# Physics

EP Curriculum Map

# Unit 1:  Thermal , nuclear and electrical physics

## Topic 1: Heating processes

### Kinetic particle model and heat flow

| Content Descriptor | Lesson Names |
|---|---|
| describe the kinetic particle model of matter | • Particle Model |
| define and distinguish between thermal energy, temperature, kinetic energy, heat and internal energy | • Heat transfer |
| explain heat transfers in terms of conduction, convection and radiation. | • Conduction<br>• Convection<br>• Radiation |

### Temperature and specific heat capacity

| Content Descriptor | Lesson Names |
|---|---|
| use $T\_K = T\_C + 273$ to convert temperature measurements between Celsius and Kelvin<br><br>use digital and other measuring devices to collect data, ensuring measurements are recorded using the correct symbol, SI unit, number of significant figures and associated measurement uncertainty (absolute and percentage); all experimental measurements should be recorded in this way<br><br>explain that a change in temperature is due to the addition or removal of energy from a system (without phase change) | • Temperature |
| define specific heat capacity and the concept of proportionality<br><br>interpret tabulated and graphical data of heat added to a substance and its subsequent temperature change (without phase change) | • Specific Heat Capacity |

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| solve problems involving specific heat capacity. | |
| Mandatory practicals:<br>• Conduct an experiment that obtains data to be plotted on a scatter graph (with correct title and symbols, units and labels on the axes), analysed by calculating the equation of a linear trend line, interpreted to draw a conclusion, and reported on using scientific conventions and language.<br>• Conduct an experiment that determines the specific heat capacity of a substance, ensuring that measurement uncertainties associated with mass and temperature are propagated. Where the mean is calculated (in this, and future experiments), determine the percentage and/or absolute uncertainty of the mean. | *Further development planned* |

## Phase changes and specific latent heat

| **Content Descriptor** | **Lesson Names** |
|---|---|
| explain why the temperature of the system remains the same during the process of state change; explain it in terms of the internal energy of a system and the kinetic particle model of matter | • Phase Changes |
| define specific latent heat<br><br>solve problems involving specific latent heat. | • Specific Latent Heat |

## Energy conservation in calorimetry

| **Content Descriptor** | **Lesson Names** |
|---|---|
| define thermal equilibrium in terms of the temperature and average kinetic energy of the particles in each of the systems<br><br>explain the process in which thermal energy is transferred between two systems until thermal equilibrium is achieved, and recognise this as the zeroth law of thermodynamics<br><br>solve problems involving specific heat capacity, specific latent heat and thermal equilibrium. | • Thermal Equilibrium |

## Energy in systems-mechanical work and efficiency

| Content Descriptor | Lesson Names |
|---|---|
| explain that a system with thermal energy has the capacity to do mechanical work | • Mechanical Work |
| recall that the change in the internal energy of a system is equal to the energy added or removed by heating plus the work done on or by the system, and recognise this as the first law of thermodynamics and that this is a consequence of the law of conservation of energy | • First Law of Thermodynamics |
| explain that energy transfers and transformations in mechanical systems always result in some heat loss to the environment, so that the amount of useable energy is reduced | • Heat Exchange Systems |
| define efficiency | • Energy Efficiency |
| solve problems involving finding the efficiency of heat transfers. | • Heat Exchange Systems<br>• Energy Efficiency |

## Science as a Human Endeavour (SHE)

| Content Descriptor | Lesson Names |
|---|---|
| Science as a Human Endeavour (SHE) | • Engines<br>• Climate<br>• Weather<br>• Low Temperature Physics |

# Topic 2: Ionising radiation and nuclear reactions

## Nuclear model and stability

| Content Descriptor | Lesson Names |
|---|---|
| describe the nuclear model of the atom characterised by a small nucleus surrounded by electrons<br><br>explain why protons in the nucleus repel each other<br><br>define the strong nuclear force<br><br>explain the stability of a nuclide in terms of the operation of the strong nuclear force over very short distances, electrostatic repulsion, and the relative number of protons and neutrons in the nucleus. | • Nuclear Model<br>• Nuclear Forces |

