KS4 Physics Curriculum Coverage:

Sequenced	**Energy**	**Electricity**
Key Knowledge	**To know:** ● That a system is an object or group of objects. ● There are changes in the way energy is stored when a system changes. ● The equation to calculate the kinetic energy of a moving object. ● The equation to calculate the amount of elastic potential energy stored in a stretched spring. ● The equation to calculate the amount of gravitational potential energy gained by an object raised above ground level. ● The equation to calculate the amount of energy stored in or released from a system as its temperature changes. ● That the specific heat capacity of a substance is the amount of energy required to raise the temperature of one kilogram of the substance by one degree Celsius. ● That power is defined as the rate at which energy is transferred or the rate at which work is done. ● Energy can be transferred usefully, stored, or dissipated, but cannot be created or destroyed. ● The higher the thermal conductivity of a material, the higher the rate of energy transfer by conduction across the material. ● The equation to calculate the energy efficiency for any energy transfer. ● The main energy resources available for use on Earth. ● A renewable energy resource is one that is being (or can be) replenished as it is used. ● The uses of energy resources include transport, electricity generation and heating.	**To know:** ● The standard circuit symbols to use in circuit diagrams. ● Electric current is a flow of electrical charge. The size of the electric current is the rate of flow of electrical charge. ● The current (I) through a component depends on both the resistance (R) of the component and the potential difference (V) across the component. The greater the resistance of the component the smaller the current for a given potential difference (pd) across the component. ● The current through an ohmic conductor (at a constant temperature) is directly proportional to the potential difference across the resistor. ● The resistance of components such as lamps, diodes, thermistors and LDRs is not constant; it changes with the current through the component. ● The resistance of a filament lamp increases as the temperature of the filament increases. ● The current through a diode flows in one direction only. The diode has a very high resistance in the reverse direction. ● The resistance of a thermistor decreases as the temperature increases. The resistance of an LDR decreases as light intensity increases. ● For components connected in series: • there is the same current through each component • the total potential difference of the power supply is shared between the components • The total resistance of two components is the sum of the resistance of each component. ● For components connected in parallel: • the potential difference across each component is the same • the total current through the whole circuit is the sum of the currents through the separate components • the total resistance of two resistors is less than the resistance of the smallest individual resistor. ● Mains electricity is an ac supply. In the United Kingdom the domestic electricity supply has a frequency of 50 Hz and is about 230 V. ● The insulation covering each wire is colour coded for easy identification: live wire – brown neutral wire – blue earth wire – green and yellow stripes. ● The live wire carries the alternating potential difference from the supply. The neutral wire completes the circuit. The earth wire is a safety wire to stop the appliance becoming live. ● The potential difference between the live wire and earth (0 V) is about 230 V. The neutral wire is at, or close to, earth potential (0 V). The earth wire is at 0 V, it only carries a current if there is a fault. ● The amount of energy an appliance transfers depends on how long the appliance is switched on for and the power of the appliance. ● The National Grid is a system of cables and transformers linking power stations to consumers. ● Step-up transformers are used to increase the potential difference from the power station to the transmission cables then step-down transformers are used to decrease, to a much lower value, the potential difference for domestic use. ● When certain insulating materials are rubbed against each other they become electrically charged. Negatively charged electrons are rubbed off one material and on to the other. The material that gains electrons becomes negatively charged. The material that loses electrons is left with an equal positive charge. ● When two electrically charged objects are brought close together they exert a force on each other. Two objects that carry the same type of charge repel. Two objects that carry different types of charge attract. Attraction and repulsion between two charged objects are examples of non-contact force. ● A charged object creates an electric field around itself. The electric field is strongest close to the charged object. The further away from the charged object, the weaker the field.
