**The New HSC Physics Syllabus:**

**What’s Changed?**

Document created for the Working Party on Physics Syllabus Change in Schools

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**Overview**

This document was created to highlight the content changes from the current NSW HSC Physics Syllabus created for 2001 and amended in 2002 and 2010 (labelled ‘current’ in this document) to the new HSC Physics Syllabus due for implementation in Year 11 in 2018 and Year 12 in 2019 (labelled ‘new’ in this document).

This document looks only at content that has been added to the new HSC Physics syllabus, has been modified from the current syllabus and placed into the new syllabus, or has been moved from the ‘Options’ section of the current syllabus and moved into the new syllabus. This document does not take into account the addition of the ‘Depth Studies’ requirements in the new syllabus, nor does it take into account the changes in the pedagogical structure of the course content. The ‘key verbs’ (like explain, observe, analyse, etc.) are also not taken into consideration.

This document outlines only the content changes to the syllabus mentioned above, with commentary provided to provide brief context into the nature of the change where appropriate. The ‘Inquiry Question’ heading each content section in the new syllabus is also not taken into account; it is meant to give a broader contextual background for each content section in the overall Module. For a broader contextual viewpoint on the changes, it is best to consult the whole syllabus document.

The different categorisations are also purely from the perspective of the author; other readers of the documents may choose different categorisations.

Resources:

Current HSC Physics syllabus – 2001-2018 (Year 12 only)

<http://www.boardofstudies.nsw.edu.au/syllabus_hsc/pdf_doc/physics-st6-syl.pdf>

New HSC Physics syllabus – From 2018 (Year 11) and 2019 (Year 12) onwards

<http://syllabus.nesa.nsw.edu.au/assets/physics_stage_6/physics-stage-6-syllabus-2017.pdf>

**How to read the tables:**  
Module Column – Module Name in **Bold** (e.g. **Kinematics**), Content Section in *Italics* (e.g. *Motion in a Straight Line*).

New Syllabus Dot Point Column – Modifications are highlighted in **bold** (e.g. Conduct a practical investigation to relate the pitch **and loudness** of a sound to its wave characteristics). Modifications may be additions to current content, change in wording or other changes deemed significant enough for consideration.

Comments Column – References to current syllabus is to the section in bold (e.g. Ideas to Implementation – Superconductors is referred to as **9.4.4**). This is taken as a general reference (although some changes may be more explicit).

