NSW Stage 6 Science

EP Curriculum Map

Senior Physics: Year 11

Module 1: Kinematics

Motion in a Straight Line

Content Descriptor	Lesson Names
describe uniform straight-line (rectilinear) motion and uniformly accelerated motion through: – qualitative descriptions – the use of scalar and vector quantities (ACSPH060)	• Distance and Time • Kinematic Equations • Calculating Displacement • Displacement • Displacement and Compass Directions • Speed • Velocity • Acceleration • Using the Acceleration Formula to Calculate Final Velocity • Using the Acceleration Formula to Calculate Initial Velocity • Using the Acceleration Formula to Calculate Time • Scalars and Vectors
conduct a practical investigation to gather data to facilitate the analysis of instantaneous and average velocity through: – quantitative, first-hand measurements – the graphical representation and interpretation of data (ACSPH061)	• Ticker Timers Investigation
calculate the relative velocity of two objects moving along the same line using vector analysis	• Scalars and Vectors • Vectors and Relative Motion • Relative Velocity
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: – time – distance – displacement – speed	• Ticker Timers Investigation

– velocity – acceleration	
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 (ACSPH061) represent the distance and displacement of objects moving on a horizontal plane using: – vector addition – resolution of components of vectors (ACSPH060) describe and analyse algebraically, graphically and with vector diagrams, the ways in which the motion of objects changes, including: – velocity – displacement (ACSPH060, ACSPH061)	• Scalars and Vectors
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)	• Classical Relativity

Module 2: Dynamics

Forces

Content Descriptor	Lesson Names
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	• Introduction to Forces • Newton's First Law • Newton's Second Law • Newton's Third Law
explore the concept of net force and equilibrium in one-dimensional and simple two-dimensional contexts using: (ACSPH050) – algebraic addition – vector addition – vector addition by resolution into components	• Forces in One Dimension • Forces in Two Dimensions • Free Body Diagrams • Forces on an Angle

solve problems or make quantitative predictions about resultant and component forces by applying the following relationships: – $\vec{F}$ AB = $-\vec{F}$BA – Fx = $F\cos\theta$, Fy = $F\sin\theta$ conduct a practical investigation to explain and predict the motion of objects on inclined planes (ACSPH098)	*Further development planned*

Forces, Acceleration and Energy

Content Descriptor	**Lesson Names**
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 $\vec{f}$ friction = μFN (ACSPH063)	• Newton's First Law • Newton's Second Law
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 – graphs and vectors – deriving relationships from graphical representations including $\vec{F}$ net = $m\vec{a}$ and relationships of uniformly accelerated motion	• Newton's Second Law
apply the special case of conservation of mechanical energy to the quantitative analysis of motion involving: – work done and change in the kinetic energy of an object undergoing accelerated rectilinear motion in one dimension $W = F_{//} s = Fs\cos\theta$ – changes in gravitational potential energy of an object in a uniform field $\Delta U = mg\Delta h$	• Weight and Mass • Types of Forces: Gravity • Types of Forces: Magnetism and Friction • Gravity and Free Fall
conduct investigations over a range of mechanical processes to analyse qualitatively and quantitatively the concept of average power P = $\Delta E \Delta t$, $P = F_{//} v = Fv\cos\theta$ including but not limited to: – uniformly accelerated rectilinear motion – objects raised against the force of gravity – work done against air resistance, rolling resistance and friction	• Power • Work

Momentum, Energy and Simple Systems

Content Descriptor	Lesson Names
conduct an investigation to describe and analyse one-dimensional (collinear) and two-dimensional interactions of objects in simple closed systems (ACSPH064)	*Further development planned*
analyse quantitatively and predict, using the law of conservation of momentum $\sum m \vec{v}$before = $\sum m \vec{v}$after and, where appropriate, conservation of kinetic energy mv before and mv after, the results of interactions in elastic collisions (ACSPH066)	• Momentum • Conservation of Momentum
investigate the relationship and analyse information obtained from graphical representations of force as a function of time	*Further development planned*
evaluate the effects of forces involved in collisions and other interactions, and analyse quantitatively the interactions using the concept of impulse	• Momentum • Impulse • Conservation of Momentum
analyse and compare the momentum and kinetic energy of elastic and inelastic collisions (ACSPH066)	• Collisions

