Physics – St Joseph's College

Subject vision statement

In line with the National Curriculum, Science looks to support students in their understanding and exploration of the world around them. Students develop skills that enable them to explain how and why things happen while being analytical and curious. Students are encouraged to think big and apply key ideas to everyday phenomenon. Each discipline (Biology, Chemistry and Physics) is taught through distinct topics, while links in understanding across the Sciences is constantly referenced. There is a large focus on practical work to support the understanding of concepts and to give students the opportunity to develop skills that are beyond learned content.

Intent statement

What: Key elements across all three sciences (e.g. particle behaviour, energy, living organisms, forces) are taught and developed across all key stages; each one drawing on fundamental concepts from previous learning and providing opportunity to develop and broaden students' understanding of the key themes that underpin scientific theory. Students revisit practical work regularly; developing skills linked to identifying variables, writing methods, analysing data and evaluating equipment and techniques, which enable them to become curious and independent scientists. Alongside developing scientific understanding, there is a core focus on the use of numeracy and literacy skills across all key stages, which enable students to successfully access all parts of the subject.

How: The structure of the Science curriculum provides varied opportunity for students to feel success and develop their interest in such a dynamic subject. Practical work, with key aspects such as planning, actioning, analysing and evaluating, is built in at every opportunity and given distinct focus. Students are encouraged to think like scientists and to develop their skill set beyond the acquisition of knowledge. The inclusion of a Reading Week in Key Stage 3 supports students in their developing of key literacy skills, including analysing and evaluating sources of information and considering their validity. There is a high level of focus on the acquisition of new language to enable students to access the curriculum, thinking about the etymology and morphology of key terms. Numerical skills are woven throughout the Science curriculum, providing opportunity to model and develop these frequently.

At KS3 students are assessed using exam-style questions during assessment points, focusing on the core skills to be a successful scientist: Knowledge recall, Mathematical skills, Graphical skills and Practical skills. Students have the option to select Triple Science as part of their GCSE choices. At KS4 students are assessed using GCSE exam questions, with final external assessments taking place at the end of the Year 11. At KS5 students can choose between the pure A Level subjects (Biology, Chemistry and Physics) or the

more contextual BTEC Applied Science course (offered as both a single and double option). A Levels are assessed at the end of the two-year course while the BTEC offers a blended approach of assessments throughout alongside high demand coursework tasks.

Why: Science enables us to explain what is happening around us; it encourages students to be curious and to ask questions. There is the opportunity to provide transferable skills, including numerical skills, analytical skills and high-quality oracy skills. Boosting science capital is of particular importance as the world develops new and exciting technology, and a rigorous but exciting curriculum is important for students to consider STEM subjects and careers in their future, where they will be at the centre of change and innovation.

Year 10						
	Autumn 1	**Autumn 2**	**Spring 1**	**Spring 2**	**Summer 1**	**Summer 2**
Topic	Electricity Use and recognise standard symbols in circuit diagrams. Define electrical current and perform calculations using Q=It. Define potential difference and perform calculations using E=QV. Use Ohm's law to find the resistance of components using V=IR. Interpret graphs to find the relationship between resistance of a wire and its length. Describe how to and carry out a practical investigation to find the IV characteristics of an ohmic conductor, filament bulb and diode. Sketch the IV graph for each component. Identify, draw, build and explain the difference between series and parallel circuits. Investigate how the resistance of a thermistor	Electricity Recognising a potential divider circuit and describing how current and potential difference across the output would vary as environmental conditions change. Defining alternating and direct potential difference and stating an example of a source of each. Recalling the p.d. and frequency of UK mains electricity. Describing the role of each wire in a plug and the dangers of providing any connection between the live wire and earth. Using the equations P=IV and $P=I^2R$ to calculate power of an appliance and relating this to energy transferred by using E=Pt. Explain how step-up transformers in the National Grid are used to increase	Energy Name and describe the different energy stores and how energy can be transferred between stores. Recall and perform calculations with the equations for kinetic energy $E_k= ½mv^2$, gravitational potential energy $E_p=mgh$ and elastic potential energy $Ee= ½ke^2$. Define the specific heat capacity of a material and describe and carry out an experiment to measure the specific heat capacity of a solid and a liquid. Perform calculations using the formula $E=mc\Delta\theta$. Describe how the efficiency of a process or appliance is measured and calculate this. Defining power as the rate of transfer of energy.	Particle Model of Matter Define density, describe and carry out an experiment to measure the density of regular and irregular objects. Use kinetic theory to explain the properties of solids, liquids and gases. Define internal energy and explaining whether kinetic or potential energy is increasing as a substance is heated. Interpret heating and cooling graphs that include changes of state. Define specific latent heat of fusion and vaporisation of a substance, perform calculations using E=mL. Describe the motion of particles in a gas, explain how the motion of the molecules in a gas is related to both its	Atomic Structure Describe the basic structure of an atom. Define an isotope and relate differences between isotopes to differences in conventional representations of their identities, charges and masses. Use atomic notation. Explain the difference between the plum pudding model of the atom and the nuclear model of the atom and how the evidence from the scattering experiment led to a change in the atomic model. State properties of the three types of radioactive decay. Use nuclear equations. explain the concept of half-life and how it is related to the random nature of radioactive decay.	Forces (and EOY revision and test) Defining scalar and vector quantities, gravitational force, finding the resultant force on an object, calculating the work done when a force moves an object.

