**Physics Curriculum Intent**

The Physics curriculum at Trinity High School has been carefully designed so that students' **knowledge** – both substantive and disciplinary – becomes more broad and more sophisticated as they progress through the key stages. We have used the strong **subject expertise** within our department to ensure **inclusivity -** that all students are able to access and understand even the most complex of concepts.

For example, in Year 9 after spending time consolidating and reviewing the knowledge of the fundamental concepts of Physics that students will have studied in middle school, we take those concepts and develop them much further. One of the most important ideas is Energy. We have a specific focus on developing the ability to both calculate and describe/explain Energy changes, starting with everyday contexts in Y9 through to a wide range of complex and unfamiliar contexts in later years.

Our curriculum also ensures that students' disciplinary knowledge develops in an equally advanced way. For example, students will use the mathematical skills developed through both Science and Mathematics, to solve increasingly complex Physics problems, eventually using multi-step calculations drawn from multiple areas within the subject.

We use the principles of **cognitive science** in the planning of our curriculum, to ensure that students develop bodies of knowledge through revisiting key concepts in different contexts. Each element of the curriculum has been **carefully sequenced** to aid the **acquisition and remembering** of this content and through this, students will be enabled in their learning - to think **metacognitively**.

Finally, although outcomes are very important, we know that teaching to the test is counterproductive in developing knowledge and understanding. Our curriculum is therefore enriched by a wealth of **cultural capital** – the glue which helps the core content to stick. For example, while students are atomic structure and nuclear radiation we look at the case of the poisoning of Alexander Litvenenko with a radioisotope in 2006 along with the Chernobyl disaster or 1986.

The document below details the core substantive and disciplinary knowledge and how these built over time in our subject.

# Curriculum Intent Year 9 Physics

| Term | Substantive Knowledge (The What) | Disciplinary Knowledge (The How) | Hinterland |
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| **KS3 Physics Autumn term of Y9** | **By the end of the topic you will be able to:**<br>**Electricity, Magnetism, Forces, Space & Waves**<br>• Name the 8 energy stores and describe energy transfers in a range of situations<br>• Recognise and draw key circuit symbols and explain what the component does in a circuit<br>• Draw/build circuit diagrams using the symbols<br>• Know and apply the rules for series and parallel circuits<br>• Classify the key objects in the solar system<br>• Explain why we have day/night and seasons<br>• Describe our place in the wider universe<br>• Explain the role of gravity in our solar system<br>• Calculate the work done and power<br>• Name and identify forces acting on an object in a range of contexts<br>• Calculate the size or direction of the resultant force and use it to explain what happens to the object next<br>• Use keywords to describe the key properties of waves<br>• Explain reflection and refraction (or dispersion) and interpret ray diagrams of each<br><br>**Developing prior knowledge**<br>This is a review of prior KS3 learning in science so the whole topic is a consolidation of existing knowledge/skills.<br>• | **Over the course of the topic you will develop your ability to use your scientific skills to:**<br>**How Science Works**<br>Over the course of the topic you will develop your ability to use your scientific skills to:<br>• Decide on an approach to investigate how mass affects the drop time of an object<br>• Plan/trial a method to ensure a fair test, controlling variables where needed and ensuring safe working<br>• Ensure that data you collect will enable you to reach a conclusion (is valid)<br>• Follow a provided method to obtain accurate and valid data<br>• Record data in a suitable table & process the data ready to plot a graph<br>• Plot a suitable graph of results<br>• Use the graph to write a conclusion for the experiment, explained using science knowledge<br>• Evaluate the experiment, deciding if it produced valid data, suggesting improvements or further investigation that could be conducted<br>• Plan and carry out a short investigation into reflection<br>**Developing prior knowledge**<br>This is a review of prior KS3 learning in science so the whole topic is a consolidation of existing knowledge/skills. | -our place in the solar system and wider universe<br>-how streamlining can affect the design of cars |
| **P1 Energy Topic (Spring Term)** | **Energy Stores, Transfers and Resources**<br>• State the 8 Energy Stores and 4 Energy Transfers<br>• Understand the nature of Energy as the capacity to do work, and the idea that it is never created or destroyed | **Over the course of the topic you will develop your ability to use your scientific skills to:** | - Fundamental ideas of energy and conservation of energy |

