	Dallam School Curriculum Overview	**Department: Physics** **Year Group: 12**

Autumn		**Spring**		**Summer**
Particles and radiation (28 lessons)	**Electricity (25 lessons)**	**Waves (22 lessons)**	**Mechanics (35 lessons)**	**Physics skills (18 lessons)**
Examine the fundamental properties of matter, radiation, and energy	**Investigate the difference between real cells and ideal cells**	**Study the properties of mechanical waves and analyse light sources using diffraction**	**Explore the principles and applications of mechanics and materials**	**Learn how scientists work in practice**
By the end of this topic pupils will know *(key knowledge, including tier 3 vocabulary)*				
Matter and radiation ➢ The definition of specific charge. ➢ Important properties of the strong nuclear force. ➢ What is meant by antimatter. ➢ The processes of annihilation and pair production. ➢ The different interactions which occur within atoms. **Quarks and leptons** ➢ Matter is composed of fundamental particles called quarks and leptons. ➢ The names and properties of hadrons composed of up, down, and strange quarks. ➢ The conservation laws for interactions involving quarks and leptons. ➢ Forces between particles are due to exchange of virtual bosons called force carriers.	**Electric current** ➢ Current is the rate of flow of charge. ➢ Potential difference is the work done per unit charge. ➢ EMF is the electrical energy produced per unit of charge passing through the source. ➢ Resistance is the ratio of the p.d. across a component to the current though it. ➢ Ohm's law and the conditions under which it applies. ➢ Resistivity is a physical property of a given conductor, and constant at room temperature. ➢ Super conductors have zero electrical resistance below a critical temperature. ➢ The characteristics of common electrical components including wires, lamps, thermistors, and diodes. ➢ The nature of ideal ammeters and voltmeters.	**Mechanical waves** ➢ The differences between transverse and longitudinal waves. ➢ Interpret the phase of particles in waves. ➢ Properties of waves including reflection, refraction, and diffraction. ➢ Wave speed is a property of the medium in which a wave is travelling. ➢ The principle of superposition. ➢ The conditions required for the formation of stationary waves. **Optics** ➢ Snell's law of refraction. ➢ The refractive index as a measure of the speed of light in an object relative to the speed of light in a vacuum. ➢ The conditions required for total internal reflection. ➢ Design considerations for optical fibres, including	**Forces** ➢ The definition of vector and scalar quantities and mathematical conventions for representing vectors. ➢ The principle of moments. ➢ Conditions required for translational and rotational equilibrium. ➢ Newton's laws of motion. ➢ The principle of conservation of momentum. ➢ The difference between elastic and inelastic collisions. **Kinematics** ➢ Definitions of key kinematic quantities. ➢ SUVAT equations for motion under uniform acceleration. **Materials** ➢ Density is the mass per unit volume. ➢ Hooke's law for springs. ➢ Stress is tension per unit cross-sectional area.	*NB: this topic is taught concurrently with, and to support other topics in year 1.* ➢ All quantities in physics can be expressed in terms of 7 SI base units. ➢ The difference between readings and measurements. ➢ Sources of experimental uncertainty and the difference between systematic and random errors. ➢ Rules for determining uncertainty in a repeat reading / measurement. ➢ Rules for combining uncertainties. ➢ Conventions for presenting measured values with their associated uncertainty. ➢ Conventions for tabulation of raw and processed data. ➢ Conventions for scaling and plotting of graphs. ➢ Conventions for citing sources in physics.

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Quantum phenomena ➢ Einstein's explanation for the photoelectric effect. ➢ Electrons can move between energy levels in the atom. ➢ That matter and light have a dual nature. ➢ Different applications of quantum physics in technology (STM, TEM, MR, SQUIDs). ***Keywords*** ➢ nucleon, atomic number, mass number, isotope, nuclide, specific charge, antimatter, Feynman diagram, weak force, electromagnetic force, photon ➢ muon, pion, kaon, strangeness, baryon, meson ➢ diffraction, threshold frequency, stopping potential, spectrum	**Direct current circuits** ➢ Kirchhoff's Laws for current and potential difference in direct current circuits. ➢ Rules for calculating equivalent resistance of series and parallel combinations. ➢ Real cells are not ideal and include internal resistance which reduces the terminal p.d. when a current flows. ➢ Potential dividers can be used as sensor circuits. ***Keywords*** ➢ charge carrier, electromotive force, light-dependent resistor, light-emitting diode, temperature coefficient ➢ series, parallel, junction, directed sum, lost volts, terminal, load, source	cladding, modal and material dispersion. ➢ The definition of coherent light sources. ➢ Young's double slit experiment and the conditions for bright fringe formation. ➢ The intensity distribution for single slit diffraction. ➢ The effect of diffraction on the intensity distribution for Young's fringes. ➢ The diffraction grating equation. ➢ Types of spectra including continuous, line emission, and line absorption. ***Keywords*** ➢ displacement, amplitude, wavelength, cycle, period, frequency, node, antinode ➢ diffraction, interference, coherent, monochromatic, spectra, dispersion,	➢ Strain is extension per unit length. ➢ The typical stress-strain curves for brittle and ductile materials. ➢ The typical force-extension curves for metal wires, rubber, and polythene. ***Keywords*** ➢ vector, scalar, resultant, equilibrium, tilting, toppling, centre of mass, ➢ displacement, distance, speed, velocity, acceleration, instantaneous, freefall, uniform, projectile, projection ➢ brittle, ductile, yield point, elastic limit, ultimate tensile stress,	***Keywords*** ➢ accurate, precise, uncertainty, error, measurement, reading, parallax, systematic, random, order of magnitude, estimate,