	changes with temperature and how the resistance of a LDR changes with light intensity. Recognising and using prefixes to convert between different units.	p.d. from the power station to the transmission cables then step-down transformers are used to decrease, the p.d. for domestic use.	Explain ways of reducing unwanted energy transfers, for example through lubrication and the use of thermal insulation. Describe the main energy resources available, which are renewable and non-renewable and which are more reliable. Describe the environmental impact arising from the use of different energy resources. Explain patterns and trends in the national and global use of energy resources.	temperature and its pressure. Explain qualitatively the relation between the temperature of a gas and its pressure at constant volume.	Determine the half-life of a radioactive isotope from given information or from a graph. Compare the hazards associated with contamination and irradiation	
Building on (knowledge, concepts and skills)	Construct a simple series electrical circuit, identifying and naming cells, wires, bulbs and switches, use recognised symbols when representing a simple circuit in a diagram (KS2). Associate the brightness of a lamp with the number and voltage of cells used in the circuit (KS2). Draw circuit diagrams, name and state the use of an ammeter and a voltmeter, investigate how the length of a wire affects resistance (Y8). Identify series and parallel circuits (Y8). Recognise the components of an electric plug from a diagram (Y9). Perform calculations using V = I x R and P = I x V (Y9). Describe the components of an electrical power station (Y9).		Name and describe the different energy stores and how energy can be transferred between stores (Y7, Y8 & Y9)	Group materials into solids, liquids and gases (KS2), observe that materials change state when they are heated or cooled (KS2). Use the particle model to explain the properties of solids, liquids and gases (Y7). Explain the difference between heat and temperature (Y8).	Describe the structure of an atom (Y7, Y8, Y9)	Forces are a push or a pull (KS2), explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object (KS2). Naming different forces and measuring the size of forces (Y7).

Building towards (knowledge, concepts and skills)	Electricity (Y12). Recognising and using prefixes to convert between different units. Drawing circuit diagrams. Sketching, describing and explaining the relationship between variables using graphs. Carrying out practical investigations safely and precisely. Analysing results.	Work, energy and power (Y12).	Thermal Physics (Y13)	Nuclear and Particle Physics (Y13)	Forces and motion (Y12)
Independent enrichment (wider reading and learning suggestions)	CGP revision guide/ workbook/ knowledge organisers/ flashcards QED: The Strange Theory of Light and Matter by Richard Feynman A Brief History of Time by Stephen Hawking Physics and Math Tutor (revision notes, flashcards, past papers): https://www.physicsandmathstutor.com/ Physics Online (Youtube channel) – teaching and revision videos: https://www.youtube.com/@PhysicsOnline Cognito (Youtube channel) – revision videos: https://www.youtube.com/@Cognitoedu Veritasium (Youtube channel) interesting videos about maths and physics: https://www.youtube.com/@veritasium				
SMSC					
Careers	Discuss relevance to careers in electrical engineering as well as apprenticeship schemes.	Discuss careers in energy resource sector e.g. Solar panel installer, wind turbine technician, nuclear power reactor operator.	Discuss relevance to careers as a particle physicist.	Discuss relevance to careers in nuclear power sector, as well as handling of radioactive sources/ medical uses e.g. Radiographer.	Discuss relevance to careers in mechanical engineering and aviation.