## Spontaneous decay and half-life

| **Content Descriptor** | **Lesson Names** |
|---|---|
| explain natural radioactive decay in terms of stability | • Rutherford's Model of the Atom<br>• The Rutherford-Bohr Model<br>• Radioactive Decay |
| define alpha radiation, beta positive radiation, beta negative radiation and gamma radiation | • Introduction to Radiation<br>• Types of Radiation |
| describe alpha, beta positive, beta negative and gamma radiation, including the properties of penetrating ability, charge, mass and ionisation ability | • Types of Radiation |
| explain how an excess of protons, neutrons or mass in a nucleus can result in alpha, beta positive and beta negative decay | • Types of Radiation<br>• Atomic Number and Mass |
| solve problems involving balancing nuclear equations | • Balancing Nuclear Equations |
| represent spontaneous alpha, beta positive and beta negative decay using decay equations | • Balancing Nuclear Equations |
| explain how a radionuclide will, through a series of spontaneous decays, become a stable nuclide | • Radioactive Decay |
| define half life<br><br>solve radioactive decay problems involving whole numbers of half-lives. | • Half-Life |

## Energy and mass defect

| **Content Descriptor** | **Lesson Names** |
|---|---|
| describe energy in terms of electron volts (eV) and joules (J) | • Energy |
| define artificial transmutation<br><br>distinguish between artificial transmutations and natural radioactive decay | • Transmutation and Decay |
| define nuclear fission<br><br>explain a neutron-induced nuclear fission reaction, including references to extra neutrons produced from many of these reactions | • Nuclear Fission |
| research nuclear safety, considering the suitability of using the sources of information in terms of their | • Nuclear Power Plants |

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| credibility | |
| explain a fission chain reaction | • Nuclear Fission<br>• Nuclear Power Plants |
| define nuclear fusion | • Nuclear Fission |
| define mass defect, binding energy and binding energy per nucleon<br><br>recall Einstein's mass–energy equivalence relationship<br><br>solve problems involving Einstein's mass–energy equivalence relationship | • Energy |
| explain that more energy is released per nucleon in nuclear fusion than in nuclear fission because a greater percentage of the mass is transformed into energy. | • Energy<br>• Nuclear Fusion |

### Science as a Human Endeavour (SHE)

| Content Descriptor | Lesson Names |
|---|---|
| Science as a Human Endeavour (SHE) | • Radioactivity in Industry<br>• Radioactivity in Medicine<br>• Effects of Radiation on Humans<br>• Marie Curie and Radioactivity |

## Topic 3: Electrical circuits

### Current, potential difference and energy flow

| Content Descriptor | Lesson Names |
|---|---|
| recall that electric charge can be positive or negative | • Electricity and Charge |
| recall that electric current is carried by discrete electric charge carriers | • Current |
| recall the law of conservation of electric charge | • Electricity and Charge<br>• Current |
| recall that electric charge is conserved at all points in an electrical circuit and recognise this as Kirchhoff's current law | • Kirchhoff's Current Law<br>• Kirchhoff's Voltage Law |
| define electric current, electrical potential difference in a circuit, and power | • Circuit Properties<br>• Potential<br>• Power |
| solve problems involving electric current, electric charge and time | • Electricity and Charge<br>• Current |

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| | • Circuit Properties |
| explain that the energy inputs in a circuit equal the sum of energy output from loads in the circuit and recognise this as Kirchhoff's voltage law | • Kirchhoff's Current Law<br>• Kirchhoff's Voltage Law |
| recall that the energy available to electric charges moving in an electrical circuit is measured using electrical potential difference<br><br>solve problems involving electrical potential difference | • Potential |
| explain why electric charge separation produces an electrical potential difference (no calculations required to demonstrate this) | • Potential<br>• Extension: Potential Difference |
| solve problems involving power | • Power |