**New Content**

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| Module (in new syllabus) | Syllabus Dot Point | Comments |
| Year 11 | | |
| Kinematics  *Motion in a Straight Line* | * describe uniform straight-line (rectilinear) motion and uniformly accelerated motion through:   + qualitative descriptions   + the use of scalar and vector quantities (ACSPH060) | Vectors are emphasised in the new syllabus; a number of modifications and additions were made to accommodate for this. |
| Kinematics  *Motion on a Plane* | * describe and analyse, using vector analysis, the relative positions and motions of one object relative to another object on a plane (ACSPH061) |  |
| * analyse the relative motion of objects in two dimensions in a variety of situations, for example:   + a boat on a flowing river relative to the bank   + two moving cars   + an aeroplane in a crosswind relative to the ground (ACSPH060, ACSPH132)  Information and communication technology capability icon Numeracy icon |  |
| Dynamics  *Forces* | * solve problems or make quantitative predictions about resultant and component forces by applying the following relationships:  Information and communication technology capability icon Numeracy icon   + , | Previously, only Newton’s 2nd Law was incorporated into the syllabus (see **8.4.2**); this is an explicit mention of other laws. Also driven by the addition of vectors into the course. |
| * conduct a practical investigation to explain and predict the motion of objects on inclined planes (ACSPH098) Critical and creative thinking icon  Information and communication technology capability icon |  |
| Dynamics  *Forces, Acceleration and Energy* | * conduct investigations over a range of mechanical processes to analyse qualitatively and quantitatively the concept of average power (, ), including but not limited to:  Information and communication technology capability icon Numeracy icon   + uniformly accelerated rectilinear motion   + objects raised against the force of gravity   + work done against air resistance, rolling resistance and friction | Power only appeared in the current syllabus in the context of Electrical Energy in the Home (see **8.3.4**) |
| Dynamics  *Momentum, Energy and Simple Systems* | * investigate the relationship and analyse information obtained from graphical representations of force as a function of time |  |
| Waves and Thermodynamics  *Wave Behaviour* | * conduct an investigation to distinguish between progressive and standing waves (ACSPH072) |  |
| * conduct an investigation to exploreresonance in mechanical systems andthe relationships between: Critical and creative thinking icon   + driving frequency   + natural frequency of the oscillating system   + amplitude of motion   + transfer/transformation of energy within the system (ACSPH073)  Information and communication technology capability icon Numeracy icon |  |
| Waves and Thermodynamics  *Sound Waves* | * model the behaviour of sound in air as a longitudinal wave |  |
| * conduct investigations to analyse the reflection, diffraction, resonance and superposition of sound waves (ACSPH071) | Experiments were conducted to investigate these properties for radio waves in Ideas to Implementation (see **9.4.2**); but were not explicitly there for sound waves, apart from superposition. |
| * investigate and model the behaviour of standing waves on strings and/or in pipes to relate quantitatively the fundamental and harmonic frequencies of the waves that are produced to the physical characteristics (eg length, mass, tension, wave velocity) of the medium (ACSPH072)  Information and communication technology capability icon Numeracy icon |  |
| * analyse qualitatively and quantitatively the relationships of the wave nature of sound to explain:   + beats ()   + the Doppler effect | The Doppler effect was part of the Medical Physics Option topic in Year 12 (see **9.6.1**) in the context of ultrasound; but the explicit equation was not part of the current syllabus. |
| Waves and Thermodynamics  *Ray Model of Light* | * conduct a practical investigation to demonstrate and explain the phenomenon of the dispersion of light Critical and creative thinking icon |  |
| Waves and Thermodynamics  *Thermodynamics* | * explain the relationship between the temperature of an object and the kinetic energy of the particles within it (ACSPH018) * explain the concept of thermal equilibrium (ACSPH022) * analyse the relationship between the change in temperature of an object and its specific heat capacity through the equation (ACSPH020) * investigate energy transfer by the process of:   + conduction   + convection   + radiation (ACSPH016) * conduct an investigation to analyse qualitatively and quantitatively the latent heat involved in a change of state * model and predict quantitatively energy transfer from hot objects by the process of thermal conductivity Critical and creative thinking icon * apply the following relationships to solve problems and make quantitative predictions in a variety of situations:  Information and communication technology capability icon Numeracy icon   + , where *c* is the specific heat capacity of a substance   + where *k* is the thermal conductivity of a material | All the content of Thermodynamics is new; this constitutes one of the major content changes from the current syllabus. The other major change is the *Light: Wave Model* section in Year 12, outlined below. |
| Electricity and Magnetism  *Electrostatics* | * conduct investigations to describe and analyse qualitatively and quantitatively: Critical and creative thinking icon  Information and communication technology capability icon   + processes by which objects become electrically charged (ACSPH002)   + the forces produced by other objects as a result of their interactions with charged objects (ACSPH103)   + variables that affect electrostatic forces between those objects (ACSPH103) |  |