Key Skills	**To be able to:** ● Describe all the changes involved in the way energy is stored when a system changes, for common situations. ● Calculate the changes in energy involved when a system is changed by heating, work done by forces and work done when a current flows. ● Calculate the energy associated with a moving object, a stretched spring and an object raised above ground level. ● Plan an investigation to determine the specific heat capacity of one or more materials (RP 1) ● Describe, with examples, how in all systems - energy is dissipated, so that it is stored in less useful ways. This energy is often described as being 'wasted'. ● Explain ways of reducing unwanted energy transfers, for example through lubrication and the use of thermal insulation. ● Investigate the effectiveness of different materials as thermal insulators (RP 2) ● Compare ways that different energy resources are used, the uses to include transport, electricity generation and heating. ● Describe the environmental impact arising from the use of different energy resources	**To be able to:** ● Draw and interpret circuit diagrams ● Recall and apply the equations. ● Use circuit diagrams to set up and check appropriate circuits to investigate the factors affecting the resistance of electrical circuits (RP 3). ● Explain the design and use of a circuit to measure the resistance of a component by measuring the current through, and potential difference across, the component. ● Use graphs to explore whether circuit elements are linear or non-linear and relate the curves produced to their function and properties. ● Use circuit diagrams to construct appropriate circuits to investigate the I–V characteristics of a variety of circuit elements, including a filament lamp, a diode and a resistor at constant temperature. (RP 4) ● Use circuit diagrams to construct and check series and parallel circuits that include a variety of common circuit components ● Describe the difference between series and parallel circuits ● Explain qualitatively why adding resistors in series increases the total resistance whilst adding resistors in parallel decreases the total resistance ● Solve problems for circuits which include resistors in series using the concept of equivalent resistance. ● Explain the difference between direct and alternating potential difference ● Explain how the power transfer in any circuit device is related to the potential difference across it and the current through it, and to the energy changes over time ● Explain how the power of a circuit device is related to: • the potential difference across it and the current through it • the energy transferred over a given time. ● Describe the production of static electricity, and sparking, by rubbing surfaces ● Draw the electric field pattern for an isolated charged sphere
Subject specific Vocabulary	Energy, joules, system, kinetic, chemical, thermal, gravitational potential, elastic potential, vibrational, efficiency, dissipated, wasted, work done, power, watts, specific heat capacity, insulation, resources, renewable, non-renewable.	Circuit, Current, Potential difference, resistance, Filament lamp, Voltmeter, Ammeter, Power, Energy, Charge, Volts, Amps, Coulombs, Ohms, Watts, Joules, Series, Parallel, Thermistor, LDR, Diode, LED, Variable resistor, Direct, Alternating, Live, Earth, Neutral, Fuse, Transformer, Electrons, Static, Electric field, Attract, Repel

KS4 Physics Curriculum Coverage:

Sequenced	**Particle Model of Matter**	**Atomic Structure**
Key Knowledge	**To know:** ● The density of a material is defined by the equation: density = mass/volume ● The particle model can be used to explain the different states of matter and differences in density. ● Changes of state are physical changes which differ from chemical changes because the material recovers its original properties if the change is reversed. ● Energy is stored inside a system by the particles (atoms and molecules) that make up the system. This is called internal energy. ● If the temperature of the system increases, the increase in temperature depends on the mass of the substance heated, the type of material and the energy input to the system. ● Change in thermal energy = mass × specific heat capacity × temperature change ($\Delta E = m c \Delta \theta$) ● The specific heat capacity of a substance is the amount of energy required to raise the temperature of one kilogram of the substance by one degree Celsius. ● The specific latent heat of a substance is the amount of energy required to change the state of one kilogram of the substance with no change in temperature. ● (PHYSICS ONLY) The molecules of a gas are in constant random motion. The temperature of the gas is related to the average kinetic energy of the molecules. Changing the temperature of a gas, held at constant volume, changes the pressure exerted by the gas. ● (PHYSICS ONLY) Work is the transfer of energy by a force. Doing work on a gas increases the internal energy of the gas and can cause an increase in the temperature of the gas.	