour in electric and magnetic fields** • **explain threshold frequency and Einstein's photoelectric law** • **investigate the effect on the current of changing the intensity and frequency of the incident radiation** • **solve appropriate problems using Einstein's photoelectric law**
5.4 The nucleus	• **discuss the source of energy of a star**

ASSESSMENT

ASSESSMENT IN LEAVING CERTIFICATE BIOLOGY

ASSESSMENT COMPONENTS

GENERAL ASSESSMENT CRITERIA

REASONABLE ACCOMODATIONS

Assessment

Assessment for certification in physics is based on the aim, objectives and learning outcomes outlined in the syllabus. Physics will be examined at two levels: Ordinary Level and Higher Level. There are two assessment components:

- Written examination 80%
- Second component assessment 20%

Both components of assessment will reflect the relationship between practical work and the theoretical content of the syllabus.

Assessment components

Written examination

The written examination will examine the following Assessment of the report will be based on the following:

- knowledge and understanding—application of physics principles and concepts
- problem solving based on integration, analysis and evaluation of qualitative and quantitative information and data
- capacity to form reasonable and logical argument based on evidence—clarity and coherence in argument, management of ideas.

–The percentage of total marks allocated to this component is 80%

General assessment criteria for the written examination

A high level of achievement in this component is characterised by a thorough knowledge and understanding of physics facts, principles, concepts and methods from the whole syllabus and with few significant omissions. Candidates consistently apply their knowledge and understanding of physics to problem solving in both familiar and new contexts. They accurately analyse and evaluate qualitative and quantitative data from different sources; manipulation of data will be almost flawless. Candidates present logical arguments and ideas which in are clearly based on evidence.

A moderate level of achievement in this component is characterised by a good knowledge and understanding of physics facts, principles, concepts and methods from many parts of the syllabus. Candidates apply their knowledge and understanding of physics to problem solving in familiar contexts and in some new contexts using appropriate scientific terminology. They carry out adequate levels of analysis and evaluation on qualitative and quantitative data from different sources; much of their manipulation of data will be correct. Candidates present arguments and ideas which, in the main, are based on evidence.

A low level of achievement in this component is characterised by a limited knowledge and understanding of physics facts, principles, concepts and methods. Candidates select appropriate facts and principles to solve problems concerning familiar material using a limited range of scientific terminology. They carry out basic manipulation of data using straightforward mathematics. Candidates present some explanations based on evidence from familiar contexts, though they may include irrelevant material.

Second component assessment

The second component assessment will assess students' abilities to conduct first- hand investigations and communicate information and understandings based on these investigations. The second component of assessment is made up of two parts.

	Description	Marks
Laboratory notebook	reports on mandatory activities authenticated by teacher	5%
Practical examination	short tasks; learners record data, observations and analysis on a task sheet which is marked externally	15%

The percentage of total marks allocated to the second component assessment is 20%

Laboratory notebook

Students must complete the practical activities specified in the syllabus. Over the two years of the course each student is required to maintain a laboratory notebook, in which a record of these activities is kept. This record must be available for inspection. As part of the assessment, marks will be awarded on a pro rata basis for the satisfactory completion of the specified practical activities.

Practical examination

The practical examination is a laboratory based practical paper focussing on the following experimental skills

- capacity to apply principles and skills of experimental investigation

- ability to critically analyse results making links to theoretical concepts
- management and control of data collection
- mechanical accuracy of scientific process skills—observation, measurement, graphical analysis.

Students will complete a series of short set tasks over a period of 90 minutes. The knowledge and theory of experimental skills are drawn from within the syllabus; the contexts for the setting of tasks are not bound by the syllabus content. Within unfamiliar contexts, students are told exactly what to do and how to do it. Students are required to follow instructions to collect data and make observations. They then use these data and observations to analyse, evaluate and make deductions. Students record their data, observations and deductions on a task sheet which is marked externally.

General assessment criteria for the second component

A high level of achievement in this component is characterised by demonstration of a comprehensive range of manipulative techniques in experimental activities. Candidates make and record observations and measurements with a high level of accuracy and precision. In almost all cases candidates recognise and describe trends and patterns in data and use physics knowledge and understanding to account for inconsistencies and anomalies. Candidates accurately interpret and analyse experimentally derived data; manipulation of the data is almost flawless. In all cases, candidates link theoretical concepts to interpretation of experimental evidence.
Candidates complete all of the prescribed practical activities carried out over the two years.

A moderate level of achievement in this component is characterised by demonstration of a good range of manipulative techniques in experimental activities. Candidates make and record observations and measurements with some accuracy and precision. In most cases candidates recognise and describe trends and patterns in data and in the main use physics knowledge and understanding to account for inconsistencies and anomalies. Candidates' interpretation and analysis of experimentally derived data is generally accurate; much of their manipulation of the data is correct. In some cases, candidates link theoretical concepts to interpretation of experimental evidence.
Candidates complete most of the prescribed practical activities carried out over the two years.

A low level of achievement in this component is characterised by demonstration of a limited range of manipulative techniques in experimental activities. There may be evidence of inaccuracy in measurement and recording of observations. Candidates fail to recognise and generally do not account for inconsistencies and anomalies. They show limited ability to interpret and analyse experimentally derived data; there may be significant levels of error in the manipulation of data Candidates do not link theoretical concepts to interpretation of experimental evidence.
Candidates complete few or none of the prescribed practical activities carried out over the two years.

Reasonable accomodations

The scheme of Reasonable Accommodations is designed to assist candidates with special needs at the Certificate examinations. The term special needs applies to candidates who have physical/medical and/or specific learning difficulties.
Reasonable accommodations are designed to remove as far as possible the impact of a disability on a candidate's performance, so as he or she can demonstrate in an examination his or her level of achievement—they are not designed to compensate for a possible lack of achievement arising from a disability.

Applications for reasonable accommodations are considered within a published framework of principles (Expert Advisory Group Report, January 2000) and are submitted by the school which a candidate attends on prescribed application forms. Applications are normally invited one year in advance of the examination concerned.

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