## Resistance

| Content Descriptor | Lesson Names |
|---|---|
| define resistance | • Resistance |
| recall and solve problems using Ohm's Law | • Ohm's Law<br>•<br>• Extension: Combination Circuits and Voltage Dividers<br>• Extension: Diodes, Variable Resistors and Transducers |
| compare and contrast ohmic and non-ohmic resistors | • Resistivity |
| interpret graphical representations of electrical potential difference versus electric current data to find resistance using the gradient and its uncertainty. | • Resistance<br>• Resistivity |

## Circuit analysis and design

| Content Descriptor | Lesson Names |
|---|---|
| define power dissipation over resistors in a circuit<br><br>solve problems involving electrical potential difference, electric current, resistance and power<br><br>recall resistor, voltmeter, ammeter, cell, battery, switch and bulb circuit diagram symbols | • Circuits<br>• Circuit Analysis<br>• Parallel Circuits and Total Resistance"<br>• Complex Circuits |

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|---|---|
| recognise series and parallel connections of components in electrical circuits<br><br>solve problems involving finding equivalent resistance, electrical potential difference and electric currents in series and parallel circuits | |
| design simple series, parallel and series/parallel circuits. | • Class Experiment: Designing a Simple Circuit |

### Science as a Human Endeavour (SHE)

| Content Descriptor | Lesson Names |
|---|---|
| Science as a Human Endeavour (SHE) | • Household Electricity<br>• A Bright Idea |

# Unit 2: Linear motion and waves

## Topic 1: Linear motion and force

### Vectors

| Content Descriptor | Lesson Names |
|---|---|
| define the terms vector and scalar, and use these terms to categorise physical quantities, e.g. velocity and speed<br><br>calculate resultant vectors through the addition and subtraction of two vectors in one dimension. | • Scalars and Vectors |

### Linear motion

| Content Descriptor | Lesson Names |
|---|---|
| define the terms displacement, velocity and acceleration | • Distance and Time<br>• Displacement<br>• Displacement and Compass Directions<br>• Speed<br>• Velocity |
| compare and contrast instantaneous and average | *Further development planned* |

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| velocity | |
| describe the motion of an object by interpreting a linear motion graph<br><br>calculate and interpret the intercepts and gradients (and their uncertainties) of displacement–time and velocity–time graphs, and the areas under velocity– time and acceleration–time graphs | • Distance-Time Graphs<br>• Displacement-Time Graphs<br>• Velocity-Time Graphs<br>• Acceleration-Time Graphs<br>• Summary of Motion Graphs |
| solve problems involving the equations of uniformly accelerated motion in one dimension | • Kinematic Equations<br>• Using the Acceleration Formula to Calculate Final Velocity<br>• Using the Acceleration Formula to Calculate Initial Velocity<br>• Using the Acceleration Formula to Calculate Time |
| recall that the acceleration due to gravity is constant near the Earth's surface. | • Gravity and Free Fall |
| Mandatory practical: Conduct an experiment to verify the value of acceleration due to gravity on the Earth's surface. All data sets that suggest a non-linear relationship, data (e.g. t 2 versus s) should be linearised and plotted, allowing for the calculation of the equation of a linear trend line. An evaluation of the experimental process undertaken, and of the conclusions drawn, will require students to discuss the reliability and validity of the experimental process with reference to the uncertainty and limitations of the data identify justifiable sources of imprecision and inaccuracy suggest improvements or extensions to the experiment using the uncertainty and limitations identified. | *Further development planned* |
| Mandatory practical: Conduct an experiment that requires students to construct and interpret displacement–time and velocity–time graphs with resulting data. Where appropriate, students should use vertical error bars when plotting data. This ensures that they can determine the uncertainty of the gradient and intercepts using minimum and maximum lines of best fit. | *Further development planned* |

## Newton's laws of motion

| Content Descriptor | Lesson Names |
|---|---|
| define Newton's three laws of motion and give examples of each | • Introduction to Forces<br>• Weight and Mass<br>• Newton's First Law |