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| | • Calculate values for Kinetic, Elastic and Gravitational potential energy, and state the factors affecting these values<br>• Define specific heat capacity in relation to thermal energy, and describe a method for finding the SHC of a material<br>• Define and calculate work, power and efficiency. Describe how to reduce energy losses in a system, including insulation<br>• State the most common global electricity resources, with an understanding of strengths and weaknesses such as cost, renewability, environmental impact and reliability<br>**<u>Developing from KS3</u>**<br>Putting values to previously known energy stores<br>Accounting for wasted energy in non-perfect energy changes | • Identify the energy stores in a variety of scenarios, and describe how the energy stores change in a system over time.<br>• select the correct equation and use it to answer questions, sometimes changing the subject of the equation<br>• apply knowledge to increasingly varied contexts, including new situations and contexts that require use of more than one equation to arrive at an answer<br>• recognise the need to convert units prior to performing a calculation and represent data to a suitable number of decimal places/significant figures<br>• use data presented in standard form and convert to base SI unit<br>• Carry out an investigation to obtain data that enables a hypothesis to be suitably tested, data gathered and recorded/present in a suitable tabular/graphical format.<br>• interpret a range of data (tables and graphs), identify anomalies, describe the trend(s) and reach a conclusion.<br>• understand the scientific methodology in using data to reach a conclusion<br>• evaluate the suitability of a solution to a problem, taking into account both the scientific and social arguments involved, and draw a conclusion<br>**<u>Developing from KS3</u>**<br>Changing subject of equations<br>Possible use of standard form in exam questions<br>Consider the social contexts of scientific arguments<br>Quantifying previously qualitative concepts | - Efficiency of lightbulbs, cars and household appliances<br>Electricity production methods, their costs and benefits and why we may be slow to adopt more environmentally friendly electricity sources |
| Year 9 End Point | By the end of year 9 students will have developed an understanding of the key principles behind the Energy Unit. Students will be able to answer both low and some standard demand CGSE questions that include the use of equations when prompted (we do not expect them to have memorised them yet) without changing the subject. Those who progress further will be able to change the subject of the more straightforward equations. Students will | | |

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| | have developed their practical skills and be confident in following an experimental procedure, risk assessing, recording data, plotting the results of experiments and drawing conclusions based on results. They will have a developing knowledge of the technical language we use in science and will be able to use the keywords covered in Year 9 in a range of practical experiments. Students will be able to interpret data, both tabulated and graphical, in an increasing wide range of contexts. |