Year 11						
	Autumn 1	**Autumn 2**	**Spring 1**	**Spring 2**	**Summer 1**	**Summer 2**
Topic	Forces (continued) Analysing displacement-time and velocity-time graphs for objects moving in a straight line, using Newton's Laws of Motion to predict the motion of an object or calculate the acceleration of an object by analysing the forces acting on it. Verifying Newton's Laws and Hooke's Law through experimentation. Describing factors which affect the stopping distance of a vehicle, using conservation of momentum to predict velocity of objects after a collision *Explain how levers and gears transmit the rotational effects of forces (triple only)* *Calculate the differences in pressure at different*	Waves Defining transverse and longitudinal waves and describing the differences between them. Describe wave motion in terms of amplitude, wavelength, frequency and period. Measure the frequency and wavelength of waves in a ripple tank. Describe properties of electromagnetic waves and their uses and applications. Investigation through experiment the amount of infrared radiation absorbed by different surfaces. Practical investigation of the reflection and refraction of light. *Use ray diagrams to show the formation of images by lenses (triple only)*	Magnetism and Electromagnetism, *Space Physics (Triple Only)* Describe the attraction and repulsion between unlike and like poles for permanent magnets, the difference between permanent and induced magnets. Draw the field around a bar magnet and describe how to plot the field using compasses. Explain the motor effect and use Flemings left hand rule to find the direction of a force on a current-carrying wire in a magnetic field. Explain how the force on a conductor in a magnetic field causes the rotation of the coil in an electric motor. *Explain how the generator effect is used in an alternator and how transformers are used to change potential difference (triple only)*	Targeted revision	Targeted revision	Exams

	depths in a fluid. Describe what causes atmospheric pressure and how it changes with height (triple only)		*Describe the life-cycle of a star. Explain how the red-shift observed from distant galaxies provides evidence for the Big Bang Theory (triple only)*			
Building on (knowledge, concepts and skills)	Forces are a push or a pull (KS2), explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object (KS2), identify the effects of air resistance, water resistance and friction, that act between moving surfaces (KS2) recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect (KS2). Naming different forces and measuring the size of forces (Y7), measuring and calculating speed (Y7, Y8), distance-time and velocity-	Experiments with light and sound, recognise that light travels in straight lines (KS2), types of waves, light and sound (Y7)	Experiments with magnets (KS2), testing magnets, magnetic materials, drawing magnetic field lines (Y8), objects in the universe, lifecycle of a star (Y7, Y9)			

	time graphs (Y8) calculating weight from mass (Y7, Y9), analysing terminal velocity (Y9)					
Building towards (knowledge, concepts and skills)	Forces and motion (Y12), Gravitational fields (Y13)	Waves (Y12), Medical Physics (Y13)	Astrophysics (Y12), Magnetic fields, Electric fields, Electromagnetism (Y13)			
Independent enrichment (wider reading and learning suggestions)	CGP revision guide/ workbook/ knowledge organisers/ flashcards QED: The Strange Theory of Light and Matter by Richard Feynman A Brief History of Time by Stephen Hawking Physics and Math Tutor (revision notes, flashcards, past papers): https://www.physicsandmathstutor.com/ Physics Online (Youtube channel) – teaching and revision videos: https://www.youtube.com/@PhysicsOnline Cognito (Youtube channel) – revision videos: https://www.youtube.com/@Cognitoedu Veritasium (Youtube channel) interesting videos about maths and physics: https://www.youtube.com/@veritasium					
SMSC			Discussing theories of how our universe formed and how it might evolve in the future.			
Careers	Discuss relevance to careers in mechanical engineering, as well as vehicle safety e.g. vehicle crash test technician.	Link relevant careers and fields to uses of EM waves e.g. Radiographer, Surgeon, Optician, Food technician, Telecommunications engineer.	Reference to careers in electricity and use of magnets in generating electricity e.g. power plant engineer. Highlight opportunities as aerospace engineers.			