Module 3: Waves and thermodynamics

Wave Properties

Content Descriptor	Lesson Names
conduct a practical investigation involving the creation of mechanical waves in a variety of situations in order to explain: – the role of the medium in the propagation of mechanical waves – the transfer of energy involved in the propagation of mechanical waves (ACSPH067, ACSPH070) conduct practical investigations to explain and analyse the differences between: – transverse and longitudinal waves (ACSPH068) – mechanical and electromagnetic waves (ACSPH070, ACSPH074)	• Transfer of Energy Through Waves • Slinky Wave Investigation
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:	• Transverse and Longitudinal Waves • Phase of Waves • Wave Graphs • Wave Frequency and Wavefronts • Wave Speed

– velocity – frequency – period – wavelength – displacement and amplitude (ACSPH069)	• Transfer of Energy Through Waves • Key Terms and Definitions: Properties of Waves
solve problems and/or make predictions by modelling and applying the following relationships to a variety of situations – $v = f\lambda$ – $f = 1/T$	• Wave Frequency and Wavefronts • Wave Speed
explain the behaviour of waves in a variety of situations by investigating the phenomena of: – reflection – refraction – diffraction – wave superposition (ACSPH071, ACSPH072)	• Diffraction Around a Barrier • Huygens' Principle • Superposition Principle • Reflection and Refraction • Two Source Interference of Waves • Law of Reflection • Key Terms and Definitions: Diffraction & Interference
conduct an investigation to distinguish between progressive and standing waves (ACSPH072) conduct an investigation to explore resonance in mechanical systems and the relationships between: – driving frequency – natural frequency of the oscillating system – amplitude of motion – transfer/transformation of energy within the system (ACSPH073)	*Further development planned*

Sound Waves

Content Descriptor	Lesson Names
conduct a practical investigation to relate the pitch and loudness of a sound to its wave characteristics	• Pitch and Loudness
model the behaviour of sound in air as a longitudinal wave	• Speed of Sound • Transverse and Longitudinal Waves
relate the displacement of air molecules to variations in pressure (ACSPH070)	• Sound Formation
investigate quantitatively the relationship between distance and intensity of sound conduct investigations to analyse the reflection, diffraction, resonance and superposition of sound waves (ACSPH071)	*Further development planned*

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 e.g. length, mass, tension, wave velocity) of the medium (ACSPH072)	• Speed of Sound • Properties of Waves • Transverse and Longitudinal Waves • Standing Waves in Pipes • Standing Waves in Strings
analyse qualitatively and quantitatively the relationships of the wave nature of sound to explain: – beats: $f_{\text{beat}} = \|f_2 - f_1$ – the Doppler effect $f' = f(v_{\text{wave}}+v_{\text{observer}})/(v_{\text{wave}}-v_{\text{source}})$	• The Doppler Effect

Ray Model of Light

Content Descriptor	**Lesson Names**
conduct a practical investigation to analyse the formation of images in mirrors and lenses via reflection and refraction using the ray model of light (ACSPH075)	• Introduction to the Ray Model • The Electromagnetic Nature of Light • Polarisation of Light • Reflection at a Straight Boundary • Intensity of Waves • Refraction of Light • Introduction to Snell's Law • Total Internal Reflection • Young's Double Slit Experiment • Multi-slit Diffraction • Reflection of Light from a Concave Mirror - Real Images (Qualitative) • Reflection of Light from a Concave Mirror - Virtual Images (Qualitative) • Reflection of Light from a Convex Mirror (Qualitative) • Refraction of Light Through a Convex Lens - Real Images (Qualitative) • Refraction of Light Through a Convex Lens - Virtual Images (Qualitative) • Refraction of Light Through a Concave Lens (Qualitative)
conduct investigations to examine qualitatively and quantitatively the refraction and total internal reflection of light (ACSPH075, ACSPH076)	• Reflection at a Straight Boundary • Refraction of Light • Total Internal Reflection
predict quantitatively, using Snell's Law, the refraction and total internal reflection of light in a variety of situations	• Refraction of Light • Introduction to Snell's Law • Total Internal Reflection
conduct a practical investigation to demonstrate and explain the phenomenon of the dispersion of light	• Refraction of Light • Polarisation of Light