**<u>Curriculum Intent Year 10 Physics</u>**

| Term | Substantive Knowledge (The What) | Disciplinary Knowledge (The How) | Hinterland |
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| **P3 Particles Topic Autumn term** | **By the end of the topic you will be able to:**<br>**Particle Model of Matter**<br>• Recall and describe the particle configuration of three states of matter<br>• Recall and describe in terms of particles the changes of state<br>• Define internal energy, kinetic energy and potential energy in materials<br>• Calculate energy changes in given temperature and state changes<br>• Define and calculate density of regular and irregular solids.<br>• **TRIPLE**<br>• State that PV is a constant in gases at constant temperature<br>• Describe how work done on a gas can increase the temperature<br>**Developing from prior learning**<br>Adding more detail to previous particle models<br>Describing state changes in terms of these particle changes, and adding the conservation of mass<br>Adding a calculation to density, and finding the volume of irregular objects<br>Learning the constituent parts of internal/thermal energy (Kinetic and potential)<br>Calculating and completing a practical to find SHC, originally seen in P1 | **Over the course of the topic students will develop your ability to use your scientific skills to:**<br>• select the correct equation and use it to answer questions, sometimes changing the subject of the equation<br>• apply knowledge to increasingly varied contexts, including new situations and contexts that require the use of multiple equations to arrive at an answer where quantities will need to be converted first<br>• combine equations in multistep processes<br>• recognise the need to convert units prior to performing a calculation and represent data to a suitable number of decimal places/significant figures<br>• Decide on a hypothesis or make a simple prediction based on a question<br>• Partly plan or contribute to the planning of a suitable practical investigation including risk assessment<br>• Record data in a suitable format (table)<br>• Analyse and represent data in a suitable format (graph)<br>• evaluate the repeatability, validity and suitability of data/methods used, identifying sources of error and suggesting improvements<br>**Developing from prior learning**<br>Changing subject of equations<br>Consideration of sources of error and validity/repeatability<br>Wider range of and more complex contexts | -Knowledge of Archimedes, and his discovery of a method to calculate the density of an irregular object<br>-Explain and understand why the temperature of stored gas is important<br>-Why ice is better at keeping drinks cool than frozen stones |
| **P2 Electricity Topic (Autumn/Spring Term)** | **By the end of the topic you will be able to:**<br>• Draw/interpret circuit diagrams<br>• Understand current, p.d. & resistance<br>• Use V=IR,  Q=It E=QV equations including units in calculations<br>• Plan and carry out 2 investigations into resistance, interpret results | **Over the course of the topic you will develop your ability to use your scientific skills to:**<br>• interpret increasingly complex circuit diagrams and use I,V,R, P data to calculate missing quantities<br>• select the correct equation and use it to answer questions, sometimes changing the subject of the equation | During the topic we cover:<br>-the growing energy supply crisis and its impact on the global environment (looking back at the 1970's energy crisis |

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| | • Obtain I,V data for Resistor, lamp, diode, interpret the data<br>• Know & apply V, I & R rules to series/parallel circuits<br>• Know the key features of mains supply including safety features<br>• Understand power (P) and use P=IV, $P=I^2R$ E=Pt in calculations<br>• Explain the construction and role of national grid<br>• **Triple only**: Describe static charge, how it is produced and the electric fields associated with charges<br>**Developing prior knowledge**<br>We extend the basics ideas of energy stores/transfers to electrical circuits<br>Use of equations to calculate values in particular we use the power/energy equations studied in P1 and add equations with current/p.d. terms<br>More varied/complex circuits/contexts | • apply knowledge to increasingly varied contexts, including new situations and contexts that require use of more than one equation to arrive at an answer<br>• recognise the need to convert units prior to performing a calculation and represent data to a suitable number of decimal places/significant figures<br>• use data presented in standard form<br>• use mathematical symbols comparing size of numbers<br>• decide on a hypothesis, then plan (including assessing risks) and carry out an investigation to obtain data that enables the hypothesis to be suitably tested, data gathered and recorded/present in a suitable tabular/graphical format.<br>• interpret a range of data (tables and graphs), identify anomalies, describe the trend(s) and reach a conclusion. This includes applying y=mx+c to proportional relationships<br>• evaluate the repeatability, validity and suitability of data/methods used, identifying sources of error and suggesting improvements<br>**Developing prior knowledge** Changing subject of equations<br>Possible use of standard form in exam questions<br>Consideration of sources of error and validity/repeatability<br>Wider range of and more complex contexts | -how energy demands are evolving over time and the future changes needed to minimise climate change<br>- the danger posed by current/static electricity and how to stay safe/minimise risk in the home<br>-The role of the national grid in meeting our energy needs |
| **P4 Atomic Structure Topic (Summer term)** | **By the end of the topic you will be able to:**<br>- describe the structure of the atom using appropriate notation and the meaning of isotope and ionisation (studied in Chemistry topic C1)<br>-apply the above to describing nuclear decay in terms of the changes taking place in the nucleus<br>-use knowledge of nuclear decay describe the key properties of 3 of the 4 named nuclear radiations<br>-use skills developed in Chemistry to write nuclear equations<br>-describe and calculate half-life, using both graphs and data | **Over the course of the topic you will develop your ability to use your scientific skills to:**<br>-use ratios, fractions, percentages and orders of magnitude in calculations<br>-plot the change in activity over time<br>-work out the half-life of a substance both from a graph and using numerical data<br>-calculate the activity of a radioactive material, accounting for background radiation<br>-Evaluate the risks and benefits of using radiation including medical uses | During the topic we cover:<br>-the risks and benefits of using nuclear energy as a power source including a knowledge of the Chernobyl disaster<br>-the poisoning of Alexander Litvinenko<br>-medical benefits and risks (and other uses) of nuclear radiation including both diagnosis and treatment |