Year 12						
	Autumn 1	**Autumn 2**	**Spring 1**	**Spring 2**	**Summer 1**	**Summer 2**
Topic	Forces and motion Analysing straight-line motion in one and two dimensions, both graphically and with calculations, describing and quantifying the effects of forces.	Forces and motion, Work, energy and power Describe and analyse the motion of bodies in collisions, and of motion with non-uniform acceleration such as objects moving through fluids.	Waves Understanding properties of EM waves, investigating the wave-like nature of light including polarisation, refraction, total internal reflection. Developing an understanding of the superposition of waves including practical techniques to demonstrate this. Understanding how stationary waves form and the difference between progressive and stationary waves and how to calculate wavelength of the progressive wave using the distance between nodes of a stationary wave.	Electricity Developing an understanding of electrical current and mean drift velocity and the distinction between e.m.f. and p.d. Analysing the IV characteristics of components. Developing an understanding of resistivity of materials and the variation of resistivity with temperature.	Electricity and Materials Investigating potential divider circuits including designing sensing circuits. Undertaking a range of experimental work to examine the physical properties of materials. Analysing data to provide evidence for relationships between physical quantities.	Quantum Physics and Astrophysics Introducing the idea that EM radiation and particles have a dual nature and behave both as particles and waves. Using the photoelectric effect to demonstrate the particle-like nature of light. Developing an understanding of the evolution of a star and how we can determine its stage of evolution by plotting a HR diagram. Understanding how stellar spectra can be analysed to determine the elements making up a stars atmosphere and its temperature.
Building on (knowledge, concepts and skills)	Building on GCSE topics such as forces, using graphs to analyse motion, calculations in science and	Building on GCSE topics such as energy and forces. Developing understanding of the motion of an object when it	Building on GCSE topics such as waves. Refining GCSE definitions of physical quantities associated with waves, using more	Building on GCSE topics such as electricity, drawing circuit diagrams, knowledge of current and potential	Building on GCSE topics such as electricity and forces, potential divider circuits, an understanding of elastic and inelastic	Building on GCSE topics such as space physics (Triple only). Using the understanding of waves and electricity to develop an understanding of

	converting units, thinking about making assumptions to model real-world situations and using mathematical models to predict outcomes of investigations. Deriving equations that were simply stated and memorised at GCSE level.	experiences several forces, the concept of how pressure differences give rise to upthrust on an object in a fluid, deriving the equation for pressure in a fluid to show that it is independent of the surface area of an object. Calculating the efficiency of a system.	technical language. Using the double slit experiment to calculate the wavelength of light in the lab. Using graphical methods to illustrate stationary waves and the principle of superposition. Calculating phase difference using radians. Determining the speed of sound in air using stationary waves formed in a resonance tube.	difference, understanding how different electrical components behave, calculating current or potential difference at/between points in a circuit, knowledge of how resistance of a circuit changes when components are added in series or parallel. Calculating the internal resistance and e.m.f. of a cell.	deformation of materials and springs.	quantum phenomena. Using ideas about superposition of waves to determine the wavelength of radiation emitted by a star. Determining the Planck constant using LEDs.
Building towards (knowledge, concepts and skills)	Analysing non-uniform motion in Autumn 2, movement of electrons in Spring 2, materials in Summer 1, acceleration of objects within gravitational, magnetic and electric fields, circular and simple harmonic motion in Y13.	Using ultrasound waves to image inside the body and determine speed of blood (medical physics in Y13)	Understanding the quantum nature of light and that it can behave both as a particle and a wave	Understanding that electrons (and all particles) have a dual nature and exhibit both wave and particle-like behaviour. Capacitors unit in Y13, medical physics in Y13	Using Hooke's law and the elastic potential energy stored in a spring to analyse the motion of oscillating springs (simple harmonic motion in Y13)	Understanding that energy is quantised, electrons can only exist in certain energy states and this explains features such as x-ray spectrums emitted from X-ray tubes (medical physics in Y13). Using light received from other galaxies as evidence for the Big Bang Theory (cosmology in Y13)

Independent enrichment (wider reading and learning suggestions)	Classical Mechanics: The Theoretical Minimum by Leonard Susskind George Hrabovsky		Physics and Music: The Science of Musical Sound by Harvey E. White and Donald H. White	Homemade Lightning: Creative Experiments in Electricity (TAB Electronics Technical Library) by R. A. Ford Why was it almost impossible to make the blue LED? (Youtube). Link: https://www.youtube.com/watch?v=AF8d72mA41M&list=PLkahZjV5wKe9q3K-nk82kVD_pNfPZ140i&index=20		Listen to, watch or read the Richard Feynman lectures on quantum mechanics (there are 4 in total). https://www.feynmanlectures.caltech.edu/flptapes.html https://www.youtube.com/watch?v=ZcpwnozMh2U Three Roads to Quantum Gravity: Lee Smolin
SMSC						Discussing theories of how our universe formed and how it might evolve in the future.
Careers	Discuss relevance to careers in engineering – mechanical, civil, and aerospace.	Identify opportunities as vehicle crash safety technician and highlight relevance of fluid dynamics to careers in oceanography i.e. meteorologist, marine engineer.	Discuss careers using waves in telecommunications. Identify opportunities for careers relating to uses of visible light/ polarisation, optician, photographer. Explain opportunities related to waves in music e.g. sound engineer, musician.	Explain relevance to careers in electrical engineering as well as apprenticeship schemes.	Discuss careers in material testing e.g. tensile test technician. Identify opportunities as Quality Inspectors.	Discuss opportunities as Astrophysicists, highlighting the importance of careers on the frontiers of science and technology.