| * analyse the effects of a moving charge in an electric field, in order torelate potential energy, work and equipotential lines, by applying: (ACSPH105)   + , where *U* is potential energy and *q* is the charge |  |
| Electricity and Magnetism  *Electric Circuits* | * investigate qualitatively and quantitativelyseries and parallel circuits to relate the flow of current through the individual components, the potential differences across those components and the rate of energy conversion by the components to the laws of conservation of charge and energy, by deriving the following relationships: (ACSPH038, ACSPH039, ACSPH044)  Information and communication technology capability icon Numeracy icon * (Kirchoff’s current law – conservation of charge) * (Kirchoff’s voltage law – conservation of energy) | While aspects of this were touched upon in Electrical Energy in the Home (**8.3.3**), this dot point is explicit about these points. |
| * investigate quantitatively the application of the law of conservation of energy to the heating effects of electric currents, including the application of and variations of this involving Ohm’s Law (ACSPH043) Critical and creative thinking icon Numeracy icon | While the concepts of Power and Ohm’s Law are not new, the application is completely new to the syllabus. |
| Electricity and Magnetism  *Magnetism* | * investigate and describe qualitatively the force produced between magnetised and magnetic materials in the context of ferromagnetic materials (ACSPH079) |  |
| * conduct investigations into and describe quantitatively the magnetic fields produced by wires and solenoids, including: (ACSPH106, ACSPH107)   + Information and communication technology capability icon Numeracy icon   + Information and communication technology capability icon | The quantitative aspects of this dot point are new; the current syllabus was only concerned with qualitative descriptions (see **8.3.5**). |
| * investigate and explain the process by which ferromagnetic materials become magnetised (ACSPH083) |  |
| Year 12 | | |
| Advanced Mechanics  *Projectile Motion* | * solve problems, create models and make quantitative predictions by applying the equations of motion relationships for uniformly accelerated and constant rectilinear motion  Information and communication technology capability icon Numeracy icon |  |
| Advanced Mechanics  *Circular Motion* | * investigate the relationship between the total energy and work done on an object executing uniform circular motion | While circular motion was mentioned in some aspects in the current syllabus, there is some focus in the new syllabus on the topic. |
| * investigate the relationship between the rotation of mechanical systems and the applied torque ()  Information and communication technology capability icon Numeracy icon | Torque was discussed in the current syllabus concerning motors (see **9.3.1**). |
| Electromagnetism  *Charged Particles, Conductors and Electric and Magnetic Fields* | * model qualitatively and quantitatively the trajectories of charged particles in electric fields and compare them with the trajectories of projectiles in a gravitational field Critical and creative thinking icon  Information and communication technology capability icon Literacy icon Numeracy icon | The new component is the explicit comparison. |
| Electromagnetism  *The Motor Effect* | * analyse the interaction between two parallel current-carrying wires and determine the relationship between the International System of Units (SI) definition of an ampere and Newton’s Third Law of Motion (ACSPH081, ACSPH106) Information and communication technology capability icon Literacy icon Numeracy icon | While the interaction is part of the old syllabus (see **9.3.1**), the relationship is new to the syllabus. |
| The Nature of Light  *Electromagnetic Spectrum* | * investigate Maxwell’s contribution to the classical theory of electromagnetism, including:   + unification of electricity and magnetism   + prediction of electromagnetic waves   + prediction of velocity (ACSPH113) Critical and creative thinking icon  Information and communication technology capability icon | While Maxwell was implicit in the discussion of Hertz (see **9.4.2**), he is now explicitly mentioned in the new syllabus. |
| The Nature of Light  *Light: Wave Model* | * conduct investigations to analyse qualitatively the diffraction of light (ACSPH048, ACSPH076)  Information and communication technology capability icon * conduct investigations to analyse quantitatively the interference of light using double slit apparatus and diffraction gratings () (ACSPH116, ACSPH117, ACSPH140)  Information and communication technology capability icon Numeracy icon * analyse the experimental evidence that supported the models of light that were proposed by Newton and Huygens (ACSPH050, ACSPH118, ACSPH123) Critical and creative thinking icon * conduct investigations quantitatively using the relationship of Malus’s Law () for plane polarisation of light, to evaluate the significance of polarisation in developing a model for light (ACSPH050, ACSPH076, ACSPH120)  Information and communication technology capability icon Numeracy icon | This is the other major content addition to the new syllabus, along with *Thermodynamics* in Year 11. |
| The Nature of Light  *Light and Special Relativity* | * describe the consequences and applications of relativistic momentum with reference to:   + Information and communication technology capability icon Numeracy icon   + the limitation on the maximum velocity of a particle imposed by special relativity (ACSPH133) Critical and creative thinking icon | This replaces the section discussing the concept of ‘mass dilation’ (see **9.2.4**). |
| From the Universe to the Atom  *Quantum Mechanical Nature of the Atom* | * analyse the contribution of Schrödinger to the current model of the atom |  |
| From the Universe to the Atom  *Properties of the Nucleus* | * account for the release of energy in the process of nuclear fusion (ACSPH035, ACSPH036)  Information and communication technology capability icon |  |

