KS5 Physics Curriculum Intent, Implementation, and Impact

Science

Curriculum Intent

To develop skilled knowledgeable independent practical scientists.

The curriculum will allow all students across the academy to become successful scientists. All students will be supported to develop their understanding, motivated to secure their knowledge, and challenged to exceed expectations and maximise their potential in science.

At KS5 students choose to study specialised sciences. In Physics they will significantly develop numeracy skills and increase their scientific literacy. Students will be encouraged to work independently both individually and as part of teams in their practical work, problem solving and presenting their understanding. The KS5 curriculum will help develop students for further scientific study beyond their A Level courses, and offer opportunities to explore scientific careers.

Embedding the Catholic Ethos in the Science Curriculum

"The son is the image of the invisible God, the firstborn over all creation. For in him all things were created: things in heaven and on Earth, visible and invisible, thrones or powers or rules or authorities; all things have been created through him and for him."

Colossians 1:15-16

Science by its nature offers many opportunities for links with the Catholic Ethos of the school. All lessons in Science, like other lessons in school, start with the academy prayer. Science Labs which are also form rooms display information shared by the chaplaincy team.

The Science curriculum focuses on teaching the skills linked to the "Scientific Method" including investigative skills, analytical skills and problem solving. Science education must also address the mechanics, reasoning, and explanation behind observations of the universe and development of new technology.

These can at times be at odds with some religious beliefs and where this occurs science teaching should focus on the "scientific facts" but acknowledge the relevant religious teaching.

Science and its study allows students to engage with their own religious or moral beliefs, while consider the believes of others and the scientific explanations. These can be addressed through links to the gospel values by considering:

- Awe and wonder of the universe and its creation.
- The miracle of life, both of humankind and the living kingdoms.
- Care for our self's and the bodies God have given us.
- Service (Medicine, Veterinary, etc)
- Stewardship and care for the planet God gave us.
- Ethical and moral discussions.

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Year 12 Implementation.

The following skills are delivered across the two-year curriculum

Maths skills

SI Units, unit prefixes, powers of ten and standard form, using equations and algebra, simultaneous equations, using calculators.
Data handling, significant figures, straight line graphs and the equation of a straight line, calculating gradients, x and y-intercepts. Curved graphs, tangents, parabolic curves, inverse curves, area under a graph, integration, quadratic formula. Modelling.
Trigonometry; angles and arcs, degrees and radians, segments, area of a triangle, trig functions, Pythagoras, vector resolution and addition, trig identities, sine and cosine curves, the sine and cosine rules.
Logarithms, rules of logarithms, base 10, natural logarithms, exponential decrease.

Practical Skills

Making measurements, valid data, repeatable and reproducible data. Errors; systematic and random errors. Uncertainty, accuracy, precision. Repeat readings.
Instruments; rulers, micrometers and Vernier callipers, timers, balances, voltmeters and ammeters, oscilloscopes, light gates, dataloggers, radiation detectors.
Planning, obtaining data, variables, analysing data, evaluating results, presenting data, graph drawing including error bars, using experimental uncertainties.

