*Our whole school curriculum aims to give our students the knowledge and skills to succeed in the world as it is, and the wisdom, empathy and courage to fashion the world as it should be.*

In **Physics**, we encourage students to appreciate the Universe and question why things behave the way they do. Students should look to challenge what they think they know and understand through scientific rigor. Physics encompasses the study of the universe from the largest galaxies to the smallest subatomic particles. It is the most basic and fundamental science. We aim to have as many students as possible studying physics or a physics related subject when they leave Dane Court.

| Year 7 | Enquiry Statement/Aim |
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| **Matter (Terms 1-3)** | The particle model is widely used to predict the behaviour of solids, liquids and gases and this has many applications in everyday life. It helps us to explain a wide range of observations and engineers use these principles when designing vessels to withstand high pressures and temperatures, such as submarines and spacecraft. It also explains why it is difficult to make a good cup of tea high up a mountain. |
| **Space and Radiation (Terms 4-6)** | Ionising radiation is hazardous but can be very useful. Although radioactivity was discovered over a century ago, it took many nuclear physicists several decades to understand the structure of atoms, nuclear forces and stability. Rules for radiological protection were first introduced in the 1930s and subsequently improved. Today radioactive materials are widely used in medicine, industry, agriculture and electrical power generation.<br>Questions about where we are, and where we came from, have been asked for thousands of years. In the past century, astronomers and astrophysicists have made remarkable progress in understanding the scale and structure of the universe, its evolution and ours. |

| Year 8 | Enquiry Statement/Aim |
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| **Energy (Terms 1-3)** | Development of an energy stores model and the processes, such as forces and electrical currents, through which energy can be transferred.<br>Measure the work done by a force acting over a distance and how this concept can be used to analyse energy changes in gravitational stores, through lifting and falling, and elastic potential stores during stretching using the relevant mathematical relationships.<br>Students will analyse the changes in temperature when a material is heated, leading to the experimental determination of specific heat capacity along with corresponding calculations. The concept of specific heat capacity will then be used to explain the choice of materials used in heating systems. |
| **Waves (Terms 4-6)** | Wave behaviour is common in both natural and man-made systems. Waves carry energy from one place to another and can also carry information. Designing comfortable and safe structures such as bridges, houses and music performance halls requires an understanding of mechanical waves. Modern technologies such as imaging and communication systems show how we can make the most of electromagnetic waves. |

| Year 9 | Enquiry Statement/Aim |
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| **Electricity and Magnetism (Terms 1-3)** | Electric charge is a fundamental property of matter everywhere. Understanding the difference in the microstructure of conductors, semiconductors and insulators makes it possible to design components and build electric circuits. Many circuits are powered with mains electricity, but portable electrical devices must use batteries of some kind. Electrical power fills the modern world with artificial light and sound, information and entertainment, remote sensing and |

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| | control. The fundamentals of electromagnetism were worked out by scientists of the 19th century. However, power stations, like all machines, have a limited lifetime. |
| **Forces and Motion (Terms 4-6)** | Engineers analyse forces when designing a great variety of machines and instruments, from road bridges and fairground rides to atomic force microscopes. Anything mechanical can be analysed in this way. Recent developments in artificial limbs use the analysis of forces to make movement possible. |

| Year 10 | Enquiry Statement/Aim |
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| **Particles and Energy (Terms 1-2)** | The particle model is widely used to predict the behaviour of solids, liquids and gases and this has many applications in everyday life. It helps us to explain a wide range of observations and engineers use these principles when designing vessels to withstand high pressures and temperatures, such as submarines and spacecraft. It also explains why it is difficult to make a good cup of tea high up a mountain! |
| **Electricity (Terms 3-4)** | Electric charge is a fundamental property of matter everywhere. Understanding the difference in the microstructure of conductors, semiconductors and insulators makes it possible to design components and build electric circuits. Many circuits are powered with mains electricity, but portable electrical devices must use batteries of some kind. Electrical power fills the modern world with artificial light and sound, information and entertainment, remote sensing and control. The fundamentals of electromagnetism were worked out by scientists of the 19th century. |
| **Atomic Structure (Term 5-6)** | Ionising radiation is hazardous but can be very useful. Although radioactivity was discovered over a century ago, it took many nuclear physicists several decades to understand the structure of atoms, nuclear forces and stability. Early researchers suffered from their exposure to ionising radiation. Rules for radiological protection were first introduced in the 1930s and subsequently improved. Today radioactive materials are widely used in medicine, industry, agriculture and electrical power generation. |