**Modified Content**

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| --- | --- | --- | --- |
| Module (in new syllabus) | New Syllabus Dot Point | Current Syllabus Dot Point | Comments and reference to current syllabus sections |
| Year 11 | | | |
| Kinematics  *Motion in a Straight Line* | * conduct a practical investigation to gather data to facilitate the analysis of instantaneous and average velocity through:  Information and communication technology capability icon   + quantitative, first-hand measurements   + **the graphical representation and interpretation of data (ACSPH061) Numeracy icon** | * compare instantaneous and average speed with instantaneous and average velocity * define average velocity as: * plan, choose equipment or resources for, and perform a first-hand investigation to measure the average speed of an object or a vehicle | **8.4.1** |
| * calculate the relative velocity of two objects moving along the same line **using vector analysis** | * describe the motion of one body relative to another | **8.4.2**  The addition of vector notation has modified several syllabus dot points. |
| * conduct practical investigations, selecting from a range of technologies, to record and analyse the motion of objects in a variety of situations in one dimension in order to measure or calculate:  Information and communication technology capability icon Numeracy icon   + time   + **distance**   + displacement   + speed   + velocity   + **acceleration** | * plan, choose equipment or resources for, and perform a first-hand investigation to measure the average speed of an object or a vehicle * present information graphically of: * displacement vs time * velocity vs time   for objects with uniform and non‑uniform linear velocity | **8.4.1**  **8.4.2** |
| * use mathematical modelling and graphs**,** selected from a range of technologies,to analyse and derive relationships between time, distance, displacement, speed, velocity and acceleration in rectilinear motion, including:   + **= t + t2**   + = + t   + **2 = 2 + 2 (ACSPH061)  Information and communication technology capability icon Numeracy icon** | * solve problems and analyse information to calculate the actual velocity of a projectile from its horizontal and vertical components using: | **9.2.2**  This dot point is derived from the Year 12 Module ‘Space’. |
| Kinematics  *Motion on a Plane* | * analyse vectors in one and two dimensions to:   + **resolve a vector into two perpendicular components**   + **add two perpendicular vector components to obtain a single vector (ACSPH061) Numeracy icon** | * plan, choose equipment or resources for and perform a first-hand investigation to demonstrate vector addition and subtraction * solve problems using vector diagrams to determine resultant velocity, acceleration and force * identify the usefulness of using vector diagrams to assist solving problems | **8.4.2**  More explicit vector mathematics. |
| * represent the distance and displacement of objects moving on a horizontal plane using:   + vector addition   + resolution of components of vectors (ACSPH060)  Information and communication technology capability icon Numeracy icon | * plan, choose equipment or resources for and perform a first-hand investigation to demonstrate vector addition and subtraction | **8.4.2**  More explicit vector mathematics. |
| Dynamics  *Forces* | * using Newton’s Laws of Motion, describe static and dynamic interactions between two or more objects and the changes that result from:   + a contact force   + **a force mediated by fields** | * identify the net force in a wide variety of situations involving modes of transport and explain the consequences of the application of that net force in terms of Newton’s Second Law of Motion | **8.4.2**  More generalised aspects of interactions. Contact forces were implicitly applied in the Year 11 syllabus. |
| * explorethe concept of net force **and equilibrium** in one-dimensional and simple two-dimensional contexts using: (ACSPH050)  Information and communication technology capability icon Numeracy icon   + algebraic addition   + **vector addition**   + **vector addition by resolution into components** | * interpret Newton’s Second Law of Motion and relate it to the equation:      * solve problems and analyse information using:     for a range of situations involving modes of transport |  |
| Dynamics  *Forces, Acceleration and Energy* | * apply **Newton’s first two laws of motion** to a variety of everyday situations, including both static and dynamic examples, **and include the role played by friction ()** (ACSPH063) Critical and creative thinking icon | * interpret Newton’s Second Law of Motion and relate it to the equation:      * identify the net force in a wide variety of situations involving modes of transport and explain the consequences of the application of that net force in terms of Newton’s Second Law of Motion | **8.4.2**  Newton’s 1st law and friction are new additions to this section of the syllabus. |
| * investigate, describe and analyse the acceleration of a single object subjected to a constant net force and relate the motion of the object to Newton’s Second Law of Motion through the use of: (ACSPH062, ACSPH063)   + qualitative descriptions Critical and creative thinking icon   + **graphs and vectors  Information and communication technology capability icon Numeracy icon**   + **deriving relationships from graphical representations including and relationships of uniformly accelerated motion  Information and communication technology capability icon Numeracy icon** | * plan, choose equipment or resources and perform first-hand investigations to gather data and use available evidence to show the relationship between force, mass and acceleration using suitable apparatus * solve problems and analyse information using:     for a range of situations involving modes of transport | **8.4.2**  While first hand data is already required; there are new additions to the content. |
| * apply the special case of conservation of mechanical energy to the quantitative analysisof motion involving:  Information and communication technology capability icon Numeracy icon   + work done and change in the kinetic energy of an object undergoing accelerated rectilinear motion in one dimension ()   + **changes in gravitational potential energy of an object in a uniform field (** | * define the law of conservation of energy * solve problems and analyse information to determine the kinetic energy of a vehicle and the work done using the formulae:     and | **8.4.3** |
| Dynamics  *Momentum, Energy and Simple Systems* | * analyse quantitatively and predict, using the law of conservation of momentum () and, **where appropriate, conservation of kinetic energy ), the results of interactions in elastic collisions (ACSPH066)  Information and communication technology capability icon Numeracy icon** | * define the law of conservation of energy * explain why momentum is conserved in collisions in terms of Newton’s Third Law of motion * perform first-hand investigations to gather data and analyse the change in momentum during collisions * solve problems that apply the principle of conservation of momentum to qualitatively and quantitatively describe the collision of a moving vehicle with: * a stationary vehicle * an immoveable object * another vehicle moving in the opposite direction * another vehicle moving in the same direction | **8.4.3**  **8.4.4** |
| * analyse and compare the momentum and kinetic energy of **elastic and inelastic** collisions (ACSPH066)  Information and communication technology capability icon Numeracy icon | * describe the energy transformations that occur in collisions * explain why momentum is conserved in collisions in terms of Newton’s Third Law of motion * perform first-hand investigations to gather data and analyse the change in momentum during collisions * analyse information to trace the energy transfers and transformation in collisions leading to irreversible distortions | **8.4.3**  **8.4.4** |
| Waves and Thermodynamics  *Wave Properties* | * conduct **practical investigations** to explain and analyse the differences between: Critical and creative thinking icon   + transverse and longitudinal waves (ACSPH068)   + **mechanical and electromagnetic waves (ACSPH070, ACSPH074)** | * identify that mechanical waves require a medium for propagation while electromagnetic waves do not * present diagrammatic information about transverse and longitudinal waves, direction of particle movement and the direction of propagation * describe the relationship between particle motion and the direction of energy propagation in transverse and longitudinal waves | **8.2.1** |