conduct an investigation to demonstrate the relationship between inverse square law, the intensity of light and the transfer of energy (ACSPH077)	• Intensity of Waves
solve problems or make quantitative predictions in a variety of situations by applying the following relationships to: – for the refractive index of medium x, vx is the speed of light in the medium – $n1 \sin \theta 1 = n2 \sin \theta 2$ (Snell's Law) – to compare the intensity of light at two points, $r1$ and $r2$	• Introduction to Snell's Law • Intensity of Waves

Thermodynamics

Content Descriptor	**Lesson Names**
explain the relationship between the temperature of an object and the kinetic energy of the particles within it (ACSPH018)	• Temperature • Phase Changes
explain the concept of thermal equilibrium (ACSPH022)	• Thermal Equilibrium • Heat Transfer
analyse the relationship between the change in temperature of an object and its specific heat capacity through the equation $Q = mc\Delta T$ (ACSPH020)	• Heat Transfer • First Law of Thermodynamics • Specific Heat Capacity • Specific Latent Heat
investigate energy transfer by the process of: – conduction – convection – radiation (ACSPH016)	• Heat Exchange Systems • Conduction • Convection • Radiation • Energy Efficiency
conduct an investigation to analyse qualitatively and quantitatively the latent heat involved in a change of state	• Specific Latent Heat
model and predict quantitatively energy transfer from hot objects by the process of thermal conductivity	• Conduction • Convection • Radiation
apply the following relationships to solve problems and make quantitative predictions in a variety of situations: – $Q = mc\Delta T$, where c is the specific heat capacity of a substance –$Q/t=kA\Delta/Td$, where k is the thermal conductivity of a material	• Specific Heat Capacity • Conduction

Module 4: Electricity and magnetism

Electrostatics

Content Descriptor	Lesson Names
conduct investigations to describe and analyse qualitatively and quantitatively: – processes by which objects become electrically charged (ACSPH002) – the forces produced by other objects as a result of their interactions with charged object s(ACSPH103) – variables that affect electrostatic forces between those objects (ACSPH103)	• Electricity and Charge
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	• Electric Fields due to Point Charges • Uniform Electric Fields • Coulomb's Law for Two Charges •
apply the electric field model to account for and quantitatively analyse interactions between charged objects using: – $F = qE$ (ACSPH103, ACSPH104) – $E = V/d$ – F =1/(4$\pi\varepsilon$0) (q1q2)/r2(ACSPH102)	• Coulomb's Law and Electric Field Strength • Electric Fields due to Point Charges • Coulomb's Law for Two Charges
analyse the effects of a moving charge in an electric field, in order to relate potential energy, work and equipotential lines, by applying: (ACSPH105) – $V = \Delta U/q$, where U is potential energy and q is the charge	• Electrical Potential Energy and Work • Potential Difference

Electric Circuits

Content Descriptor	Lesson Names
investigate the flow of electric current in metals and apply models to represent current, including: – $I = q/t$(ACSPH038)	• Circuit Properties • Electricity and Charge • Conductors and Insulators • Potential • Current • Resistance • Power • Circuits • Circuit Analysis • Designing Simple Circuits