**To know:** ● Atoms are very small, having a radius of about 1 × 10-10 metres ● The basic structure of an atom is a positively charged nucleus composed of both protons and neutrons surrounded by negatively charged electrons. ● The radius of a nucleus is less than 1/10 000 of the radius of an atom. Most of the mass of an atom is concentrated in the nucleus ● The electrons are arranged at different distances from the nucleus (different energy levels). ● In an atom the number of electrons is equal to the number of protons in the nucleus. Atoms have no overall electrical charge ● Atoms of the same element can have different numbers of neutrons; these atoms are called isotopes of that element. ● New experimental evidence may lead to a scientific model being changed or replaced. ● Activity is the rate at which a source of unstable nuclei decays. Activity is measured in becquerel (Bq) Count-rate is the number of decays recorded each second by a detector (e.g. Geiger-Muller tube). ● an alpha particle (α) – this consists of two neutrons and two protons, it is the same as a helium nucleus ● a beta particle (β) – a high speed electron ejected from the nucleus as a neutron turns into a proton ● a gamma ray (γ) – electromagnetic radiation from the nucleus • a neutron (n) ● use the names and symbols of common nuclei and particles to write balanced equations that show single alpha (α) and beta (β) decay ● The half-life of a radioactive isotope is the time it takes for the number of nuclei of the isotope in a sample to halve, or the time it takes for the count rate (or activity) from a sample containing the isotope to fall to half its initial level. ● Radioactive contamination is the unwanted presence of materials containing radioactive atoms on other materials ● Irradiation is the process of exposing an object to nuclear radiation. ● Natural sources such as rocks and cosmic rays from space ● Man-made sources such as the fallout from nuclear weapons testing and nuclear accidents. ● Radiation dose is measured in sieverts (Sv) ● Nuclear radiations are used in medicine for the: • exploration of internal organs • control or destruction of unwanted tissue. ● Nuclear fission is the splitting of a large and unstable nucleus (e.g. uranium or plutonium). ● Nuclear fusion is the joining of two light nuclei to form a heavier nucleus. In this process some of the mass may be converted into the energy of radiation.
Key Skills	**To be able to:** ● Students should be able to recognise/draw simple diagrams to model the difference between solids, liquids and gases. ● Students should be able to explain the differences in density between the different states of matter in terms of the arrangement of atoms or molecules. ● Students should be able to describe how, when substances change state (melt, freeze, boil, evaporate, condense or sublimate), mass is conserved. ● Required practical activity 5: use appropriate apparatus to make and record the measurements needed to determine the densities of regular and irregular solid objects and liquids. Volume should be determined from the dimensions of regularly shaped objects, and by a displacement technique for irregularly shaped objects. ● Students should be able to explain how the motion of the molecules in a gas is related to both its temperature and its pressure and explain qualitatively the relation between the temperature of a gas and its pressure at constant volume. ● (PHYSICS ONLY) Students should be able to explain how, in a given situation eg a bicycle pump, doing work on an enclosed gas leads to an increase in the temperature of the gas. ● Students should be able to calculate the energy change involved when the temperature of a material changes. ● (PHYSICS ONLY) Students should be able to use the particle model to explain how increasing the volume in which a gas is contained, at constant temperature, can lead to a decrease in pressure. ● (PHYSICS ONLY) Students should be able to calculate the change in the pressure of a gas or the volume of a gas (a fixed mass held at constant temperature) when either the pressure or volume is increased or decreased.	**To be able to:** ● Describe why the new evidence from the scattering experiment led to a change in the atomic model ● Describe the difference between the plum pudding model of the atom and the nuclear model of the atom. ● Apply their knowledge to the uses of radiation and evaluate the best sources of radiation to use in a given situation. ● Explain the concept of half-life and how it is related to the random nature of radioactive decay. ● Determine the half-life of a radioactive isotope from given information. ● Compare the hazards associated with contamination and irradiation. ● Explain why the hazards associated with radioactive material differ according to the half-life involved. ● Use data presented in standard form. ● Describe and evaluate the uses of nuclear radiations for exploration of internal organs, and for control or destruction of unwanted tissue ● Evaluate the perceived risks of using nuclear radiations in relation to given data and consequences. ● Draw/interpret diagrams representing nuclear fission and how a chain reaction may occur.
Subject specific Vocabulary	Energy, Density, Volume, Mass, Specific Heat Capacity, Latent Heat, Freezing, Melting, Sublimation, Evaporation, Condensation, Boiling, Physical Change, Temperature, Pressure, Solids, Liquids, Gases.	Proton, Neutron, Electron, Isotope, Ion, Nucleus, Plum Pudding, Alpha, Beta, Gamma, Ionizing, Penetrating, Activity, Half-Life, Count-rate, Irradiation, Contamination, Fission, Fusion.