| * construct and/or interpret graphs of displacement as a function of time and as a function of position of transverse and longitudinal waves, and relate the features of those graphs to the following wave characteristics:   + velocity   + frequency   + period   + wavelength   + **wave number**   + displacement and amplitude (ACSPH069)  Information and communication technology capability icon Numeracy icon | * define and apply the following terms to the wave model: medium, displacement, amplitude, period, compression, rarefaction, crest, trough, transverse waves, longitudinal waves, frequency, wavelength, velocity * present and analyse information from displacement-time graphs for transverse wave motion * present diagrammatic information about transverse and longitudinal waves, direction of particle movement and the direction of propagation | **8.2.1** |
| * solve problems and/or make predictions by modelling and applying the following relationships to a variety of situations:  Information and communication technology capability icon Numeracy icon | * quantify the relationship between velocity, frequency and wavelength for a wave:      * solve problems and analyse information by applying the mathematical model of     to a range of situations   * plan, choose equipment for and perform a first-hand investigation to gather information to identify the relationship between the frequency and wavelength of a sound wave travelling at a constant velocity | **8.2.1** |
| Waves and Thermodynamics  *Wave Behaviour* | * explainthe behaviour of waves in a variety of situations by investigating the phenomena of:   + reflection   + refraction   + **diffraction**   + wave superposition (ACSPH071, ACSPH072) | * describe and apply the law of reflection and explain the effect of reflection from a plane surface on waves * describe the principle of superposition and compare the resulting waves to the original waves in sound * explain that refraction is related to the velocities of a wave in different media and outline how this may result in the bending of a wavefront | **8.2.2**  **8.2.3** |
| Waves and Thermodynamics  *Sound Waves* | * conduct a practical investigation to relate the pitch and **loudness** of a sound to its wave characteristics | * explain qualitatively that pitch is related to frequency and volume to amplitude of sound waves | **8.2.2** |
| * relate the displacement of air molecules **to variations in pressure** (ACSPH070) | * identify that sound waves are vibrations or oscillations of particles in a medium * relate compressions and rarefactions of sound waves to the crests and troughs of transverse waves used to represent them | **8.2.2** |
| * investigate quantitatively the relationship between distance and intensity **of sound** | * plan, choose equipment or resources for and perform a first-hand investigation and gather information to model the inverse square law for light intensity and distance from the source | **8.2.3**  Previous focus was on light; relationship now extended to sound. |
| Waves and Thermodynamics  *Ray Model of Light* | * conduct investigations to examine qualitatively and quantitatively the refraction **and** **total internal reflection of light** (ACSPH075, ACSPH076) | * perform an investigation and gather information to graph the angle of incidence and refraction for light encountering a medium change showing the relationship between these angles * identify the conditions necessary for total internal reflection with reference to the critical angle | **8.2.4**  Now includes a focus on quantitatively looking at total internal reflection |
| * predict quantitatively, using Snell’s Law, the refraction **and total internal reflection of light** in a variety of situations Critical and creative thinking icon | * solve problems and analyse information using Snell’s Law * define Snell’s Law: | **8.2.4**  More explicit than the current syllabus |
| * conduct an investigation to demonstrate the relationship between inverse square law, the intensity of light **and** **the transfer of energy** (ACSPH077) | * plan, choose equipment or resources for and perform a first-hand investigation and gather information to model the inverse square law for light intensity and distance from the source | **8.2.3** |
| * solve problems or make quantitative predictions in a variety of situations by applying the following relationships to:  Information and communication technology capability icon Numeracy icon   + **– for the refractive index of medium *x*, *vx* is the speed of light in the medium**   + **(Snell’s Law)**   + **– for the critical angle of medium *x***   + **– to compare the intensity of light at two points, and** | * solve problems and analyse information using Snell’s Law * define Snell’s Law: * solve problems to apply the inverse square law of intensity of light to relate the brightness of a star to its luminosity and distance from the observer | **8.2.3**  **8.5.3**  Includes an aspect of the Cosmic Engine experiments regarding intensity of light and inverse square law relationships. |
| Electricity and Magnetism  *Electrostatics* | * using the electric field lines representation, model qualitatively the direction and strength of electric fields produced by:   + simple point charges   + pairs of charges   + **dipoles**   + parallel charged plates  Information and communication technology capability icon | * describe the behaviour of electrostatic charges and the properties of the fields associated with them * present diagrammatic information to describe the electric field strength and direction: * between charged parallel plates * about and between a positive and negative point charge | **8.3.2** |
| * apply the electric field model to account for and quantitatively analyse interactions between charged objects using:  Information and communication technology capability icon Numeracy icon   + (ACSPH103, ACSPH104)   + **(ACSPH102)** | * define the electric field as a field of force with a field strength equal to the force per unit charge at that point: * solve problems and analyse information using: * solve problem and analyse information using:     and | **8.3.2**  **9.4.2**  The electric field between two parallel plates equation is taken from the Ideas to Implementation Module in Year 12. |
| Electricity and Magnetism  *Electric Circuits* | * investigate the flow of electric current in metals and apply models to represent current, including:   + **(ACSPH038) *Critical and creative thinking icon  Information and communication technology capability icon Numeracy icon*** | * define electric current as the rate at which charge flows (coulombs/ second or amperes) under the influence of an electric field * identify that current can be either direct with the net flow of charge carriers moving in one direction or alternating with the charge carriers moving backwards and forwards periodically | **8.3.2**  Addition of an equation to the dot point. |
| * investigate quantitatively the current–voltage relationships in ohmic **and non-ohmic resistors to explore the usefulness and limitations of Ohm’s Law** using:   + (ACSPH003, ACSPH041, ACSPH043)  Information and communication technology capability icon Numeracy icon | * describe electric potential difference (voltage) between two points as the change in potential energy per unit charge moving from one point to the other (joules/coulomb or volts) * discuss how potential difference changes between different points around a DC circuit * define resistance as the ratio of voltage to current for a particular conductor: | **8.3.2**  There is now a discussion regarding Ohm’s law and how applicable it can be to different situations. |
| * investigate qualitatively and quantitativelyseries and parallel circuits to relate the flow of current through the individual components, the potential differences across those components and the rate of energy conversion by the components to the laws of conservation of charge and energy, by deriving the following relationships: (ACSPH038, ACSPH039, ACSPH044)  Information and communication technology capability icon Numeracy icon * **(Kirchoff’s current law – conservation of charge)** * **(Kirchoff’s voltage law – conservation of energy)** | * compare parallel and series circuits in terms of voltage across components and current through them | **8.3.3**  The concept in the current syllabus has been expanded and equations are now provided for the different relationships. |