	• Complex Circuits
investigate quantitatively the current–voltage relationships in ohmic and non-ohmic resistors to explore the usefulness and limitations of Ohm's Law using: – $W = qV$ – $V = IR$ (ACSPH003, ACSPH041, ACSPH043) investigate quantitatively and analyse the rate of conversion of electrical energy in components of electric circuits, including the production of heat and light, by applying $P = VI$ and $E = Pt$ and variations that involve Ohm's Law (ACSPH042)	• Current • Resistance • Ohm's Law
investigate qualitatively and quantitatively series 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) – $\Sigma I = 0$ (Kirchhoff's current law – conservation of charge) – $\Sigma V = 0$ (Kirchhoff's voltage law – conservation of energy) – RSeries = $R$1 + $R$2+. . . + Rn –1/RParallel = 1/$R$1+1/$R$2+. . . +1/Rn	• Ohm's Law • Power • Kirchhoff's Current Law • Kirchhoff's Voltage Law • Parallel Circuits and Total Resistance • Total Circuit Properties of Parallel Circuits
investigate quantitatively the application of the law of conservation of energy to the heating effects of electric currents, including the application of $P = VI$ and variations of this involving Ohm's Law (ACSPH043)	*Further development planned*

Magnetism

Content Descriptor	**Lesson Names**
investigate and describe qualitatively the force produced between magnetised and magnetic materials in the context of ferromagnetic materials (ACSPH079)	• 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)	• Magnetic Fields • Permanent Magnetic Fields • Magnetic Fields due to Conductors • Magnetic Field of a Current-Carrying Wire
conduct investigations into and describe quantitatively the magnetic fields produced by wires and solenoids, including: (ACSPH106, ACSPH107)	• Magnetic Field of a Current-Carrying Wire • Solenoids • Magnetism

– $B = \mu 0 I / 2 \pi r$ – $B = \mu 0 N I$ investigate and explain the process by which ferromagnetic materials become magnetised (ACSPH083) apply models to represent qualitatively and describe quantitatively the features of magnetic fields	• Magnetic Fields • Examples of Magnetic Fields • Permanent Magnetic Fields

Senior Physics: Year 12

Module 5: Advanced mechanics

Projectile Motion

Content Descriptor	Lesson Names
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	• Projectile Motion • Projectile Calculations
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)	• Projectile Motion • Projectile Calculations
conduct a practical investigation to collect primary data in order to validate the relationships derived above. solve problems, create models and make quantitative predictions by applying the equations of motion relationships for uniformly accelerated and constant rectilinear motion	*Further development planned*

Circular Motion

Content Descriptor	Lesson Names
conduct investigations to explain and evaluate, for objects executing uniform circular motion, the relationships that exist between: – centripetal force – mass – speed – radius	• Circular Motion • Uniform Circular Motion • Vertical Circular Motion • Centripetal Force
analyse the forces acting on an object executing uniform circular motion in a variety of situations, for example: – cars moving around horizontal circular bends	• Centripetal Force • Circular Motion on Banked Curves

– a mass on a string – objects on banked tracks (ACSPH100)	
solve problems, model and make quantitative predictions about objects executing uniform circular motion in a variety of situations, using the following relationships: – ac =v2/r – v = 2$\pi r/T$ – Fc =mv2/r – ω =$\Delta\theta$	• Uniform Circular Motion
investigate the relationship between the total energy and work done on an object executing uniform circular motion	• Uniform Circular Motion
investigate the relationship between the rotation of mechanical systems and the applied torque – τ = $r\perp F$ = rF sin	• Torque from Force at an Angle • Torque • Net Torque • Equilibrium