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They will understand *(key concepts)*				
➢ How to interpret nuclear notation. ➢ How to calculate the specific charge of particles, nuclei, and ions. ➢ The role of the strong nuclear force in nuclear stability and why unstable nuclei emit radiation. ➢ How the conservation of energy applies to the processes of pair production and annihilation. ➢ How to interpret Feynman diagrams to explain forces between particles. ➢ Why a wave model of light cannot explain the photo electric effect. ➢ How to interpret the evidence from vacuum photocells experiments. ➢ The evidence showing energy levels in the atom are discrete. ➢ Different causes of excitation in the atom. ➢ How fluorescent tubes work. ➢ How electron diffraction experiments provide evidence of wave like behaviour for particles.	➢ The difference between the direction of conventional current flow, and the flow of charge carriers. ➢ How the behaviour of charge carriers in different materials leads to the classification of insulators, metallic conductors, and semiconductors. ➢ How to use a potential divider circuit to determine the resistance of a component across a full range of available p.d. ➢ How the length and cross-sectional area of a wire affects its resistance. ➢ How to use a rules-based approach to determine unknown current, p.d. and resistance values in direct current circuits. ➢ Use circuit theory to solve problems involving resistance heating. ➢ Why maximum power is delivered to a load when the load resistance is matched with the internal resistance of the source.	➢ Why only transverse waves can be polarised. ➢ How diffraction influences the design of satellite dishes. ➢ How to use Snell's law to predict the path of a light ray across boundaries of different refractive indices. ➢ Practical applications of refraction in rain sensors ➢ How to use the concept of path difference to determine the location of bright and dark fringes in Young's double slit experiment. ➢ The differences between the output of different light sources including vapour lamps / discharge tubes, light from filament lamps / Sun, and laser light. ➢ Explain the differences between the double slit fringe pattern produced by blue, red, and white light. ➢ How diffraction gratings can be used to analyse the wavelengths of light emitted by objects.	➢ Why three forces acting on a body at equilibrium form a closed triangle. ➢ The difference between stable and unstable equilibrium. ➢ Why heavy and light objects freefall at the same rate in a vacuum. ➢ Why the support force varies during a journey in a lift. ➢ How Newton's laws influence the design of safer road vehicles. ➢ How to apply the principle of conservation of momentum to collisions and explosions. ➢ The information that can be obtained from different types of motion graph. ➢ Strategies for applying SUVAT equations. ➢ How energy conservation can provide an alternative way to solve many kinematic problems. ➢ How to calculate density of alloys. ➢ Why materials such as metal wires, rubber, polythene, and glass behave differently under stress.	➢ How to make order of magnitude estimates. ➢ How to use SI prefixes and convert between quantities expressed in different units. ➢ How to check the homogeneity of equations in terms of SI base units. ➢ How to determine an appropriate number of significant figures in a value. ➢ How to assess the error in a single reading / measurement and that of a repeated one. ➢ How to determine errors in derived quantities. ➢ How to test for proportion and inverse proportion between variables. ➢ How to linearise equations and use graphical methods to test the validity of suggested relationships between variables. ➢ How to use ICT to support research, typesetting equations, referencing, and data analysis. ➢ How to compare results against accepted values.