| Electricity and Magnetism  *Magnetism* | * use magnetic field lines to model qualitatively the direction and strength of magnetic fields produced by magnets, current-carrying wires and solenoids **and relate these fields to their effect on magnetic materials that are placed within them** (ACSPH083)  Information and communication technology capability icon | * perform a first-hand investigation to observe magnetic fields by mapping lines of force: * around a bar magnet * surrounding a straight DC current-carrying conductor * a solenoid * present information using ⊗ and ʘ to show the direction of a current and direction of a magnetic field * describe the production of a magnetic field by an electric current in a straight current-carrying conductor and describe how the right hand grip rule can determine the direction of current and field lines * define the direction of the magnetic field at a point as the direction of force on a very small north magnetic pole when placed at that point | **8.3.5**  These are now more explicit regarding the fields and its effect on magnetic materials placed in the presence of the fields. |
| Year 12 | | | |
| Advanced Mechanics  *Projectile Motion* | * analyse the motion of projectiles by resolving the motion into horizontal and vertical components, **making the following assumptions**:   + **a constant vertical acceleration due to gravity**   + **zero air resistance** | * describe the trajectory of an object undergoing projectile motion within the Earth’s gravitational field in terms of horizontal and vertical components * solve problems and analyse information to calculate the actual velocity of a projectile from its horizontal and vertical components using: | **9.2.2**  The assumptions for these sets of equations are now explicit; also note that due to the introduction of vectors these equations need to be reframed through vector notation. |
| * apply the modelling of projectile motion to quantitatively derive the relationships between the following variables:   + initial velocity   + **launch angle**   + maximum height   + time of flight   + final velocity   + **launch height**   + horizontal range of the projectile (ACSPH099) | * perform a first-hand investigation, gather information and analyse data to calculate initial and final velocity, maximum height reached, range and time of flight of a projectile for a range of situations by using simulations, data loggers and computer analysis | **9.2.2** |
| Advanced Mechanics  *Circular Motion* | * conduct investigations to explain and evaluate, **for objects executing uniform circular motion**, the relationships that exist between:   + centripetal force   + mass   + speed   + radius | * solve problems and analyse information involving   for vehicles travelling around curves   * solve problems and analyse information to calculate the centripetal force acting on a satellite undergoing uniform circular motion about the Earth using: | **8.4.2**  **9.2.2**  This is a more generalised concept than in the current syllabus, which only focused on vehicles and satellites. |
| * analyse the forces acting on an object executing uniform circular motion in a variety of situations, for example:   + cars moving around horizontal circular bends   + **a mass on a string**   + **objects on banked tracks (ACSPH100) Critical and creative thinking icon  Information and communication technology capability icon** | * analyse the forces involved in uniform circular motion for a range of objects, including satellites orbiting the Earth | **9.2.2**  The cars moving around horizontal circular bends are part of the Year 11 course. |
| * solve problems, model and make quantitative predictions about objects executing uniform circular motion in a variety of situations, using the following relationships:    + Information and communication technology capability icon Numeracy icon | * solve problems and analyse information involving   for vehicles travelling around curves   * solve problems and analyse information to calculate the centripetal force acting on a satellite undergoing uniform circular motion about the Earth using: | **8.4.2**  **9.2.2**  The inserted equations are new to the syllabus, complementing the centripetal force equation already present. |
| Advanced Mechanics  *Motion in Gravitational Fields* | * applyqualitatively and quantitatively Newton’s Law of Universal Gravitation to:   + determine the force of gravity between two objects)   + investigate the factors that affect the gravitational field strength **()**   + predict the gravitational field strength at any point in a gravitational field, including at the surface of a planet (ACSPH094, ACSPH095, ACSPH097) | * describe a gravitational field in the region surrounding a massive object in terms of its effects on other masses in it * define Newton’s Law of Universal Gravitation:      * present information and use available evidence to discuss the factors affecting the strength of the gravitational force | **9.2.3** |
| * investigate the relationship of Kepler’s Laws of Planetary Motion to the forces acting on, **and the total energy of**, planets in circular and **non-circular orbits** using: (ACSPH101)   + Information and communication technology capability icon Numeracy icon | * define the term orbital velocity and the quantitative and qualitative relationship between orbital velocity, the gravitational constant, mass of the central body, mass of the satellite and the radius of the orbit using Kepler’s Law of Periods | **9.2.2** |
| * derive quantitatively and apply the concepts of gravitational force and gravitational potential energy in radial gravitational fields to a variety of situations, including but not limited to:  Information and communication technology capability icon Numeracy icon   + the concept of escape velocity ()   + **total potential energy of a planet or satellite in its orbit ()**   + **total energy of a planet or satellite in its orbit ()**   + **energy changes that occur when satellites move between orbits (ACSPH096)**   + Kepler’s Laws of Planetary Motion (ACSPH101) | * identify that a slingshot effect can be provided by planets for space probes * define the term orbital velocity and the quantitative and qualitative relationship between orbital velocity, the gravitational constant, mass of the central body, mass of the satellite and the radius of the orbit using Kepler’s Law of Periods * define gravitational potential energy as the work done to move an object from a very large distance away to a point in a gravitational field      * explain the concept of escape velocity in terms of the: * gravitational constant * mass and radius of the planet | **9.2.1**  **9.2.2**  **9.2.3** |
| Electromagnetism  *Charged Particles, Conductors and Electric and Magnetic Fields* | * investigate and quantitatively derive and analyse the interaction between charged particles and uniform electric fields, including: (ACSPH083)  Information and communication technology capability icon Numeracy icon   + electric field between parallel charged plates ()   + **acceleration of charged particles by the electric field )**   + **work done on the charge )** | * identify that charged plates produce an electric field * discuss qualitatively the electric field strength due to a point charge, positive and negative charges and oppositely charged parallel plates * solve problem and analyse information using:     and | **9.4.2** |
| * analysethe interaction between charged particles and uniform magnetic fields, including: (ACSPH083)   + **acceleration, perpendicular to the field, of charged particles**   + the force on the charge ) Numeracy icon | * describe quantitatively the force acting on a charge moving through a magnetic field | **9.4.2** |
| * compare the interaction of charged particles moving in magnetic fields to: Critical and creative thinking icon   + the interaction of charged particles with electric fields   + **other examples of uniform circular motion (ACSPH108)** | * identify that moving charged particles in a magnetic field experience a force * define the electric field as a field of force with a field strength equal to the force per unit charge at that point: | **8.3.2**  **9.4.2** |