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| | • Newton's Second Law<br>• Newton's Third Law<br>• Types of Forces: Gravity<br>• Types of Forces: Magnetism and Friction<br>• Equilibrium |
| identify forces acting on an object<br><br>construct free-body diagrams representing forces acting on an object | • Free Body Diagrams |
| determine the resultant force acting on an object in one dimension | • Forces in One Dimension |
| solve problems using each of Newton's three laws of motion | • Forces in One Dimension<br>• Forces in Two Dimensions |
| define the terms momentum and impulse | • Momentum<br>• Impulse<br>• Conservation of Momentum |
| recall the principle of conservation of momentum | • Conservation of Momentum |
| solve problems involving momentum, impulse, the conservation of momentum and collisions in one dimension | • Momentum<br>• Impulse<br>• Conservation of Momentum |
| determine and interpret the area under a force–time graph. | *Further development planned* |

## Energy

| **Content Descriptor** | **Lesson Names** |
|---|---|
| define the terms mechanical work, kinetic energy and gravitational potential energy | • What is Energy?<br>• Kinetic Energy<br>• Potential Energy<br>• Work |
| solve problems involving work done by a force | *Further development planned* |
| solve problems involving kinetic energy and gravitational potential energy | • Identifying KE or PE<br>• Calculating KE and GPE |
| determine and interpret the area under a force–displacement graph<br><br>interpret meaning from an energy–time graph | *Further development planned* |
| define the terms elastic collision and inelastic collision<br><br>compare and contrast elastic and inelastic collisions<br><br>solve problems involving elastic collisions and inelastic collisions. | • Collisions |

## Science as a Human Endeavour (SHE)

| Content Descriptor | Lesson Names |
|---|---|
| Science as a Human Endeavour (SHE) | • Car Safety<br>• Rockets<br>• Sports Science |

# Topic 2: Waves

## Wave properties

| Content Descriptor | Lesson Names |
|---|---|
| recall that waves transfer energy<br><br>define the term mechanical wave | • Transfer of Energy Through Waves |
| compare the terms transverse wave and longitudinal wave<br><br>describe examples of transverse and longitudinal waves, such as sound, seismic waves and vibrations of stringed instruments | • Transverse and Longitudinal Waves |
| recall the terms compression, rarefaction, crest, trough, displacement, amplitude, period, frequency, wavelength and velocity, identifying them on graphical and visual representations of a wave | • Wave Graphs |
| interpret and calculate the amplitude, period, frequency and wavelength from graphs of transverse and longitudinal waves | • Wave Frequency and Wavefronts |
| solve problems involving the wavelength, frequency, period and velocity of a wave | • Wave Frequency and Wavefronts<br>• Wave Speed |
| define the terms reflection, refraction, diffraction and superposition<br><br>using the wave model of light, explain phenomena related to reflection and refraction | • Reflection and Refraction |
| describe the reflection and refraction of a wave at a boundary between two media | • Reflection and Refraction<br>• Huygens' Principle |
| apply the principle of superposition to determine the resultant amplitude of two simple waves | • Superposition Principle |
| explain constructive interference and destructive | • Two Source Interference of Waves |

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| interference of two simple waves | |
| explain the formation of standing waves in terms of superposition with reference to constructive and destructive interference, and nodes and antinodes. | • Phase of Waves<br>• Two Source Interference of Waves |

## Sound

| **Content Descriptor** | **Lesson Names** |
|---|---|
| solve problems involving standing wave formation in pipes open at both ends, closed at one end, and on stretched strings | • Standing Waves in Strings<br>• Standing Waves in Pipes |
| define the concept of resonance in a mechanical system | • Standing Waves in Strings<br>• Standing Waves in Pipes |
| define the concept of natural frequency<br><br>identify that energy is transferred efficiently in resonating systems | *Further development planned* |

## Light

| **Content Descriptor** | **Lesson Names** |
|---|---|
| recall that light is not modelled as a mechanical wave, because it can travel through a vacuum<br><br>recall that a wave model of light can explain reflection, refraction, total internal reflection, dispersion, diffraction and interference<br><br>describe polarisation using a transverse wave model | • Introduction to the Ray Model<br>• The Electromagnetic Nature of Light |
| use ray diagrams to demonstrate the reflection and refraction of light | • Reflection at a Straight Boundary<br>• Refraction of Light |
| solve problems involving the reflection of light on plane mirrors | • Reflection at a Straight Boundary |
| define Snell's Law | • Introduction to Snell's Law |
| solve problems involving the refraction of light at the boundary between two mediums | • Refraction of Light<br>• Total Internal Reflection |
| recall that the speed of light in a vacuum is $c$ = 3 × 10ˆ8$ms$ˆ(−1)<br><br>contrast the speed of light and the speed of mechanical | *Further development planned* |