| Year 11 | Enquiry Statement/Aim |
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| **Forces (Term 1-2)** | Engineers analyse forces when designing a great variety of machines and instruments, from road bridges and fairground rides to atomic force microscopes. Anything mechanical can be analysed in this way. Recent developments in artificial limbs use the analysis of forces to make movement possible.<br>Throughout this section (Forces and motion), students should be able to use ratios and proportional reasoning to convert units and to compute rates. Students should recognise and be able to use the symbol for proportionality, $\propto$ |
| **Waves (Term 2)** | Wave behaviour is common in both natural and man-made systems. Waves carry energy from one place to another and can also carry information. Designing comfortable and safe structures such as bridges, houses and music performance halls requires an understanding of mechanical waves. Modern technologies such as imaging and communication systems show how we can make the most of electromagnetic waves. |
| **Magnetism and EM (Term 3)** | Electromagnetic effects are used in a wide variety of devices. Engineers make use of the fact that a magnet moving in a coil can produce electric current and also that when current flows around a magnet it can produce movement. It |

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| | means that systems that involve control or communications can take full advantage of this. |
| **Space TA Only (Term 4)** | Questions about where we are, and where we came from, have been asked for thousands of years. In the past century, astronomers and astrophysicists have made remarkable progress in understanding the scale and structure of the universe, its evolution and ours. New questions have emerged recently. 'Dark matter', which bends light and holds galaxies together but does not emit electromagnetic radiation, is everywhere – what is it? And what is causing the universe to expand ever faster? |

| Year 12 | Enquiry Statement/Aim |
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| **Topic 2 - Mechanics** | The ideas of motion are fundamental to many areas of physics, providing a link to the consideration of forces and their implication. The kinematic equations for uniform acceleration were developed through careful observations of the natural world.<br>Using mathematics: Isaac Newton provided the basis for much of our understanding of forces and motion by formalizing the previous work of scientists through the application of mathematics by inventing calculus to assist with this.<br>Many phenomena can be fundamentally understood through application of the theory of conservation of energy. Over time, scientists have utilized this theory both to explain natural phenomena and, more importantly, to predict the outcome of previously unknown interactions. The concept of energy has evolved as a result of recognition of the relationship between mass and energy.<br>The concept of momentum and the principle of momentum conservation can be used to analyse and predict the outcome of a wide range of physical interactions, from macroscopic motion to microscopic collisions. |
| **Topic 3 – Thermal Physics** | Evidence through experimentation: Scientists from the 17th and 18th centuries were working without the knowledge of atomic structure and sometimes developed theories that were later found to be incorrect, such as phlogiston and perpetual motion capabilities. Our current understanding relies on statistical mechanics providing a basis for our use and understanding of energy transfer in science.<br>Scientists in the 19th century made valuable progress on the modern theories that form the basis of thermodynamics, making important links with other sciences, especially chemistry. The scientific method was in evidence with contrasting but complementary statements of some laws derived by different scientists. Empirical and theoretical thinking both have their place in science and this is evident in the comparison between the unattainable ideal gas and real gases. |
| **Topic 4 - Waves** | Oscillations play a great part in our lives, from the tides to the motion of the swinging pendulum that once governed our perception of time. General principles govern this area of physics, from water waves in the deep ocean or the oscillations of a car suspension system. This introduction to the topic reminds us that not all oscillations are isochronous. However, the simple harmonic oscillator is of great importance to physicists because all periodic oscillations can be described through the mathematics of simple harmonic motion.<br>Scientists have discovered common features of wave motion through careful observations of the natural world, looking for patterns, trends and discrepancies and asking further questions based on these findings.<br>It is speculated that polarization had been utilized by the Vikings through their use of Iceland Spar over 1300 years ago for navigation (prior to the |