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They will know how to *(key skills)*				
➢ Calculate the absolute masses and charges of different species. ➢ Interpret a force-separation curve for nucleons. ➢ Write nuclear decay equations for α, β, and γ radiation. ➢ Use a spark counter to detect alpha particles and observe their range. ➢ Calculate the energy of a photon. ➢ Convert between different energy units. ➢ Classify hadronic matter according to their quark composition. ➢ Apply conservation laws and knowledge of quantum numbers to predict which types of decay and interactions are possible. ➢ Calculate the maximum kinetic energy of electrons emitted due to photoemission. ➢ Calculate the wavelength and energy of photons emitted during de-excitation. ➢ Calculate the de Broglie wavelength of particles.	➢ Make competent use of key equations for current, p.d. electrical working, electrical power, resistance, and resistivity. ➢ Determine the resistivity of an unknown metal using experimental and graphical means. ➢ Make competent use of common unit prefixes. ➢ Investigate the characteristics of key electrical components. ➢ Interpret graphs of p.d against current, and current against time. ➢ Use models to explain how the resistance of a filament lamp depends on temperature. ➢ Model how the power delivered to a load depends on the load resistance. ➢ Determine the emf and internal resistance of a cell through experimental and graphical means. ➢ Solve circuit problems involving parallel and series combinations of cells.	➢ Convert between different units of angle. ➢ Determine the refractive index of a material using graphical methods. ➢ Use an oscilloscope to produce a trace of a wave form. ➢ Interpret wave forms displayed on an oscilloscope screen. ➢ Investigate how the frequency of a wave on a string depends on its tension and mass per unit length. ➢ Confirm the diffraction grating equation through experimental means. ➢ Measure the wavelength of laser light.	➢ Use scale drawings and trigonometry to resolve vectors into perpendicular components and determine the magnitude and direction of a vector. ➢ Apply the principle of moments to solve equilibrium problems involving multiple supports. ➢ Apply Newton's second law to determine the acceleration of systems involving unbalanced forces. ➢ Analyse force-time graphs of colliding objects. ➢ Determine the acceleration due to gravity through experimental means. ➢ Apply SUVAT equations to solve problems involving motion in 2-dimensions. ➢ Measure the density of regular and irregular objects. ➢ Plot and interpret stress-strain curves for different materials. ➢ Accurately determine the Young modulus of a metal wire through experimental means.	➢ Follow written instructions to carry out experimental techniques or procedures. ➢ Select appropriate instrumentation to carry out investigative procedures and use suitable measurement strategies to ensure accurate results. ➢ Work methodically, in sequence, identifying practical issues and adjusting when necessary. ➢ Identify and control significant quantitative variables, and plan to take account of variables that cannot readily be controlled. ➢ Identify hazards and assess risks associated with these hazards. ➢ Obtain accurate, precise, and sufficient data and record this methodically in a logbook using appropriate units and conventions. ➢ Use appropriate software / tools to process data, carry out research and report findings. ➢ Cite sources of information to demonstrate that research has taken place, supporting planning and conclusions.

	Dallam School Curriculum Overview	**Department: Physics** **Year Group: 13**

Autumn		**Spring**		**Summer**
Further mechanics (14 lessons)	**Thermal physics (14 lessons)**	**Fields (35 lessons)**	**Nuclear physics (20 lessons)**	**Turning points in physics (20 lessons)**
Explore the physics of maximum speed limits, fairground rides, and oscillating systems	**Link the microscale and macroscopic properties of materials**	**Learn about field theory and understand the differences and similarities between gravitational, electric, and magnetic forces**	**Model radioactive decay using maths and examine the process of nuclear fission in domestic power generation**	**Review the key developments in physics through history and the experiments which led to them**
By the end of this topic pupils will know *(key knowledge, including tier 3 vocabulary)*				
Circular motion ➢ What is meant by angular displacement and angular speed. ➢ Equations for calculating angular displacement and speed for objects in uniform circular motion. ➢ The definition of the radian as a unit of angle. ➢ Equations for calculating the magnitude of the centripetal force. **Simple harmonic motion** ➢ The fundamental conditions that apply to systems undergoing simply harmonic motion. ➢ General equations for modelling SHM systems. ➢ Equations for the oscillation period of simple pendula and masses on springs. ➢ Different types of damping. ➢ The difference between free and forced oscillations.	**Thermal physics** ➢ The internal energy of a body is the sum of the random kinetic and potential energies of the particles contained within. ➢ The zeroth and first laws of thermodynamics. ➢ The meaning of (specific) heat capacity and (specific) latent heat. **Gases** ➢ The experimental gas laws (Boyle's law, Charles law, and Gay Lussac's law). ➢ The definition of the mole. ➢ The ideal gas law and key assumptions underpinning it. ➢ Variables of state for ideal gases. ➢ The concept of root mean square as applied to the speed of particles in a gas. ➢ The Maxwell-Boltzmann distribution of particle energies.	**Gravitational + electrical fields** ➢ Newton's law of gravitation ➢ Coulomb's law ➢ Definitions of potential, potential energy, potential gradient, and field strength and their associated mathematical representations for uniform and radial fields. ➢ Kepler's third law. **Capacitors** ➢ Capacitance as the energy stored per unit applied p.d. ➢ Relative permittivity / dielectric constant. ➢ Equations for modelling capacitor charging and discharging. **Magnetic field + induction** ➢ Fleming's left hand rule for the force acting on a conductor in a magnetic field.	**Radioactivity** ➢ Rutherford's alpha particle scattering experiment. ➢ Properties of alpha, beta, and gamma radiation including ionisation, absorption, and range in air, ➢ Inverse square law for gamma radiation. ➢ Hazards associated with ionising radiation. ➢ Radioactive decay is random and spontaneous. ➢ Half-life is the time taken for the activity of a source to halve. ➢ The decay constant is the probability of an individual nucleus decaying per second. ➢ Nuclear energy levels. ➢ The nuclear radius equation and that the density of all nuclei is constant.	**The discovery of the electron** ➢ The process of thermionic emission and formation of cathode rays. ➢ Millikan's oil drop experiment to measure the charge to mass ratio of an electron. **Wave particle duality** ➢ Newton's corpuscular theory of light. ➢ Huygen's wave theory of light to explain Young's interference fringes. ➢ Einstein's photon theory of light to explain the photo electric effect. ➢ Hertz's discovery of radio waves. ➢ Maxwell's mathematical prediction that the speed of light is constant. ➢ Fizeau's experiment to measure the speed of light. ➢ De Broglie's hypothesis and the direct evidence of matter waves.