KS4 Physics Curriculum Coverage:

Sequenced	**Forces**	**Waves**
Key Knowledge	**To know:** ● Scalar quantities have magnitude only. Vector quantities have magnitude and an associated direction. A vector may be represented by an arrow. ● A force is a push or pull that acts on an object due to the interaction with another object. All forces between objects are either contact or non-contacts. Force is a vector quantity. ● The weight of an object may be considered to act at a single point referred to as the object's 'centre of mass'. ● The weight of an object and the mass of an object are directly proportional. ● A number of forces acting on an object may be replaced by a single force that has the same effect as all the original forces acting together. This single force is called the resultant force. ● When a force causes an object to move through a distance work is done on the object. ● One joule of work is done when a force of one newton causes a displacement of one metre. ● Work done against the frictional forces acting on an object causes a rise in the temperature of the object. ● The extension of an elastic object is directly proportional to the force applied, provided that the limit of proportionality is not exceeded. ● Distance is how far an object moves. Distance is a scalar quantity. Displacement includes both the distance an object moves, measured in a straight line from the start point to the finish point and the direction of that straight line. Displacement is a vector quantity. ● Speed does not involve direction. Speed is a scalar quantity. ● The velocity of an object is its speed in a given direction. Velocity is a vector quantity. ● If an object moves along a straight line, the distance travelled can be represented by a distance–time graph. The speed of an object can be calculated from the gradient of its distance–time graph. ● The acceleration of an object can be calculated from the gradient of a velocity–time graph. ● An object falling through a fluid initially accelerates due to the force of gravity. Eventually the resultant force will be zero and the object will move at its terminal velocity ● Newton's First Law, Newton's Second Law, Newton's Third Law ● The stopping distance of a vehicle is the sum of the distance the vehicle travels during the driver's reaction time (thinking distance) and the distance it travels under the braking force (braking distance). ● When a force is applied to the brakes of a vehicle, work done by the friction force between the brakes and the wheel reduces the kinetic energy of the vehicle and the temperature of the brakes increases ● (HT) In a closed system, the total momentum before an event is equal to the total momentum after the event. ● (HT) When a force acts on an object that is moving, or able to move, a change in momentum occurs.	**To know:** ● Waves may be either transverse or longitudinal. ● Longitudinal waves show areas of compression and rarefaction. Sound waves travelling through air are longitudinal. ● The amplitude of a wave is the maximum displacement of a point on a wave away from its undisturbed position. ● The wavelength of a wave is the distance from a point on one wave to the equivalent point on the adjacent wave. ● The frequency of a wave is the number of waves passing a point each second. ● The wave speed is the speed at which the energy is transferred (or the wave moves) through the medium. ● Waves can be reflected at the boundary between two different materials. ● Waves can be absorbed or transmitted at the boundary between two different materials. ● Sound waves can travel through solids causing vibrations in the solid. ● The range of normal human hearing is from 20 Hz to 20 kHz. ● Ultrasound waves have a frequency higher than the upper limit of hearing for humans. ● Seismic waves are produced by earthquakes. P-waves are longitudinal, seismic waves. P-waves travel at different speeds through solids and liquids. S-waves are transverse, seismic waves. S-waves cannot travel through a liquid. ● Electromagnetic waves are transverse waves that transfer energy from the source of the waves to an absorber. ● The waves that form the electromagnetic spectrum are grouped in terms of their wavelength and their frequency. ● A lens forms an image by refracting light. In a convex lens, parallel rays of light are brought to a focus at the principal focus. The distance from the lens to the principal focus is called the focal length. ● Reflection from a smooth surface in a single direction is called specular reflection. Reflection from a rough surface causes scattering: this is called diffuse reflection. ● The colour of an opaque object is determined by which wavelengths of light are more strongly reflected. Wavelengths that are not reflected are absorbed. ● All bodies (objects), no matter what temperature, emit and absorb infrared radiation. ● A perfect black body is an object that absorbs all of the radiation incident on it.