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| | introduction of the magnetic compass). Scientists across Europe in the 17th–19th centuries continued to contribute to wave theory by building on the theories and models proposed as our understanding developed.<br>The conflicting work of Huygens and Newton on their theories of light and the related debate between Fresnel, Arago and Poisson are demonstrations of two theories that were valid yet flawed and incomplete. This is an historical example of the progress of science that led to the acceptance of the duality of the nature of light.<br>From the time of Pythagoras onwards the connections between the formation of standing waves on strings and in pipes have been modelled mathematically and linked to the observations of the oscillating systems. In the case of sound in air and light, the system can be visualized in order to recognize the underlying processes occurring in the standing waves. |
| **Topic 7 - Atomic, nuclear and particle physics** | Radioactivity was discovered by accident when Becquerel developed photographic film that had accidentally been exposed to radiation from radioactive rocks. The marks on the photographic film seen by Becquerel probably would not lead to anything further for most people. What Becquerel did was to correlate the presence of the marks with the presence of the radioactive rocks and investigate the situation further.<br>Graphs of binding energy per nucleon and of neutron number versus proton number reveal unmistakable patterns. This allows scientists to make predictions of isotope characteristics based on these graphs.<br>Our present understanding of matter is called the Standard Model, consisting of six quarks and six leptons. Quarks were postulated on a completely mathematical basis in order to explain patterns in properties of particles. It was much later that large-scale collaborative experimentation led to the discovery of the predicted fundamental particles. |
| **Topic 9 – Wave Phenomena** | The equation for simple harmonic motion (SHM) can be solved analytically and numerically. Physicists use such solutions to help them to visualize the behaviour of the oscillator. The use of the equations is very powerful as any oscillation can be described in terms of a combination of harmonic oscillators. Numerical modelling of oscillators is important in the design of electrical circuits.<br>When light passes through an aperture the summation of all parts of the wave leads to an intensity pattern that is far removed from the geometrical shadow that simple theory predicts.<br>Observed patterns of iridescence in animals, such as the shimmer of peacock feathers, led scientists to develop the theory of thin film interference. The first laboratory production of thin films was accidental.<br>The Rayleigh criterion is the limit of resolution. Continuing advancement in technology such as large diameter dishes or lenses or the use of smaller wavelength lasers pushes the limits of what we can resolve.<br>Although originally based on physical observations of the pitch of fast moving sources of sound, the Doppler effect has an important role in many different areas such as evidence for the expansion of the universe and generating images used in weather reports and in medicine. |
| **Topic 12 – Quantum and Nuclear** | Much of the work towards a quantum theory of atoms was guided by the need to explain the observed patterns in atomic spectra. The first quantum model of matter is the Bohr model for hydrogen. The acceptance of the wave–particle duality paradox for light and particles required scientists in many fields to view research from new perspectives.<br>Progress in atomic, nuclear and particle physics often came from theoretical advances and strokes of inspiration. New ways of detecting subatomic particles due to advances in electronic technology were also crucial. Finally, the analysis of |