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| waves | |
| define the concept of intensity | • Intensity of Waves |
| solve problems involving the proportional relationship between intensity of light and the inverse-square of the distance from the source. | • Intensity of Waves |
| Mandatory practical: Conduct an experiment to determine the refractive index of a transparent substance. | *Further development planned* |

### Science as a Human Endeavour (SHE)

| Content Descriptor | Lesson Names |
|---|---|
| Science as a Human Endeavour (SHE) | • Hearing Sound<br>• Bionic Ears<br>• Turned Down for What: Workplace Noise<br>• Context Lesson: Earthquakes and Tsunamis<br>• Electromagnetic Wave Model |

# Unit 3: Gravity and electromagnetism

## Topic 1: Gravity and motion

### Vectors

| Content Descriptor | Lesson Names |
|---|---|
| use vector analysis to resolve a vector into two perpendicular components<br><br>solve vector problems by resolving vectors into components, adding or subtracting the components and recombining them to determine the resultant vector. | • Vector Forces |

### Projectile motion

| Content Descriptor | Lesson Names |
|---|---|
| recall that the horizontal and vertical components of a velocity vector are independent of each other | • Vector Forces<br>• Velocity |

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| apply vector analysis to determine horizontal and vertical components of projectile motion | • Projectile Motion |
| solve problems involving projectile motion. | • Projectile Calculations |
| Mandatory practical: Conduct an experiment to determine the horizontal distance travelled by an object projected at various angles from the horizontal. | *Further development planned* |

## Inclined planes

| **Content Descriptor** | **Lesson Names** |
|---|---|
| solve problems involving force due to gravity (weight) and mass using the mathematical relationship between them<br><br>define the term normal force<br><br>describe and represent the forces acting on an object on an inclined plane through the use of free-body diagrams<br><br>calculate the net force acting on an object on an inclined plane through vector analysis. | *Further development planned* |

## Circular motion

| **Content Descriptor** | **Lesson Names** |
|---|---|
| describe uniform circular motion in terms of a force acting on an object in a perpendicular direction to the velocity of the object<br><br>define the concepts of average speed and period<br><br>solve problems involving average speed of objects undergoing uniform circular motion | • Circular Motion |
| define the terms centripetal acceleration and centripetal force<br><br>solve problems involving forces acting on objects in uniform circular motion. | • Centripetal Force |

## Gravitational force and fields

| Content Descriptor | Lesson Names |
|---|---|
| recall Newton's Law of Universal Gravitation | • The Earth's Gravitational Field<br>• Newton's Law of Universal Gravitation |
| solve problems involving the magnitude of the gravitational force between two masses | • Newton's Law of Universal Gravitation<br>• Motion under Gravity |
| define the term gravitational fields | • The Earth's Gravitational Field |
| solve problems involving the gravitational field strength at a distance from an object. | • The Earth's Gravitational Field<br>• Gravitational Potential Energy and Work |

## Orbitals

| Content Descriptor | Lesson Names |
|---|---|
| recall Kepler's laws of planetary motion | • Satellite Motion<br>• Kepler's Laws of Planetary Motion |
| solve problems involving Kepler's third law | • Kepler's Laws of Planetary Motion |
| recall that Kepler's third law can be derived from the relationship between Newton's Law of Universal Gravitation and uniform circular motion. | *Further development planned* |

## Science as a Human Endeavour (SHE)

| Content Descriptor | Lesson Names |
|---|---|
| Science as a Human Endeavour (SHE) | • Models of the Solar System<br>• End of the Universe<br>• Exploring Space<br>• Satellites<br>• Telescopes |