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➢ Resonance and the conditions required for resonance (qualitative only). ***Keywords*** ➢ uniform, angular, radian, arc, centripetal ➢ driven, forced, proportional, resonance, sinusoidal, phase difference	***Keywords*** ➢ absolute, thermal, latent, equilibrium, rate, specific thermodynamics ➢ isothermal, isobaric, isochoric, root mean square, Avogadro's number, proportion, inverse proportion, state variables	➢ Fleming's right hand rule for induction. ➢ Lenz's law for the direction of an induced current. ➢ Faraday's law of electromagnetic induction. ➢ The function of alternating current generators and the equations governing their output. ➢ The operating principles of transformers. ***Keywords*** ➢ radial, uniform, field, inverse square law, potential, equipotential, potential gradient, point mass, point charge, attraction, repulsion, geostationary ➢ capacitance, time constant, exponential decay, discharge, dielectric, polarised ➢ motor effect, magnetic flux density, cyclotron, mass spectrometer, induction, dynamo, flux linkage, back emf, eddy currents	**Nuclear energy** ➢ The binding energy is the work done to completely separate a nucleus in to its constituent neutrons and protons. ➢ The mass defect. ➢ Key features of the binding energy per nucleon curve for all nuclides. ➢ In nuclear fission, a large unstable nucleus splits into two fragments. ➢ In nuclear fusion, two small nuclei fuse to form a larger nucleus. ➢ The process of induced fission. ➢ The proton-proton cycle as an example of nuclear fusion occurring in stars. ➢ The operating principles of thermal nuclear reactors. ***Keywords*** ➢ stability, scattering, deflection, ionisation, absorber, nuclear radius, background radiation, half-life, activity, decay constant, random, spontaneous, energy level ➢ binding energy, mass defect, fission, fusion, moderator, control rods, critical mass	**Special relativity** ➢ Einstein's postulates of special relativity. ➢ Lorentz transforms for time dilation and length contraction. ➢ Bertozzi's experiment as direct evidence of relativistic mass and energy. ***Keywords*** ➢ ionise, emission, filament, anode, cathode, viscous drag ➢ duality, corpuscle, instantaneous, threshold photon ➢ relative, inertial, frame of reference, invariant, time dilation, length contraction