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	Autumn Term	Spring Term	Summer Term
Year 12 Implementation – Teacher One	**Teacher One** **Particles and Radiation** **Matter and Radiation** Particles and Radiation; structure of the atom, isotopes, specific charge. The strong nuclear, radioactive decay. Photons: EM Waves, photon energy, laser power. Antimatter; pair production, annihilation, $E=mc^2$. Particle Interactions, Feynman Diagrams, the weak nuclear force, Electron capture, force carriers/exchange particles. **Quarks and Leptons** The Particle Zoo, classifying particles; Hadrons, Baryons, Mesons, Leptons, neutrinos. Quarks and antiquarks, kaons, pions, strangeness. Conservation rules. **Quantum Phenomena** The photoelectric effect; photon energy, threshold frequency, work function, stopping potential. The Vacuum Photocell. Electron Collisions; ionisation, the electronvolt, excitation. Energy levels: ground state, excited states, de-excitation, Fluorescence, excitation using photons. Spectra, The Bohr Atoms. Wave-particle duality, deBroglie Wavelength. **Mechanics and Materials** **Force in Equilibrium** Vectors and Scalars, vector addition, vector resolution. Balanced forces. Systems in equilibrium. Moments: Centre of mass, moments calculations, couples. Stability; tilting and toppling. Equilibrium Rules; triangles of force. Statics calculations.	**Teacher One** **Mechanics and Materials (cont.)** **On The Move** Speed: displacement, velocity, average speed vs instantaneous speed, displacement time graphs. Acceleration: uniform and non-uniform acceleration. Velocity-time graphs. Equations of Motion. Free-fall; acceleration due to gravity. Practical methods. Motion Graphs. Projectile Motion. **Force and Acceleration** Newton's first law of motion. F=ma. Newton's second law of motion, weight, gravitational field strength, inertia. Using F=ma; trailers, rockets, lifts, pulleys, slopes. Terminal Speed; drag, motion through a fluid, motion of vehicles. On the road; thinking, braking and stopping distance. Vehicle Safety; impact forces, impact time, car safety features. **Force and Momentum** Momentum; recapping Newton's first and second law, rate of change of momentum, impulse, force-time graphs. Impact Forces, rebounds. Conservation of Momentum; Newton's third law of motion, collisions. Elastic and Inelastic collisions. Explosions. **Work, Energy and Power** Work and Energy; energy rules, energy stores, energy transfers, work done, force-distance graphs. Kinetic and potential energy. Power. Efficiency. Energy resources.	**Teacher One** **Mechanics and Materials (cont.)** **Materials** Density. Springs; Hooke's Law, elastic limit, springs in series and parallel, elastic potential energy. Deformation of solids; tensile and compressive forces, stress and strain, Young's Modulus, elastic and plastic deformation, breaking stress, ultimate tensile stress. Brittle and ductile materials. Loading and unloading, hysteresis curves. **Further Mechanics** **Circular Motion** Uniform circular motion, angular displacement and speed. Centripetal acceleration; centripetal force. On the road; hills, roundabouts, corners, banked tracks. At the fairground; the big dipper, long swings, Big wheels. **Simple Harmonic Motion** Oscillations, amplitude, period, frequency, angular frequency, phase difference. Variations of velocity and acceleration over time. Sime waves and their solutions. Applications of SHM; mass-spring systems, loaded springs, simple pendulums. Energy and SHM; free oscillations, damped oscillations. Forced oscillations; resonance, resonant frequency.

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Year 12 Implementation – Teacher Two	**Teacher Two** **Waves and Optics** **Waves** Electromagnetic and mechanical waves, longitudinal and transverse waves, polarisation. Displacement, amplitude, wavelength, period, frequency, wave speed, phase difference. Ripple tanks, reflection, refraction, diffraction, satellite dishes. Superposition, stationary and progressive waves, interference, coherence. Stationary waves; nodes and antinodes, harmonics. Oscilloscopes. **Optics** Refraction; refractive index, Snell's law, critical angle, total internal reflection, optical fibres, material and model dispersion. Double slit interference, young's double slit experiment, fringe separation, path difference. Coherence, colour, light sources, white light. Diffraction, of water, single slit diffraction, diffraction gratings. Spectra; continuous, emission and absorption.	**Teacher Two** **Electric Current** **Current and charge** Current, charge carriers, charge flow. Potential difference, electromotive force, electrical power. Resistance; Ohm's law, resistivity, superconductors. Components; circuit symbols, characteristics, IV graphs, diodes, resistance and temperature. **Direct Current Circuits** Circuit rules (Kirchhoff's laws); current rules, potential difference rules, series and parallel circuits. Resistors; in series and parallel, resistance heating. Electromotive force and internal resistance; terminal pd, lost volts, load resistance. Cells in series and parallel, diodes. The potential divider, variable potential dividers, sensor circuits.	**Teacher Two** **Thermal Physics** **Thermal Physics** Internal energy, first law of thermodynamics, states of matter, temperature, thermal equilibrium, temperature scales, absolute zero. Specific heat capacity, inversion tube, continuous flow heating. Change of state, latent heat, temperature-time graphs. **Gases** Gas laws; Boyle's law, Charles' law, the pressure law. The ideal gas equation; Brownian motion, Avogadro's constant, molar mass, Boltzmann constant. Kinetic Theory of gases; assumptions of the theory, root mean square speed, deriving the kinetic theory equation.
Impact	Each topic includes the following assessments: • End of Topic Knowledge Checker. • CPAC assessment of required practicals • Past paper practice End of Term Synoptic assessment assesses all content from this term.	Each topic includes the following assessments: • End of Topic Knowledge Checker. • CPAC assessment of required practicals • Past paper practice End of Term Synoptic assessment assesses all content from the Autumn and Spring terms	Each topic includes the following assessments: • End of Topic Knowledge Checker. • CPAC assessment of required practicals • Past paper practice End of Year Synoptic assessment assesses all content from this year.