Key Skills	**To be able to:** ● Describe the interaction between pairs of objects which produce a force on each object. The forces to be represented as vectors. ● Calculate the resultant of two forces that act in a straight line. ● (HT only) Describe examples of the forces acting on an isolated object or system • use free body diagrams to describe qualitatively examples where several forces lead to a resultant force on an object, including balanced forces when the resultant force is zero. ● (HT only) Resolve a single force into two components acting at right angles to each other. ● (HT only) Use vector diagrams to illustrate resolution of forces, equilibrium situations and determine the resultant of two forces, to include both magnitude and direction (scale drawings only). ● Convert between newton-metres and joules. ● Give examples of the forces involved in stretching, bending or compressing an object ● Describe the difference between elastic deformation and inelastic deformation caused by stretching forces. ● Describe the difference between a linear and non-linear relationship between force and extension ● Calculate a spring constant in linear cases ● Interpret data from an investigation of the relationship between force and extension ● Express a displacement in terms of both the magnitude and direction. ● Make measurements of distance and time and then calculate speeds of objects. ● Interpret distance/time graphs and speed/time graphs. ● Calculate average speed for non-uniform motion. ● (HT only) Explain safety features such as: air bags, seat belts, gymnasium crash mats, with reference to the concept of rate of change of momentum. ● Apply equations relating force, mass, velocity and acceleration to explain how the changes involved are inter-related.	**To be able to:** ● describe the difference between longitudinal and transverse waves. ● describe evidence that, for both ripples on a water surface and sound waves in air, it is the wave and not the water or air itself that travels. ● identify amplitude and wavelength from given diagrams ● describe a method to measure the speed of sound waves in air ● describe a method to measure the speed of ripples on a water surface. ● make observations to identify the suitability of apparatus to measure the frequency, wavelength and speed of waves in a ripple tank and waves in a solid and take appropriate measurements. (RP 8) ● construct ray diagrams to illustrate the reflection of a wave at a surface. ● describe the effects of reflection, transmission and absorption of waves at material interfaces. ● investigate the reflection of light by different types of surface and the refraction of light by different substances. (RP 9) ● construct ray diagrams to illustrate the refraction of a wave at the boundary between two different media. ● investigate how the amount of infrared radiation absorbed or radiated by a surface depends on the nature of that surface. (RP 10) ● construct ray diagrams to illustrate the similarities and differences between convex and concave lenses. ● Explain the effect of viewing objects through filters or the effect on light of passing through filters ● Explain why an opaque object has a particular colour. ● Use information, or draw/ interpret diagrams to show how radiation affects the temperature of the Earth's surface and atmosphere.
Subject specific Vocabulary	Force, Newtons, Weight, Mass, Resultant Force, Equilibrium, Extension, Compression, Directly Proportional, Linear, Non linear, Scalar, Vector, Speed, Velocity, System, Terminal Velocity, Momentum, Moments, Conservation, Deformation, Elastic, Plastic, Uniform, Non-uniform, Interaction, Stopping Distance, Thinking Distance, Braking Distance.	Longitudinal, Transverse, Oscillation, Energy transfer, Compression, Rarefaction, Amplitude, Wavelength, Frequency, Hertz, Reflection, Refraction, Electromagnetic, Absorption, Emission, Ultrasound, Seismic waves, Convex, Concave, Focal Point, Virtual, Real, Magnified, Diminished, Inverted, Upright, Black-Body.

KS4 Physics Curriculum Coverage:

Sequenced	**Magnetism & Electromagnetism**	**Space Physics (SEP Only)**
Key Knowledge	**To know:** ● The poles of a magnet are the places where the magnetic forces are strongest. ● Two like poles repel each other. Two unlike poles attract each other. ● A permanent magnet produces its own magnetic field. An induced magnet is a material that becomes a magnet when it is placed in a magnetic field. ● The region around a magnet where a force acts on another magnet or on a magnetic material is called the magnetic field. ● The strength of the magnetic field depends on the distance from the magnet. The field is strongest at the poles of the magnet. ● The direction of a magnetic field line is from the north pole of a magnet to the south pole of the magnet. ● The Earth has a magnetic field. The compass needle points in the direction of the Earth's magnetic field. ● When a current flows through a conducting wire a magnetic field is produced around the wire. ● Shaping a wire to form a solenoid increases the strength of the magnetic field created by a current through the wire. ● Adding an iron core increases the strength of the magnetic field of a solenoid. An electromagnet is a solenoid with an iron core. ● When a conductor carrying a current is