| Electromagnetism  *The Motor Effect* | * investigate qualitatively and quantitatively the interaction between a current-carrying conductor and a uniform magnetic field ( to establish: (ACSPH080, ACSPH081) Critical and creative thinking icon  Information and communication technology capability icon Numeracy icon   + **conditions under which the maximum force is produced**   + the relationship between the directions of the force, magnetic field strength and current   + **conditions under which no force is produced on the conductor** | * solve problems and analyse information about the force on current-carrying conductors in magnetic fields using:      * discuss the effect on the magnitude of the force on a current-carrying conductor of variations in: * the strength of the magnetic field in which it is located * the magnitude of the current in the conductor * the length of the conductor in the external magnetic field * the angle between the direction of the external magnetic field and the direction of the length of the conductor | **9.3.1** |
| Electromagnetism  *Electromagnetic Induction* | * describe how magnetic flux can change, with reference to the relationship (ACSPH083, ACSPH107, ACSPH109)  Information and communication technology capability icon Numeracy icon | * define magnetic field strength B as magnetic flux density * describe the concept of magnetic flux in terms of magnetic flux density and surface area * describe generated potential difference as the rate of change of magnetic flux through a circuit | **9.3.2**  Includes an equation that was not explicit in the current syllabus |
| * analyse qualitatively and quantitatively, with reference to energy transfers and transformations, examples of **Faraday’s Law** and Lenz’s Law **,** including but not limited to: (ACSPH081, ACSPH110)  Information and communication technology capability icon Numeracy icon   + the generation of an electromotive force (emf) and evidence for Lenz’s Law produced by the relative movement between a magnet, straight conductors, metal plates and solenoids   + **the generation of an emf produced by the relative movement or changes in current in one solenoid in the vicinity of another solenoid** | * outline Michael Faraday’s discovery of the generation of an electric current by a moving magnet * account for Lenz’s Law in terms of conservation of energy and relate it to the production of back emf in motors * explain the production of eddy currents in terms of Lenz’s Law * perform an investigation to model the generation of an electric current by moving a magnet in a coil or a coil near a magnet * plan, choose equipment or resources for, and perform a first-hand investigation to predict and verify the effect on a generated electric current when: * the distance between the coil and magnet is varied * the strength of the magnet is varied * the relative motion between the coil and the magnet is varied | **9.3.2**  Adds equations, an explicit reference to Faraday’s Law and Lenz' |
| * analyse quantitatively the operation of ideal transformers through the application of: (ACSPH110)  Information and communication technology capability icon Numeracy icon | * identify the relationship between the ratio of the number of turns in the primary and secondary coils and the ratio of primary to secondary voltage * explain why voltage transformations are related to conservation of energy | **9.3.4** |
| * evaluate qualitatively the limitations of the ideal transformer model and the strategies used to improve transformer efficiency, including but not limited to: Critical and creative thinking icon   + **incomplete flux linkage**   + resistive heat production and eddy currents | * gather, analyse and use available evidence to discuss how difficulties of heating caused by eddy currents in transformers may be overcome | **9.3.4** |
| The Nature of Light  *Electromagnetic Spectrum* | * describe the production and propagation of **electromagnetic waves** and relate these processes qualitatively to the predictions made by Maxwell’s electromagnetic theory (ACSPH112, ACSPH113) | * describe Hertz’s observation of the effect of a radio wave on a receiver and the photoelectric effect he produced but failed to investigate * outline qualitatively Hertz’s experiments in measuring the speed of radio waves and how they relate to light waves * perform an investigation to demonstrate the production and reception of radio waves | **9.4.2**  This is a more generalised dot point; no longer just considering radio wave but electromagnetic waves in general. |
| * conduct investigations of historical and **contemporary methods** used to determine the speed of light **and its current relationship to the measurement of time and distance** (ACSPH082) Critical and creative thinking icon  Information and communication technology capability icon | * outline qualitatively Hertz’s experiments in measuring the speed of radio waves and how they relate to light waves | **9.4.2** |
| The Nature of Light  *Light: Quantum Model* | * analyse the experimental evidence gathered about black body radiation, **including Wein’s Law** related to Planck's contribution to a changed model of light (ACSPH137) Critical and creative thinking icon  Information and communication technology capability icon Numeracy icon | * identify Planck’s hypothesis that radiation emitted and absorbed by the walls of a black body cavity is quantised | **9.4.2**  While implicit in the current syllabus, this is a more explicit analysis. |
| The Nature of Light  *Light and Special Relativity* | * analyse and evaluate the evidence confirming or denying Einstein’s two postulates:   + the speed of light in a vacuum is an absolute constant   + **all inertial frames of reference are equivalent (ACSPH131)** | * outline the nature of inertial frames of reference * discuss the principle of relativity * describe the significance of Einstein’s assumption of the constancy of the speed of light * identify that if c is constant then space and time become relative * analyse information to discuss the relationship between theory and the evidence supporting it, using Einstein’s predictions based on relativity that were made many years before evidence was available to support it | **9.2.4**  The relationship between the two postulates and Einstein’s theory is made more explicit. |
| * investigate the evidence, from Einstein’s thought experiments and subsequent experimental validation, for time dilation and length contraction , and analyse quantitatively situations in which these are observed, for example:   + **observations of cosmic-origin muons at the Earth’s surface  Information and communication technology capability icon Numeracy icon**   + **atomic clocks (Hafele–Keating experiment) Critical and creative thinking icon  Information and communication technology capability icon Numeracy icon**   + **evidence from particle accelerators Critical and creative thinking icon  Information and communication technology capability icon Numeracy icon**   + **evidence from cosmological studies**  Information and communication technology capability icon | * analyse and interpret some of Einstein’s thought experiments involving mirrors and trains and discuss the relationship between thought and reality * analyse information to discuss the relationship between theory and the evidence supporting it, using Einstein’s predictions based on relativity that were made many years before evidence was available to support it * solve problems and analyse information using: | **9.2.4**  Explicit examples are now given to support Einstein’s theory. |
| From the Universe to the Atom  *Structure of the Atom* | * investigate, assess and model the experimental evidence supporting the existence and properties of the electron, including:  Information and communication technology capability icon   + early experiments examining the nature of cathode rays   + Thomson’s charge-to-mass experiment   + **Millikan's oil drop experiment (ACSPH026)** | * outline Thomson’s experiment to measure the charge/mass ratio of  an electron * explain why the apparent inconsistent behaviour of cathode rays caused debate as to whether they were charged particles or electromagnetic waves * perform an investigation to demonstrate and identify properties of cathode rays using discharge tubes: * containing a maltese cross * containing electric plates * with a fluorescent display screen * containing a glass wheel * analyse the information gathered   to determine the sign of the charge   on cathode rays | **9.4.1**  There is now the addition of the Millikan experiment to the cathodes/Thomson experiments on electron and electron beams. |