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| | the data gathered in modern particle detectors in particle accelerator experiments would be impossible without modern computing power. |
| **Option D - Astrophysics** | The systematic measurement of distance and brightness of stars and galaxies has led to an understanding of the universe on a scale that is difficult to imagine and comprehend.<br>The simple light spectra of a gas on Earth can be compared to the light spectra of distant stars. This has allowed us to determine the velocity, composition and structure of stars and confirmed hypotheses about the expansion of the universe.<br>The Big Bang model was purely speculative until it was confirmed by the discovery of the cosmic microwave background radiation. The model, while correctly describing many aspects of the universe as we observe it today, still cannot explain what happened at time zero.<br>Observations of stellar spectra showed the existence of different elements in stars. Deductions from nuclear fusion theory were able to explain this.<br>According to everybody's expectations the rate of expansion of the universe should be slowing down because of gravity. The detailed results from the 1998 (and subsequent) observations on distant supernovae showed that the opposite was in fact true. The accelerated expansion of the universe, whereas experimentally verified, is still an unexplained phenomenon. |

| Year 13 | Enquiry Statement/Aim |
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| **Topic 5 – Electricity and Electromagnetism** | Electrical theory demonstrates the scientific thought involved in the development of a microscopic model (behaviour of charge carriers) from macroscopic observation. The historical development and refinement of these scientific ideas when the microscopic properties were unknown and unobservable is testament to the deep thinking shown by the scientists of the time.<br>Although Ohm and Barlow published their findings on the nature of electric current around the same time, little credence was given to Ohm. Barlow's incorrect law was not initially criticized or investigated further. This is a reflection of the nature of academia of the time, with physics in Germany being largely non-mathematical and Barlow held in high respect in England. It indicates the need for the publication and peer review of research findings in recognized scientific journals.<br>Scientists need to balance the research into electric cells that can store energy with greater energy density to provide longer device lifetimes with the long-term risks associated with the disposal of the chemicals involved when batteries are discarded.<br>Magnetic field lines provide a powerful visualization of a magnetic field. Historically, the field lines helped scientists and engineers to understand a link that begins with the influence of one moving charge on another and leads onto relativity. |
| **Topic 6 - Circular Motion and Gravitation** | Observations and subsequent deductions led to the realization that the force must act radially inwards in all cases of circular motion.<br>Newton's law of gravitation and the laws of mechanics are the foundation for deterministic classical physics. These can be used to make predictions but do not explain why the observed phenomena exist. |

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| **Topic 8 – Energy Production** | Since early times mankind understood the vital role of harnessing energy and large-scale production of electricity has impacted all levels of society. Processes where energy is transformed require holistic approaches that involve many areas of knowledge. Research and development of alternative energy sources has lacked support in some countries for economic and political reasons. Scientists, however, have continued to collaborate and share new technologies that can reduce our dependence on non-renewable energy sources. The kinetic theory of gases is a simple mathematical model that produces a good approximation of the behaviour of real gases. Scientists are also attempting to model the Earth's climate, which is a far more complex system. Advances in data availability and the ability to include more processes in the models together with continued testing and scientific debate on the various models will improve the ability to predict climate change more accurately. |
| **Topic 10 - Fields** | The move from direct, observable actions being responsible for influence on an object to acceptance of a field's "action at a distance" required a paradigm shift in the world of science.<br>The ability to apply field theory to the unobservable (charges) and the massively scaled (motion of satellites) required scientists to develop new ways to investigate, analyse and report findings to a general public used to scientific discoveries based on tangible and discernible evidence. |
| **Topic 11 – Electromagnetic Induction** | In 1831 Michael Faraday, using primitive equipment, observed a minute pulse of current in one coil of wire only when the current in a second coil of wire was switched on or off but nothing while a constant current was established. Faraday's observation of these small transient currents led him to perform experiments that led to his law of electromagnetic induction.<br>In the late 19th century Edison was a proponent of direct current electrical energy transmission while Westinghouse and Tesla favoured alternating current transmission. The so called "battle of currents" had a significant impact on today's society.<br>Examples of exponential growth and decay pervade the whole of science. It is a clear example of the way that scientists use mathematics to model reality.<br>This topic can be used to create links between physics topics but also to uses in chemistry, biology, medicine and economics. |