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| | -use irradiation and contamination in evaluating risk<br>**Triple only**- describe the process of nuclear fission/fusion and how it is controlled<br><br>**Developing prior learning**<br>-Retrieval of prior knowledge of the structure of the atom, extended to account for decay changes<br>-More precise definitions of keywords<br>-Use of equations to calculate values including multi-step calculations<br>-More varied/complex contexts | -Evaluate the risks and benefits of using nuclear fission to generate power, in comparison to other resources including fusion<br><br>**Developing prior learning**<br>-using skills developed in learning to write chemical equations to write nuclear decay equations<br>-Using numbers presented in standard form and starting to make order of magnitude estimates/calculations<br>-half-life graphs/calculations involving half-life including fractional changes and calculating ratio | |
| **Spring Term**<br>**P8 Space Physics (Triple only)** | **By the end of the topic you will be able to:**<br>**Triple only**- name the key objects in the solar system/beyond, rank them in size and describe their key features including what they orbit<br>-explain the role of gravity in orbital motion and how radius is related to speed<br>-describe the key stages of stellar evolution and how fusion changes over time.<br>-Explain red shift as evidence for expansion of the universe (and Cosmic Microwave Background Radiation) and how it led to the Big Bang Theory.<br>- Explain why explanations around the ideas of dark energy and dark matter are still developing.<br><br>**Developing prior learning**<br>-Retrieval of prior knowledge of the structure of the solar system<br>-More precise definitions of space related keywords<br>-basic knowledge of gravity is extended to account for stable orbital motions | **Over the course of the topic you will develop your ability to use your scientific skills to:**<br>-use ratios, fractions, percentages and orders of magnitude in calculations<br>-Perform calculations involving very large numbers in standard form<br>- Explain the importance of the peer review process to the scientific method<br>-Convert distances in light years to metres<br><br>**Developing prior learning**<br>-Use knowledge of standard form developed earlier in the year and through Maths lessons to deal with very large numbers. | During the topic we cover:<br>-the main scientific (and non-scientific theories for the existences and evolution of the universe and the history of the key discoveries/ observations in science that to led to the development of those theories. |
| **Summer Term: P5 Forces (first half only)** | **By the end of the topic you will be able to:**<br><br>• Differentiate between scalar and vector quantities and contact and non-contact forces | **Over the course of the topic you will develop your ability to use your scientific skills to:**<br><br>Use a variety of models such as representational, spatial, descriptive, computational and mathematical to solve | Students will learn about the importance of driving safely and safety features in car design during the latter part of the forces topic. |