**‘Options’ to Core**

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| --- | --- | --- | --- |
| Module (in new syllabus) | New Syllabus Dot Point | Module from Current Syllabus | Comments |
| Year 12 | | | |
| The Nature of Light  *Electromagnetic Spectrum* | * conduct an investigation to examine a variety of spectra produced by discharge tubes, reflected sunlight or incandescent filaments | **Astrophysics (9.7.3)**  **Quanta to Quarks (9.8.1)** |  |
| * investigate how spectroscopy can be used to provide information about:  Information and communication technology capability icon   + the identification of elements | **Astrophysics (9.7.3)** |  |
| * investigate how the spectra of stars can provide information on: Critical and creative thinking icon  Information and communication technology capability icon   + surface temperature   + rotational and translational velocity   + density   + chemical composition | **Astrophysics (9.7.3)** |  |
| The Nature of Light  *Light and Special Relativity* | * Use Einstein’s mass–energy equivalence relationship ( to calculate the energy released by processes in which mass is converted to energy, for example: (ACSPH134)  Information and communication technology capability icon Numeracy icon   + production of energy by the sun   + particle–antiparticle interactions, eg positron–electron annihilation   + **combustion of conventional fuel** | **Medical Physics (9.6.3)**  **Astrophysics (9.7.3)** | The combustion of conventional fuel example is new to the syllabus .  The production of energy by the sun is derived from Astrophysics.  The context of the particle-antiparticle interactions comes up with PET scans in Medical Physics. |
| From the Universe to the Atom  *Origin of the Elements* | * investigate the processes that led to the transformation of radiation into matter that followed the ‘Big Bang’ Critical and creative thinking icon  Information and communication technology capability icon | **The Cosmic Engine (8.5.2)** | A number of dot points are derived from the Year 11 core topic (although usually skimmed past) The Cosmic Engine. |
| * investigate the evidence that led to the discovery of the expansion of the Universe by Hubble (ACSPH138)  Information and communication technology capability icon Numeracy icon | **The Cosmic Engine (8.5.2)** | This omits the mention of Friedmann from the current syllabus. |
| * analyse and apply Einstein’s description of the equivalence of energy and mass **and relate this to the nuclear reactions that occur in stars** (ACSPH031) Critical and creative thinking icon | **The Cosmic Engine (8.5.2)**  **Astrophysics (9.7.6)** | This is a combination of the Year 11 ‘The Cosmic Engine’ and Year 12 ‘Astrophysics’ (Year 12 section highlighted) dot points. |
| * account for the production of emission and absorption spectra and compare these with a continuous black body spectrum (ACSPH137) Critical and creative thinking icon  Information and communication technology capability icon | **Astrophysics (9.7.3)** |  |
| * investigate the key features of stellar spectra and describe how these are used to classify stars Numeracy icon | **Astrophysics (9.7.3)** |  |
| * investigate the Hertzsprung-Russell diagram and how it can be used to determine the following about a star: Critical and creative thinking icon  Information and communication technology capability icon Numeracy icon   + characteristics and evolutionary stage   + surface temperature   + colour   + luminosity | **The Cosmic Engine (8.5.3)** |  |
| * investigate the types of nucleosynthesis reactions involved in Main Sequence and Post-Main Sequence stars, including but not limited to: Critical and creative thinking icon  Information and communication technology capability icon   + proton–proton chain   + CNO (carbon-nitrogen-oxygen) cycle | **Astrophysics (9.7.6)** | This explicitly outlines two processes that students should encounter which were not explicit in the current syllabus |
| From the Universe to the Atom  *Structure of the Atom* | * investigate, assess and model the experimental evidence supporting the nuclear model of the atom, including:  Information and communication technology capability icon   + **the Geiger-Marsden experiment**   + Rutherford’s atomic model   + Chadwick’s discovery of the neutron (ACSPH026) | **Quanta to Quarks (9.8.1, 9.8.3)** | The Geiger-Marsden experiment is now an explicit part of the syllabus. |
| From the Universe to the Atom  *Quantum Mechanical Nature of the Atom* | * assess the limitations of the Rutherford and Bohr atomic models  Information and communication technology capability icon | **Quanta to Quarks (9.8.1)** | Discussions on the limitations of the Rutherford model is made more explicit than the current syllabus. |
| * investigate the line emission spectra to examine the Balmer series in hydrogen (ACSPH138)  Information and communication technology capability icon | **Quanta to Quarks (9.8.1)** |  |
| * relate qualitatively and quantitatively the quantised energy levels of the hydrogen atom and the law of conservation of energy to the line emission spectrum of hydrogen using:   + (ACSPH136)  Information and communication technology capability icon Numeracy icon | **From Ideas to Implementation (9.4.2)**  **Quanta to Quarks (9.8.1)** | Incorporates aspects covered in the ‘Ideas to Implementations’ core module in the current Year 12 syllabus. |
| * investigate de Broglie’s matter waves, and the experimental evidence that developed the following formula:   + (ACSPH140)  Information and communication technology capability icon Numeracy icon | **Quanta to Quarks (9.8.2)** | This is more explicit about mentioning the ‘matter waves’ than the current syllabus. |
| From the Universe to the Atom  *Properties of the Nucleus* | * analyse the spontaneous decay of unstable nuclei, and the properties of the alpha, beta and gamma radiation emitted (ACSPH028, ACSPH030)  Information and communication technology capability icon | **The Cosmic Engine (8.5.4)**  **Medical Physics (9.6.3)**  **Quanta to Quarks (9.8.3, 9.8.4)** | The different modules investigate this dot point in different contexts – what are they (Cosmic), how can you detect them (Quanta) and how could you use them (Medical); amongst other ways. |
| * examine the model of half-life in radioactive decay and make quantitative predictions about the activity or amount of a radioactive sample using the following relationships:   where = number of particles at time , = number of particles present at decay constant, = time for half the radioactive amount to decay (ACSPH029)  Information and communication technology capability icon Numeracy icon | **Medical Physics (9.6.3)** | This now also includes the explicit use of equations (highlighted); not just a qualitative statement as presented in ‘Medical Physics’ |
| * model and explain the process of nuclear fission, including the concepts of controlled and uncontrolled chain reactions, and account for the release of energy in the process (ACSPH033, ACSPH034)  Information and communication technology capability icon | **Quanta to Quarks (9.8.3, 9.8.4)** | This dot point combines a number of dot points from the current syllabus. |
| * analyse relationships that represent conservation of mass-energy in spontaneous and artificial nuclear transmutations, including alpha decay, beta decay, nuclear fission **and nuclear fusion** (ACSPH032)  Information and communication technology capability icon Numeracy icon | **Astrophysics (9.7.6)**  **Quanta to Quarks (9.8.3)** | The discussion on nuclear fusion is new to the syllabus. |
| * predict quantitatively the energy released in nuclear decays or transmutations, including nuclear fission **and nuclear fusion**, by applying: (ACSPH031, ACSPH035, ACSPH036)  Information and communication technology capability icon Numeracy icon   + the law of conservation of energy   + mass defect   + binding energy   + Einstein’s mass–energy equivalence relationship() | **Quanta to Quarks (9.8.3)** | The discussion on nuclear fusion is new to the syllabus. |
| From the Universe to the Atom  *Deep Inside the Atom* | * analyse the evidence that suggests:   + that protons and neutrons are not fundamental particles   + the existence of subatomic particles other than protons, neutrons and electrons | **Quanta to Quarks (9.8.2, 9.8.4)** |  |
| * investigate the Standard Model of matter, including:   + quarks, and the quark composition hadrons   + leptons   + fundamental forces (ACSPH141, ACSPH142)  Information and communication technology capability icon | **Quanta to Quarks (9.8.4)** |  |
| * investigate the operation and role of particle accelerators in obtaining evidence that tests and/or validates aspects of theories, including the Standard Model of matter (ACSPH120, ACSPH121, ACSPH122, ACSPH146)  Information and communication technology capability icon | **Quanta to Quarks (9.8.4)** |  |