# Topic 2: Electromagnetism

## Electrostatics

| Content Descriptor | Lesson Names |
|---|---|
| define Coulomb's Law and recognise that it describes the force exerted by electrostatically charged objects on other electrostatically charged objects<br><br>solve problems involving Coulomb's Law | • Coulomb's Law for Two Charges<br>• Coulomb's Law and Electric Field Strength |

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| define the terms electric fields, electric field strength and electrical potential energy<br><br>solve problems involving electric field strength | • Electric Fields due to Point Charges<br>• Coulomb's Law and Electric Field Strength |
| solve problems involving the work done when an electric charge is moved in an electric field. | • Electrical Potential Energy and Work<br>• Potential Difference |

## Magnetic fields

| Content Descriptor | Lesson Names |
|---|---|
| define the term magnetic field | • Magnetism<br>• Magnetic Field |
| recall how to represent magnetic field lines, including sketching magnetic field lines due to a moving electric charge, electric currents and magnets | • Magnetic Fields<br>• Examples of Magnetic Fields (Solenoids)<br>• Magnetic Field of a Current-Carrying Wire<br>• Force on a Charge in a Magnetic Field |
| recall that a moving electric charge generates a magnetic field<br><br>determine the magnitude and direction of a magnetic field around electric current-carrying wires and inside solenoids<br><br>solve problems involving the magnitude and direction of magnetic fields around a straight electric current-carrying wire and inside a solenoid | • Magnetic Field of a Current-Carrying Wire<br>• Examples of Magnetic Fields (Solenoids)<br>• Motion of Charges in a Magnetic Field |
| recall that electric current-carrying conductors and moving electric charges experience a force when placed in a magnetic field | • Magnetic Force on a Wire<br>• Magnetic Fields due to Conductors<br>• Magnetic Field of a Current-Carrying Wire |
| solve problems involving the magnetic force on an electric current-carrying wire and moving charge in a magnetic field. | • Magnetic Force on a Charged Particle<br>• Magnetic Force on a Wire |

## Electromagnetic induction

| Content Descriptor | Lesson Names |
|---|---|
| define the terms magnetic flux, magnetic flux density, electromagnetic induction, electromotive force (EMF), Faraday's Law and Lenz's Law | • Magnetic Flux<br>• Electromagnetic Induction in a Conductor<br>• Faraday's Law<br>• Lenz's Law |
| solve problems involving the magnetic flux in an electric | • Magnetic Flux |

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| current-carrying loop | |
| describe the process of inducing an EMF across a moving conductor in a magnetic field | • Electromagnetic Induction |
| solve problems involving Faraday's Law and Lenz's Law | • Faraday's Law<br>• Lenz's Law |
| explain how Lenz's Law is consistent with the principle of conservation of energy | • Lenz's Law |
| explain how transformers work in terms of Faraday's Law and electromagnetic induction. | • Transformers<br>• Faraday's Law |
| define and explain electromagnetic radiation in terms of electric fields and magnetic fields. | • The Electromagnetic Nature of Light |

## Science as a Human Endeavour (SHE)

| **Content Descriptor** | **Lesson Names** |
|---|---|
| Science as a Human Endeavour (SHE) | • Low Temperature Physics<br>• Radar Ranging<br>• Observing Space<br>• Electromagnetic Radiation and Medicine |