Year 13						
	Autumn 1	**Autumn 2**	**Spring 1**	**Spring 2**	**Summer 1**	**Summer 2**
Topic	Cosmology, Gravitational fields, Electric fields, Capacitors Using the Doppler effect to determine if a galaxy is moving towards or away from us. Provide an understanding of the Cosmological Principle that our universe is homogenous and isotropic on a large scale, and the Big Bang Theory including evidence for the Big Bang Theory. Estimating the age of our universe. Discussion of current ideas that our universe is made of dark energy and dark matter. Newton's law of gravitation, planetary motion and gravitational potential and energy. Understanding of Coulomb's law and the motion of particles in a	Magnetic fields, Circular motion, Simple Harmonic Motion Provide knowledge and understanding of magnetic fields, motion of charged particles in magnetic fields, Lenz's law and Faraday's law. Developing the classical mechanics taught in Y12 to include objects travelling in circular motion and linking to examples e.g. planetary motion, electrons orbiting a nucleus, people on a fairground ride. Understanding of the physics involved in simple harmonic motion, including forced oscillations and resonance. Conducting practical experiments to	Thermal Physics, Nuclear and Particle Physics Using the Kinetic Model explain the macroscopic properties of solids, liquids and gases. Experimentally determining the specific heat capacity, specific latent heat of fusion and specific latent heat of vaporisation of materials. Using Newton's laws to model the behaviour of gases and investigating the gas laws experimentally. Knowledge and understanding of the atom, nucleus, fundamental particles including their classification, radioactivity, fission and fusion.	Medical Physics Knowledge and understanding of X-rays, CAT scans, PET scans and ultrasound scans. Discussion of how the developments in medical imaging have led to a number of valuable non-invasive techniques used in hospitals.	Targeted revision	Exams

	uniform electric field. Introduce the properties of capacitors and how they are used in electrical circuits and building circuits to test the theory experimentally.	investigate simple harmonic motion in springs and pendulums.				
Building on (knowledge, concepts and skills)	Understanding of gravitational force and how this links to a gravitational field.	Investigations with magnets (since primary school) and linking this to the concept of a magnetic field. Linking topics taught in Forces and Motion and Waves to understanding circular motion and oscillations in SHM.	Particle Model of Matter, Kinetic Theory, Atomic structure	Wave behaviour, quantum physics.		
Building towards (knowledge, concepts and skills)	UK universities generally require a Physics A-level to study Physics, General Engineering, Aeronautical Engineering, Civil Engineering, Mechanical Engineering and Chemical Engineering at degree level. Additionally, the Physics A-level is *recommended* to study Biochemistry, Biology, Chemistry, Medicine, Dentistry, Nursing, other practice-based medicine courses, Architecture, Computer Science, Geography, Earth and Environmental Sciences, Maths, Materials Science, Pharmacy, Sports Science, Surveying, and Psychology. A Physics A-level may be need for some advanced, higher and degree apprenticeships in engineering or to work as a science technician or a science teacher.					

Independent enrichment (wider reading and learning suggestions)	A Brief History of Time by Stephen Hawking	Simple Harmonic motion: Crash Course Physics #16 (Youtube). Link: https://www.youtube.com/watch?v=jxstE6A_CYQ	The particle at the end of the universe by Sean Carroll Why Does $E=mc^2$? (and Why Should We Care?) by Brian Cox and Jeff Forshaw	How do Medicine and Physics overlap? (Youtube). Link: https://www.youtube.com/watch?v=-zXLZEe7N98		
SMSC	Discussing theories of how our universe formed and how it might evolve in the future.	The application of Faraday's law used to demonstrate how science has benefited society with important devices such as generators and transformers. Transformers are used in the transmission of electrical energy using the national grid and are an integral part of many electrical devices in our homes	Evaluating the benefits and risks to society when building nuclear power stations, including ethical, environmental and government decision making issues	Ethical decisions when deciding to treat patients using radiotherapy. Discussion of the ways in which society uses science to inform decision making.		
Careers	Explain relevance of gravitational fields to space engineering and aviation. Discuss use of capacitors in computing and electrical engineering.	Highlight relevance of SHM to careers in music (musician) and engineering (importance of SHM in shock absorption).	Discussion of careers in the nuclear energy sector.	Discuss careers in medical physics e.g. radiographer, radiation therapist.		