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| | • Use vector diagrams to illustrate resolution of forces, equilibrium situations and determine the resultant of two forces, to include both magnitude and direction<br>• Give examples of the forces involved in stretching, bending, or compressing an object and describe the difference between elastic deformation and inelastic deformation caused by stretching forces.<br>• Describe the difference between a linear and non-linear relationship between force and extension<br>• Calculate a spring constant in linear cases<br>• Calculate average speed for non-uniform motion.<br>• Draw distance–time graphs from measurements and extract and interpret lines and slopes of distance–time graphs, including obtaining the average speed.<br>• Draw velocity–time graphs from measurements and interpret lines and slopes to determine acceleration<br>• (HT only) interpret enclosed areas in velocity–time graphs to determine distance travelled (or displacement)<br>• Apply Newton's First Law to explain the motion of objects moving with a uniform velocity and objects where the speed and/or direction changes<br>• (HT only) explain that inertial mass is a measure of how difficult it is to change the velocity of an object<br>• Apply Newton's Third Law to examples of equilibrium situations.<br>• Explain, interpret and evaluate measurements from simple methods to measure the different reaction times of students<br>• explain the factors which affect the distance required for road transport vehicles to come to rest in emergencies and explain the dangers caused by large decelerations | problems, make predictions and to develop scientific explanations and understanding of familiar and unfamiliar facts.<br>• Plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data or explore phenomena.<br>• Carrying out and represent mathematical and statistical analysis.<br>• Interpreting observations and other data (presented in verbal, diagrammatic, graphical, symbolic or numerical form), including identifying patterns and trends, making inferences and drawing conclusions.<br>• Being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error.<br>• Recognise the importance of scientific quantities and understand how they are determined.<br>• Convert between units.<br>• Use of appropriate apparatus to make and record a range of measurements accurately, including length, area, mass, time, volume and temperature.<br>• Use of appropriate apparatus to measure and observe the effects of forces including the extension of springs<br>• Use of appropriate apparatus and techniques for measuring motion, including determination of speed and rate of change of speed<br>• substitute numerical values into algebraic equations using appropriate units for physical quantities<br>• change the subject of an equation<br>• use a variety of models such as representational, spatial, descriptive, computational and mathematical to solve problems, make predictions and to develop scientific explanations and understanding of familiar and unfamiliar facts.<br>• use an appropriate number of significant figures in calculation | |

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| | • (HT only) estimate the forces involved in the deceleration of road vehicles in typical situations on a public road<br>• (HT only) use the concept of momentum as a model to describe and explain examples of momentum in an event, such as a collision.<br>**Triple Only**<br>• able to describe examples in which forces cause rotation<br>• able to calculate the size of a force, or its distance from a pivot, acting on an object that is balanced.<br>• explain how levers and gears transmit the rotational effects of forces.<br>• explain why, in a liquid, pressure at a, certain point increases, with the height of the column of liquid above it and with the density of the liquid.<br>• describe the factors which influence floating and sinking.<br>• describe a simple model of the Earth's atmosphere and of atmospheric pressure and explain why atmospheric pressure varies with height above a surface.<br>**Developing prior knowledge:**<br>We extend the basic ideas of forces taught in KS3 to cover a variety of different types of forces and how to resolve them to obtain the resultant force of a system. | • use SI units (eg kg, g, mg; km, m, mm; kJ, J) and IUPAC chemical nomenclature unless inappropriate.<br>• recognise the importance of scientific quantities and understand how they are determined.<br>**Developing prior knowledge:**<br>We will continue to practice changing the state of equations using equation triangles.<br>We will develop the skills to plan, carry out and analyse scientific experiments relating to forces, including using standard form in a range of questions. | |
| **Year 10 End Point** | By the end of year 10 students will have developed an understanding of the key principles behind the Electricity, Atomic Structure, Space (Triple only) and Particles of Matter Physics Units. Students will also have reviewed the principles behind the Energy topic studied in Year 9. Students will be able to answer both low, standard and for some high demand CGSE questions in both familiar and unfamiliar contexts. Students will be confident in the use of equations without prompting (we expect them to have memorised the equations covered in the topic studied) including changing the subject of the more basic equations. Those who progress further will be able to change the subject of the more complex equations and perform multi-step calculations. Students will have further developed their practical skills and be confident in following an experimental procedure, risk assessing, recording data, plotting the results of experiments and drawing conclusions based on results for all required practical's studied to date. They will have a secure knowledge of the technical language we use in science and will be able to use the keywords covered in Year 9 & 10 in a range of contexts, both familiar and new, including interpreting data, both tabulated and graphical. | | |