Motion in Gravitational Fields

Content Descriptor	Lesson Names
apply qualitatively and quantitatively Newton's Law of Universal Gravitation to: – determine the force of gravity between two objects F =GMm/r2 – investigate the factors that affect the gravitational field strength g = GM/r2 – predict the gravitational field strength at any point in a gravitational field, including at the surface of a planet (ACSPH094, ACSPH095, ACSPH097)	• Motion under Gravity • Free Fall • Newton's Law of Universal Gravitation
investigate the orbital motion of planets and artificial satellites when applying the relationships between the following quantities: – gravitational force – centripetal force – centripetal acceleration – mass – orbital radius – orbital velocity – orbital period	• Planetary Motion • Satellites • Satellite Motion
predict quantitatively the orbital properties of planets and satellites in a variety of situations, including near the Earth and geostationary orbits, and relate these to their uses (ACSPH101)	• Planetary Motion • Satellites • Satellite Motion
investigate the relationship of Kepler's Laws of	• Planetary Motion

Planetary Motion to the forces acting on, and the total energy of, planets in circular and non-circular orbits using: (ACSPH101) – $v = 2\pi r/T$ – $r3/T2 = GM/4\pi 2$	• Kepler's Laws of Planetary Motion
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: – the concept of escape velocity $v$esc = √2GM/r – total potential energy of a planet or satellite in its orbit U = $-GMm/r$ – total energy of a planet or satellite in its orbit U + K = $-GMm/2r$ – energy changes that occur when satellites move between orbits (ACSPH096) – Kepler's Laws of Planetary Motion (ACSPH101)	• Satellite Motion • Kepler's Laws of Planetary Motion

Module 6: Electromagnetism

Charged Particles, Conductors and Electric and Magnetic Fields

Content Descriptor	Lesson Names
investigate and quantitatively derive and analyse the interaction between charged particles and uniform electric fields, including: (ACSPH083) – electric field between parallel charged plates $E = V/d$ – acceleration of charged particles by the electric field Fnet = $m\vec{a}$, $F = qE$ – work done on the charge $W = qV$, $W = qEd$, $K = 1/2mv2$	• Force on a Particle • Uniform Electric 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	• Motion of Charges in a Magnetic Field
analyse the interaction between charged particles and uniform magnetic fields, including: (ACSPH083) – acceleration, perpendicular to the field, of charged particles – the force on the charge $F = qv\perp B = qvB$sin	• Force on a Particle • Magnetic Force on a Charged Particle
compare the interaction of charged particles moving in magnetic fields to: – the interaction of charged particles with electric fields – other examples of uniform circular motion (ACSPH108)	• Magnetic Force on a Charged Particle

The Motor Effect

Content Descriptor	Lesson Names
investigate qualitatively and quantitatively the interaction between a current-carrying conductor and a uniform magnetic field $F = lI_{\perp}B = lIB\sin\theta$ to establish: (ACSPH080, ACSPH081) – 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	• Motors • The Motor Effect
conduct a quantitative investigation to demonstrate the interaction between two parallel current carrying wires analyse the interaction between two parallel current-carrying wires $F/l = \mu_0/2\pi \; I_1I_2/r$ and determine the relationship between the International System of Units (SI) definition of an ampere and Newton's Third Law of Motion (ACSPH081, ACSPH106)	*Further development planned*

Electromagnetic Induction

Content Descriptor	Lesson Names
describe how magnetic flux can change, with reference to the relationship $\Phi = B_{\parallel}A = BA\cos\theta$ (ACSPH083, ACSPH107, ACSPH109)	• Magnetic Flux • Faraday's Law
analyse qualitatively and quantitatively, with reference to energy transfers and transformations, examples of Faraday's Law and Lenz's Law $\varepsilon = -N\Delta\Phi/\Delta t$, including but not limited to: (ACSPH081, ACSPH110) – 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	• Faraday's Law • Lenz's Law • Transformers
analyse quantitatively the operation of ideal transformers through the application of: (ACSPH110) –$V_p/V_s=N_p/N_s$ – $V_pI_p = V_sI_s$ evaluate qualitatively the limitations of the ideal transformer model and the strategies used to	• Transformers

improve transformer efficiency, including but not limited to: – incomplete flux linkage – resistive heat production and eddy currents analyse applications of step-up and step-down transformers, including but not limited to: – the distribution of energy using high-voltage transmission lines	