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	Autumn Term	Spring Term	Summer Term
Year 13 Implementation – Teacher One	**Teacher One** **Fields** **Gravitational Fields** Gravitational Field Strength, free fall, radial and uniform fields. Gravitational Potential, potential gradient, gravitational potential energy. Newton's law of gravitation; Kepler's third law, universal constant of gravitation. Planetary fields, escape velocity. Satellite Motion, geo stationary satellites. **Electric Fields** Field Patterns; static electricity, electrical insulators, shuttle ball experiment, gold leaf electroscope, field lines. Electric Field Strength, electric field between two parallel plates, non-uniform fields, field factors. Electrical potential, the Van de Graaff generator, potential gradient, equipotentials. Coulomb's Law. Point Charges, radial fields. Comparing electric and gravitational fields. **Capacitors** Charging capacitors at constant current, capacitance. Energy stored in a charged capacitor, energy stored in a thundercloud. Charging and discharging a capacitor through a fixed resistor. Exponential increase and decrease, time constant. Dielectrics; relative permittivity. Capacitor design.	**Teacher One** **Fields (cont.)** **Magnetic Fields** Permanent magnets, magnetic field of a current carrying conductor, conductors inside magnetic fields, the motor effect, Fleming's left-hand rule, magnetic flux density coils in magnetic fields, simple electric motor. Moving charges in a magnetic field, electron beams, the Hall probe. Charged particles in circular orbits, cyclotron, the mass spectrometer. **Electromagnetic Induction** Induced emf, dynamos and the dynamo rule, Faraday. The law of electromagnetic induction; coils, currents and fields, Lenz's law. Faraday's Law, magnetic flux and flux linkage. The alternating current generator, back emf. Alternating current; power and heating effect of an alternating current. Transformers; transformer rules, step-up and step-down transformers, transformer efficiency and eddy currents. The national grid.	**Revision of all A Level content.** **Completion of outstanding required practicals.** **Paper 3 – practical skills practice.** **All other exam practice.**

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Year 13 Implementation – Teacher Two	**Teacher Two** **Nuclear Physics** **Radioactivity** Alpha, Beta, and Gamma radiation. Rutherford scattering, the nucleus, nuclear size. Ionisation, cloud chambers, absorption tests, the Geiger tube, range of radiation in air. Nuclear decay equations. Inverse square law for gamma radiation. Dangers of radioactivity, hazards of ionising radiation, radiation monitoring, background radiation, storage and safe use of radioactive materials. Half-life, activity, random nature of radioactive decay, the decay constant. Carbon dating, Argon dating, radioactive tracers, industrial uses or radioactivity. Decay modes, the NZ graph, radioactive series, nuclear energy levels. Nuclear radii, nuclear density. **Nuclear Energy** $E=mc^2$ pair production and annihilation. Binding Energy, mass defect, nuclear stability, alpha particle tunnelling. Fission and fusion, induced fission, chain reactions. Fusion in the sun, Fusion reactors. The thermal nuclear reactor, control rods, coolant, heat exchanger, moderator. Safety features, Nuclear accidents, Radioactive waste.	**Teacher Two** **Option** Students will study one of the following options: A. Astrophysics B. Medical Physics C. Engineering Physics D. Turning points in Physics E. Electronics	
Impact.	Each topic includes the following assessments: • End of Topic Knowledge Checker. • CPAC assessment of required practicals • Past paper practice Mock One will take place during November	Each topic includes the following assessments: • End of Topic Knowledge Checker. • CPAC assessment of required practicals • Past paper practice Mock Two will take place during February.	A Level Exams start in late May and continue into June.