placed in a magnetic field the magnet producing the field and the conductor exert a force on each other. This is called the motor effect. ● The factors that affect the size of the force on the conductor ● A coil of wire carrying a current in a magnetic field tends to rotate. This is the basis of an electric motor. ● Loudspeakers and headphones use the motor effect to convert variations in current in electrical circuits to the pressure variations in sound waves. ● If an electrical conductor moves relative to a magnetic field, a potential difference is induced across the ends of the conductor. If the conductor is part of a complete circuit, a current is induced in the conductor. This is called the generator effect. ● The factors that affect the size of the induced potential difference/induced current. ● The factors that affect the direction of the induced potential difference/induced current. ● The generator effect is used in an alternator to generate ac and in a dynamo to generate dc. ● Microphones use the generator effect to convert the pressure variations in sound waves into variations in current in electrical circuits. ● A basic transformer consists of a primary coil and a secondary coil wound on an iron core. Iron is used as it is easily magnetised. ● The ratio of the potential differences across the primary and secondary coils of a transformer Vp and Vs depends on the ratio of the number of turns on each coil, np and ns .	**To know:** ● Within our solar system there is one star, the Sun, plus the eight planets and the dwarf planets that orbit around the Sun. Natural satellites, the moons that orbit planets, are also part of the solar system. ● Our solar system is a small part of the Milky Way galaxy. ● The Sun was formed from a cloud of dust and gas (nebula) pulled together by gravitational attraction. ● Fusion processes in stars produce all of the naturally occurring elements. Elements heavier than iron are produced in a supernova. ● Gravity provides the force that allows planets and satellites (both natural and artificial) to maintain their circular orbits. ● There is an observed increase in the wavelength of light from most distant galaxies. The further away the galaxies, the faster they are moving and the bigger the observed increase in wavelength. This effect is called red-shift. ● The observed red-shift provides evidence that space itself (the universe) is expanding and supports the Big Bang theory. ● The Big Bang theory suggests that the universe began from a very small region that was extremely hot and dense.
Key Skills	**To be able to:** ● Describe the attraction and repulsion between unlike and like poles for permanent magnets ● Describe the difference between permanent and induced magnets ● Describe how to plot the magnetic field pattern of a magnet using a compass ● Draw the magnetic field pattern of a bar magnet showing how strength and direction change from one point to another ● Draw the magnetic field pattern for a straight wire carrying a current and for a solenoid (showing the direction of the field) ● Explain how a solenoid arrangement can increase the magnetic effect of the current. ● Interpret diagrams of electromagnetic devices in order to explain how they work ● Show that Fleming's left-hand rule represents the relative orientation of the force, the current in the conductor and the magnetic field. ● Apply the magnetic flux equation. ● Explain how the force on a conductor in a magnetic field causes the rotation of the coil in an electric motor ● Explain how a moving-coil loudspeaker and headphones work. ● Apply the principles of the generator effect in a given context ● Explain how the generator effect is used in an alternator to generate ac and in a dynamo to generate dc ● Draw/interpret graphs of potential difference generated in the coil against time. ● Explain how a moving-coil microphone works. ● Apply the transformer equations.	**To be able to:** ● Explain how, at the start of a star's life cycle, the dust and gas drawn together by gravity causes fusion reactions ● Explain that fusion reactions lead to an equilibrium between the gravitational collapse of a star and the expansion of a star due to fusion energy. ● Describe the life cycle of a star: • the size of the Sun • much more massive than the Sun. ● Explain how fusion processes lead to the formation of new elements ● Explain how for circular orbits, the force of gravity can lead to changing velocity but unchanged speed ● Explain how for a stable orbit, the radius must change if the speed changes. ● Explain qualitatively the red-shift of light from galaxies that are receding ● Explain that the change of each galaxy's speed with distance is evidence of an expanding universe ● Explain how red-shift provides evidence for the Big Bang model
Subject specific Vocabulary	Attract, Repel, Magnetic field, North, South, Poles, Permanent, Induced, Solenoid, Electromagnet, Coil, Current, Potential difference, Motor, Generator, Transformer, Core, Magnetic Flux, Tesla, Loudspeaker, Microphone, Dynamo, Alternator.	Planet, Solar system, Galaxy, Universe, Orbit, Speed, Velocity, Acceleration, Nebula, Protostar, Main sequence star, Red-Giant, White-Dwarf, Black-Dwarf, Supernova, Neutron Star, Black hole, Red-Shift, Expansion, Wavelength, Frequency, Big-Bang.