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They will understand *(key concepts)*				
➢ How to identify the real forces responsible for the centripetal force in real world contexts. ➢ How to apply Newton's second law to derive equations for the magnitude of the centripetal force acting. ➢ Why humped bridges, roundabouts, and banked tracks have maximum speed limits. ➢ How the forces acting on people on fairground rides vary. ➢ How to identify a system that can be modelled by simple harmonic motion. ➢ How to use trigonometry to model simple harmonic systems. ➢ The phase relationships between displacement, velocity, and acceleration for objects undergoing SHM. ➢ How to apply the principles of conservation of energy to SHM systems. ➢ Maths students will know how sine and cosine functions are solutions to the differential equation for SHM.	➢ How the internal energy of an object can be changed when work is done by the object or on the object. ➢ Why the kelvin temperature scale is fundamental. ➢ The concept of thermal equilibrium. ➢ Why gas law calculations require use of absolute temperature units. ➢ The difference between real and idea gases. ➢ How to determine the molar mass of a substance. ➢ How to select the most appropriate form of the ideal gas law to solve problems. ➢ The effect of temperature on the distribution of speeds of particles in a gas. ➢ How to derive an equation for the mean kinetic energy of a particle of an ideal gas from first principles. ➢ Why the internal energy of an ideal gas is equal to the total kinetic energy of the particles contained in that gas.	➢ The difference between radial and uniform fields. ➢ How a torsion balance can be used to make an accurate measurement of G. ➢ How to model gravitational fields of planetary bodies. ➢ How to determine the orbital periods of planetary bodies and satellites. ➢ How to derive an expression for the escape speed. ➢ Sign conventions when dealing with potential energy. ➢ The link between potential gradient and field strength. ➢ The similarities and differences between electric and gravitational fields. ➢ How to use exponential equations to model the charging and discharging of capacitors. ➢ How dielectrics affect the energy storage of a capacitor. ➢ How simple electric motors work. ➢ How transformers are designed to minimise eddy currents.	➢ How to apply energy conservation to predict the distance of closest approach in scattering experiments. ➢ How radiation is detected in GM tubes and cloud chambers. ➢ How to model radioactive decay using exponential functions. ➢ How to radioactive dating is used. ➢ How radioactive tracers are used in medicine and industry. ➢ Why the energy of alpha particles and gamma rays emitted in radioactive decay is discrete. ➢ How scattering experiments can be used to determine the radius of a nucleus. ➢ Safety features of nuclear reactors. ➢ How radioactive waste is categorised, and how this effects its disposal route.	➢ The significance of the experiments and evidence which led to the discovery of the electron. ➢ Why scientists have changed their ideas about light over time. ➢ Why both a wave and particle model are needed to explain all observed behaviours of light. ➢ Applications of wave particle duality in microscopy. ➢ The significance of the null result in the Michelson-Morley experiment. ➢ What is meant by an inertial frame of reference. ➢ Why moving clocks run slow. ➢ Why objects with mass cannot travel at the speed of light. ➢ Observations which support the theory of special relativity.

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They will know how to *(key skills)*				
➢ Calculate the magnitude of the centripetal acceleration / force in various real-world contexts. ➢ Calculate the maximum possible speeds for vehicles ➢ Draw free-body force diagrams to describe the forces acting on passengers on fairground rides. ➢ Interpret graphs of displacement, velocity, and acceleration against time. ➢ Derive equations for the period of oscillation of simple pendula and masses oscillating on springs. ➢ Investigate simple pendula and oscillating springs and test theoretical relationships using log-log graphs. ➢ How to apply the principles of SHM to explore unfamiliar contexts. ➢ Assess when systems may experience resonance and propose strategies to mitigate its impact.	➢ Convert between arbitrary and absolute units of temperature. ➢ Determine the specific heat capacity of materials using a rage of investigative approaches. ➢ Solve calorimetry problems involving changes of state and / or changes of temperature. ➢ Solve thermodynamics problems involving the continuous flow of liquids. ➢ Interpret energy- and temperature- time graphs. ➢ Verify the experimental gas laws.	➢ Calculate the gravitational or electric forces acting on an object in a uniform or radial field. ➢ Calculate the potential energy of configurations of masses and charges. ➢ Apply field theory to describe the motion of charged particles e.g. in cyclotrons and mass spectrometers. ➢ Build circuits to verify the equation for capacitor discharge through a fixed resistor. ➢ Use Faraday's law to determine the induced emf. ➢ Apply Lenz's law to determine the direction of an induced current. ➢ Interpret graphs of the time varying emf and flux linkage of an alternating current generator. ➢ How to calculate the root mean square value from the peak value of p.d. or current.	➢ Verify the inverse square law for radiation. ➢ How to safely handle radioactive sources in a school laboratory environment (see CLEAPSS L093). ➢ How to write nuclear equations for alpha, beta minus, and beta plus decays, and electron capture. ➢ Calculate the age of objects using radioactive dating techniques. ➢ Interpret N-Z graphs to identify different decay modes. ➢ Calculate the binding energy per nucleon for a nucleus. ➢ Calculate the mass defect and energy released in nuclear reactions.	➢ Analyse experimental data from historically significant experiments. ➢ Explain why each experiment studied represents a key turning point in physics understanding. ➢ Identify the proper time and proper length in relativistic scenarios. ➢ Calculate the time and positions of events as observed in different inertial frames.