**Curriculum Intent Year 11 Physics**

| Term | Substantive Knowledge (The What) | Disciplinary Knowledge (The How) |
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| **P5 Forces topic**<br>**Autumn term** | **By the end of the topic you will be able to:**<br><br>• Differentiate between scalar and vector quantities and contact and non-contact forces<br>• Use vector diagrams to illustrate resolution of forces, equilibrium situations and determine the resultant of two forces, to include both magnitude and direction<br>• Give examples of the forces involved in stretching, bending, or compressing an object and describe the difference between elastic deformation and inelastic deformation caused by stretching forces.<br>• Describe the difference between a linear and non-linear relationship between force and extension<br>• Calculate a spring constant in linear cases<br>• Calculate average speed for non-uniform motion.<br>• Draw distance–time graphs from measurements and extract and interpret lines and slopes of distance–time graphs, including obtaining the average speed.<br>• Draw velocity–time graphs from measurements and interpret lines and slopes to determine acceleration<br>• (HT only) interpret enclosed areas in velocity–time graphs to determine distance travelled (or displacement)<br>• Apply Newton's First Law to explain the motion of objects moving with a uniform velocity and objects where the speed and/or direction changes<br>• (HT only) explain that inertial mass is a measure of how difficult it is to change the velocity of an object<br>• Apply Newton's Third Law to examples of equilibrium situations.<br>• Explain, interpret and evaluate measurements from simple methods to measure the different reaction times of students<br>• explain the factors which affect the distance required for road transport vehicles to come to rest in emergencies and explain the dangers caused by large decelerations<br>• (HT only) estimate the forces involved in the deceleration of road vehicles in typical situations on a public road | **Over the topic you will develop your ability to use your scientific skills to:**<br>• Use a variety of models such as representational, spatial, descriptive, computational and mathematical to solve problems, make predictions and to develop scientific explanations and understanding of familiar and unfamiliar facts.<br>• Plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data or explore phenomena.<br>• Carrying out and represent mathematical and statistical analysis.<br>• Interpreting observations and other data (presented in verbal, diagrammatic, graphical, symbolic or numerical form), including identifying patterns and trends, making inferences and drawing conclusions.<br>• Being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error.<br>• Recognise the importance of scientific quantities and understand how they are determined.<br>• Convert between units.<br>• Use of appropriate apparatus to make and record a range of measurements accurately, including length, area, mass, time, volume and temperature.<br>• Use of appropriate apparatus to measure and observe the effects of forces including the extension of springs<br>• Use of appropriate apparatus and techniques for measuring motion, including determination of speed and rate of change of speed<br>• substitute numerical values into algebraic equations using appropriate units for physical quantities<br>• change the subject of an equation<br>• use a variety of models such as representational, spatial, descriptive, computational and mathematical to solve problems, make predictions and to develop scientific explanations and understanding of familiar and unfamiliar facts.<br>• use an appropriate number of significant figures in calculation |