# Unit 4: Revolutions in modern physics

## Topic 1: Special relativity

### Special relativity

| Content Descriptor | Lesson Names |
|---|---|
| describe an example of natural phenomena that cannot be explained by Newtonian physics, such as the presence of muons in the atmosphere | • Evidence for Special Relativity: Muons |
| define the terms frame of reference and inertial frame of reference | • Origins of Special Relativity<br>• Einstein's Theory of Special Relativity |
| recall the two postulates of special relativity | • Origins of Special Relativity<br>• Einstein's Theory of Special Relativity |
| recall that motion can only be measured relative to an observer | • Relativity of Simultaneity |
| explain the concept of simultaneity | • Relativity of Simultaneity |
| recall the consequences of the constant speed of light in a vacuum, e.g. time dilation and length contraction | • Time Dilation<br>• Length Contraction |
| define the terms time dilation, proper time interval, relativistic time interval, length contraction, proper length, relativistic length, rest mass and relativistic momentum | • Time Dilation<br>• Length Contraction<br>• Relativistic Mass and Momentum |
| describe the phenomena of time dilation and length contraction, including examples of experimental evidence of the phenomena | • Time Dilation<br>• Length Contraction |
| solve problems involving time dilations, length contraction and relativistic momentum | • Time Dilation<br>• Length Contraction<br>• Relativistic Mass and Momentum |
| recall the mass–energy equivalence relationship | • Mass-Energy Equivalence<br>• Mass Defect in Nuclear Physics |
| explain why no object can travel at the speed of light in a vacuum | • Relativistic Mass and Momentum |
| explain paradoxical scenarios such as the twins' paradox, flashlights on a train and the ladder in the barn paradox. | • Twins Paradox |

## Science as a Human Endeavour (SHE)

| Content Descriptor | Lesson Names |
|---|---|
| Science as a Human Endeavour (SHE) | *Further development planned* |

# Topic 2: Quantum theory

## Quantum theory

| Content Descriptor | Lesson Names |
|---|---|
| explain how Young's double slit experiment provides evidence for the wave model of light | • Young's Double Slit Experiment |
| describe light as an electromagnetic wave produced by an oscillating electric charge that produces mutually perpendicular oscillating electric fields and magnetic fields | • The Nature of Light |
| explain the concept of black-body radiation | *Further development planned* |
| identify that black-body radiation provides evidence that electromagnetic radiation is quantised into discrete values | • Quantisation of Energy |
| describe the concept of a photon<br><br>solve problems involving the energy, frequency and wavelength of a photon | • Photons |
| describe the photoelectric effect in terms of the photon<br><br>define the terms threshold frequency, Planck's constant and work function<br><br>solve problems involving the photoelectric effect | • The Photoelectric Effect |
| recall that photons exhibit the characteristics of both waves and particles | • Photons |
| describe Rutherford's model of the atom including its limitations | *Further development planned* |
| describe the Bohr model of the atom and how it addresses the limitations of Rutherford's model<br><br>explain how the Bohr model of the hydrogen atom integrates light quanta and atomic energy states to explain the specific wavelengths in the hydrogen line spectrum | • Bohr's Model of the Hydrogen Atom |

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| solve problems involving the line spectra of simple atoms using atomic energy states or atomic energy level diagrams<br><br>describe wave–particle duality of light by identifying evidence that supports the wave characteristics of light and evidence that supports the particle radiation and nuclear reactions). | *Further development planned* |

## Science as a Human Endeavour (SHE)

| Content Descriptor | Lesson Names |
|---|---|
| Science as a Human Endeavour (SHE) | *Further development planned* |

# Topic 3: The standard model

## The standard model

| Content Descriptor | Lesson Names |
|---|---|
| define the concept of an elementary particle and antiparticle<br><br>recall the six types of quarks<br><br>define the terms baryon and meson<br><br>recall the six types of leptons<br><br>recall the four gauge bosons | • Elementary Particles<br>• The Standard Model |
| describe the strong nuclear, weak nuclear and electromagnetic forces in terms of the gauge bosons<br><br>contrast the fundamental forces experienced by quarks and leptons. | • The Fundamental Forces |

## Particle interactions

| Content Descriptor | Lesson Names |
|---|---|
| define the concept of lepton number and baryon number | *Further development planned* |
| recall the conservation of lepton number and baryon | • Conservation Laws |

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| number in particle interaction | |
| explain the following interactions of particles using Feynman diagrams:<br>- electron and electron<br>- electron and positron<br>- a neutron decaying into a proton | • Reaction Diagrams |
| describe the significance of symmetry in particle interactions. | *Further development planned* |

## Science as a Human Endeavour (SHE)

| **Content Descriptor** | **Lesson Names** |
|---|---|
| Science as a Human Endeavour (SHE) | *Further development planned* |