Applications of the Motor Effect

Content Descriptor	Lesson Names
investigate the operation of a simple DC motor to analyse: – the functions of its components – production of a torque $\tau = nIA_{\perp}B = nIAB\sin\theta$ – effects of back emf (ACSPH108) analyse the operation of simple DC and AC generators and AC induction motors (ACSPH110)	• Behaviour of Inductors • Electric Motors
relate Lenz's Law to the law of conservation of energy and apply the law of conservation of energy to: – DC motors and – magnetic braking	• Electric Motors • Lenz's Law • Alternating Current

Module 7: The nature of light

Electromagnetic Spectrum

Content Descriptor	Lesson Names
investigate Maxwell's contribution to the classical theory of electromagnetism, including: – unification of electricity and magnetism – prediction of electromagnetic waves – prediction of velocity (ACSPH113) describe the production and propagation of electromagnetic waves and relate these processes qualitatively to the predictions made by Maxwell's electromagnetic theory (ACSPH112, ACSPH113) conduct investigations of historical and contemporary methods used to determine the speed of light and its	• The Electromagnetic Nature of Light • Determining the Nature and Speed of Light

current relationship to the measurement of time and distance (ACSPH082)	
conduct an investigation to examine a variety of spectra produced by discharge tubes, reflected sunlight or incandescent filaments investigate how spectroscopy can be used to provide information about: – the identification of elements	• Multi-slit Diffraction • Atomic Absorption Spectroscopy
investigate how the spectra of stars can provide information on: – surface temperature – rotational and translational velocity – density – chemical composition	Properties of Stars Reading Hertzsprung-Russell Diagrams

Light: Wave Model

Content Descriptor	Lesson Names
conduct investigations to analyse qualitatively the diffraction of light (ACSPH048, ACSPH076)	• Models of Light • Young's Double Slit Experiment • Huygen's Principle • Diffraction Around a Barrier • Multi-slit Diffraction
conduct investigations to analyse quantitatively the interference of light using double slit apparatus and diffraction gratings $d\sin\theta = m\lambda$ (ACSPH116, ACSPH117, ACSPH140)	• Young's Double Slit Experiment • Huygen's Principle • Diffraction Around a Barrier • Multi-slit Diffraction
analyse the experimental evidence that supported the models of light that were proposed by Newton and Huygens (ACSPH050, ACSPH118, ACSPH123)	• Models of Light • Huygen's Principle
conduct investigations quantitatively using the relationship of Malus' Law $I = I\text{max}\,cos2\theta$ for plane polarisation of light, to evaluate the significance of polarisation in developing a model for light (ACSPH050, ACSPH076, ACSPH120)	• Polarisation of Light

Light: Quantum Model

Content Descriptor	Lesson Names
analyse the experimental evidence gathered about black body radiation, including Wien's Law related to Planck's contribution to a changed model of light (ACSPH137) – λmax =b/T	• Photons • Quantisation of Energy • The Photoelectric Effect

investigate the evidence from photoelectric effect investigations that demonstrated inconsistency with the wave model for light (ACSPH087, ACSPH123, ACSPH137) analyse the photoelectric effect Kmax = $\hbar f - \phi$ as it occurs in metallic elements by applying the law of conservation of energy and the photon model of light, (ACSPH119)	*Further development planned*