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| | <ul><li>(HT only) use the concept of momentum as a model to describe and explain examples of momentum in an event, such as a collision.</li></ul>**<u>Triple Only</u>**<ul><li>able to describe examples in which forces cause rotation</li><li>able to calculate the size of a force, or its distance from a pivot, acting on an object that is balanced.</li><li>explain how levers and gears transmit the rotational effects of forces.</li><li>explain why, in a liquid, pressure at a, certain point increases, with the height of the column of liquid above it and with the density of the liquid.</li><li>describe the factors which influence floating and sinking.</li><li>describe a simple model of the Earth's atmosphere and of atmospheric pressure and explain why atmospheric pressure varies with height above a surface.</li></ul>**<u>Developing prior knowledge:</u>**<br>We extend the basic ideas of forces taught in KS3 to cover a variety of different types of forces and how to resolve them to obtain the resultant force of a system. | <ul><li>use SI units (eg kg, g, mg; km, m, mm; kJ, J) and IUPAC chemical nomenclature unless inappropriate.</li><li>recognise the importance of scientific quantities and understand how they are determined.</li></ul>**<u>Developing prior knowledge:</u>**<br>We will continue to practice changing the state of equations using equation triangles.<br>We will develop the skills to plan, carry out and analyse scientific experiments relating to forces, including using standard form in a range of questions. |
| **<u>P6 Waves Topic (Autumn/Spring Term)</u>** | **<u>By the end of the topic you will be able to:</u>**<br>**<u>Waves</u>**<ul><li>State the difference between Transverse and Longitudinal waves and give examples</li><li>Describe the different sections of the EM spectrum (uses and dangers)</li><li>Describe, explain and draw how waves act at a boundary, including refraction diagrams</li><li>Recall the wave equation</li></ul>**<u>TRIPLE</u>**<ul><li>Describe the properties of sound waves and how they affect the pitch and volume of sounds</li><li>Explain how soundwaves can be used for medical and exploration purposes</li><li>Describe, draw and interpret ray diagrams for concave and convex lenses</li></ul> | **<u>Over the course of the topic students will develop your ability to use your scientific skills to:</u>**<ul><li>Identify and suggest which EM radiation is best for different jobs</li><li>select the correct equation and use it to answer questions, often changing the subject of the equation</li><li>Recognise a transverse or longitudinal wave based on its shape and behaviour</li><li>apply knowledge to increasingly varied contexts, including new situations and contexts that require use of more than one equation to arrive at an answer</li><li>Convert units prior to performing a calculation and represent data to a suitable number of decimal places/significant figures</li><li>use data presented in standard form and convert to base SI unit</li><li>Carry out an investigation to obtain data that enables a hypothesis to be suitably tested, data gathered and recorded/present in a suitable tabular/graphical format.</li></ul> |

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| | • Define the term "black body radiation" and explain how the radiation of an object is related to temperature<br>• Describe how an objects colour is related to its wave interactions<br>**Developing from prior knowledge**<br>Expanding knowledge of waves and radiation from a transfer in P1, as well as the example of Gamma radiation learned in P4.<br>Sound travelling speed linked to particle structure of matter from P3.<br>Light being a wave is learned in KS3, but here we add more detail as to the kind of wave, and its place in the EM spectrum | • interpret a range of data (tables and graphs), identify anomalies, describe the trend(s) and reach a conclusion.<br>• evaluate the suitability of a solution to a problem, taking into account both the scientific and social arguments involved, and draw a conclusion<br>**Developing from prior knowledge**<br>Changing subject of equations<br>Use of standard form in exam questions<br>Quantifying previously qualitative concepts |
| **P7 Magnets and Electromagnets (Spring term)** | **By the end of the topic you will be able to:**<br>• Describe the attraction and repulsion between unlike and like poles for permanent magnets.<br>• describe how to plot the magnetic field pattern of a magnet using a compass and plot fields around a bar magnet, current carrying wire and solenoid.<br>• explain how the behaviour of a magnetic compass is related to evidence that the core of the Earth must be magnetic<br>• describe how the magnetic effect of a current can be demonstrated<br>• explain how a solenoid arrangement can increase the magnetic effect of the current.<br>• (HT only) show that Fleming's left-hand rule represents the relative orientation of the force, the current in the conductor and the magnetic field.<br>• (HT only) recall the factors that affect the size of the force on the conductor.<br>• (HT only) explain how the force on a conductor in a magnetic field causes the rotation of the coil in an electric motor.<br>**Triple Only:**<br>• explain how a moving-coil loudspeaker and headphones work.<br>• recall the factors that affect the direction and size of the induced potential difference/induced current.<br>• explain how the generator effect is used in an alternator to generate ac and in a dynamo to generate dc.<br>• explain how the coils in a transformer allows it to perform its function and how the effect of an alternating current in one coil can induce a current in another. | **Over the topic you will develop your ability to use your scientific skills to:**<br>• change the subject of an equation<br>• substitute numerical values into algebraic equations using appropriate units for physical quantities<br>• Explain every day and technological applications of science; evaluate associated personal, social, economic and environmental implications; and make decisions based on the evaluation of evidence and arguments.<br>• change the subject of an equation<br>• substitute numerical values into algebraic equations using appropriate units for physical quantities.<br>• Visualise and represent 2D and 3D forms including two dimensional representations of 3D objects.<br>**Developing prior knowledge:**<br>Continue to practice changing the subject of equations from KS3 and topics 1-6 using equation triangles and multi-step calculations. |