Light and Special Relativity

Content Descriptor	**Lesson Names**
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)	• Einstein's Theory of Special Relativity
investigate the evidence, from Einstein's thought experiments and subsequent experimental validation, for time dilation t = t0/√(1−v2/c2) and length contraction l = l0√(1 −v2/c2), and analyse quantitatively situations in which these are observed, for example: – observations of cosmic-origin muons at the Earth's surface – atomic clocks (Hafele–Keating experiment) – evidence from particle accelerators – evidence from cosmological studies	• Einstein's Theory of Special Relativity • Time Dilation • Length Contraction • Relativity of Simultaneity • Twins Paradox • Evidence for Special Relativity: Muons
describe the consequences and applications of relativistic momentum with reference to: – pv = m0v/√(1−v2/c2) – the limitation on the maximum velocity of a particle imposed by special relativity (ACSPH133)	• Relativistic Mass and Momentum
Use Einstein's mass–energy equivalence relationship E = mc2 to calculate the energy released by processes in which mass is converted to energy, for example: (ACSPH134) – production of energy by the sun – particle–antiparticle interactions, eg positron–electron annihilation – combustion of conventional fuel	• Mass-Energy Equivalence • Mass Defect in Nuclear Physics

Module 8: From the Universe to the atom

Origins of the Elements

Content Descriptor	Lesson Names
investigate the processes that led to the transformation of radiation into matter that followed the 'Big Bang'	• The Big Bang Theory
investigate the evidence that led to the discovery of the expansion of the Universe by Hubble (ACSPH138)	• Cosmic Background Radiation
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)	• The Life Cycle of Stars
account for the production of emission and absorption spectra and compare these with a continuous black body spectrum (ACSPH137) investigate the key features of stellar spectra and describe how these are used to classify stars	*Further development planned*
investigate the Hertzsprung-Russell diagram and how it can be used to determine the following about a star: – characteristics and evolutionary stage – surface temperature – colour – luminosity	• Hertzsprung-Russell Diagrams
investigate the types of nucleosynthesis reactions involved in Main Sequence and Post-Main Sequence stars, including but not limited to: – proton–proton chain – CNO (carbon-nitrogen-oxygen) cycle	*Further development planned*

Quantum Mechanical Nature of the Atom

Content Descriptor	Lesson Names
assess the limitations of the Rutherford and Bohr atomic models	• Bohr's Model of the Hydrogen Atom • The Rutherford-Bohr Model
investigate the line emission spectra to examine the Balmer series in hydrogen (ACSPH138)	*Further development planned*
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: – $E = hf$ – $E = hc/\lambda$ –$1/\lambda = R\,[1/nf2 - 1/ni2]$ (ACSPH136)	• Quantisation of Energy

investigate de Broglie's matter waves, and the experimental evidence that developed the following formula: – $\lambda = h/mv$ (ACSPH140) analyse the contribution of Schrödinger to the current model of the atom	*Further development planned*

Properties of the Nucleus

Content Descriptor	Lesson Names
analyse the spontaneous decay of unstable nuclei, and the properties of the alpha, beta and gamma radiation emitted (ACSPH028, ACSPH030)	• Introduction to Radiation • Types of Radiation
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: – Nt = Noeˆ$-\lambda t$ – λ =ln2/t1/2 where Nt = number of particles at time t, N0 = number of particles present at t = 0, λ = decay constant, t1/2 = time for half the radioactive amount to decay (ACSPH029)	• Radioactive Decay • Half-Life
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)	• Nuclear Fission • Nuclear Power Plants • Energy
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)	• Transmutation and Decay • Balancing Nuclear Equations
account for the release of energy in the process of nuclear fusion (ACSPH035, ACSPH036)	• Nuclear Fusion
predict quantitatively the energy released in nuclear decays or transmutations, including nuclear fission and nuclear fusion, by applying: (ACSPH031, ACSPH035, ACSPH036) – the law of conservation of energy – mass defect – binding energy – Einstein's mass–energy equivalence relationship E = mc2	• Nuclear Fission • Nuclear Fusion • Energy

Deep inside the Atom

Content Descriptor	Lesson Names
analyse the evidence that suggests: – that protons and neutrons are not fundamental particles – the existence of subatomic particles other than protons, neutrons and electrons	• Elementary Particles
investigate the Standard Model of matter, including: – quarks, and the quark composition hadrons – leptons – fundamental forces (ACSPH141, ACSPH142)	• The Standard Model • The Fundamental Forces • Conservation Laws
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)	• Particle Accelerators