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| | • Apply the correct equation to transformer contexts.<br>**<u>Developing prior knowledge:</u>**<br>We extend the basic ideas of magnets from KS3 to forces taught in KS4, including how magnetism is a non-contact force and can induce current in objects. For triple science, we will develop our knowledge about transformers from P2 and how the change the potential difference to reduce power losses. | |
| **Year 11 End Point** | By the end of year 11 students will have developed an understanding of the key principles behind Ks4 Physics. Students will be able to answer both low, standard and for many high demand CGSE questions in both familiar and unfamiliar contexts. Students will be confident in the use of equations without prompting (we expect them to have memorised the equations covered in the topic studied) including changing the subject of the more basic equations. Those who progress further will be able to change the subject of the more complex equations and perform multi-step calculations. Students will have further developed their practical skills and be confident in following an experimental procedure, risk assessing, recording data, plotting the results of experiments and drawing conclusions based on results for all required practical's studied to date. They will have a secure knowledge of the technical language we use in science and will be able to use the keywords covered in Year 9 in a  through to 11 in a wide range of contexts, both familiar and new, including interpreting data, both tabulated and graphical. | |

## <u>Curriculum Intent Year 12 Physics</u>

**As of September 2024 Year 12 students will study the OCR Physics A Specification. We are in the process of preparing for first teaching, Intent document will be added soon.**

# Curriculum Intent Year 13 Physics

| Term | Substantive Knowledge (The What) | Disciplinary Knowledge (The How) | Hinterland |
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| **Year 12 Summer 2**<br><br>**3.6 Further Mechanics** | By the end of the topic students will be able to:<br><br>-Recall that motion in a circular path at constant speed implies there is an acceleration and requires a centripetal force<br>-Use the equation $\omega = v/r = 2\pi f$ for magnitude of angular speed<br>-Recall that the radian is a measure of an angle and estimate the acceleration and centripetal force in situations that involve rotation<br>-Use the equation $a = v2/r = \omega 2r$ for centripetal acceleration<br>-Use the equation $F = mv2/r = m\omega 2r$ for centripetal force<br>-Describe and analyse characteristics of simple harmonic motion (SHM).<br>-Describe the condition for SHM as: $a \propto - x$<br>-Define and use the equations $a = - \omega 2x$ and $x = A \cos \omega t$ and $v= \pm \omega \sqrt{}(A2-x2)$<br>-Sketch relationships between x, v, a and − t for simple harmonic oscillators.<br>-Draw graphical representations linking the variations of x, v and a with time<br>-Explain how the v − t graph is derived from the gradient of the x − t graph and that the a − t graph is derived from the gradient of the v − t graph<br>-Recall that maximum speed = $\omega A$ and maximum acceleration = $\omega 2A$<br>-Use the small-angle approximation in the derivation of the time period for examples of approximate SHM<br>-Use the equation $T = 2\pi\sqrt{}(m/k)$ for the study of a mass spring system and $T = 2\pi \sqrt{}(l/g)$ for a simple pendulum<br>-Explain the variation of Ek, Ep, and total energy with both displacement and time<br>-Describe the effects of damping on oscillations<br>-Explain how free and forced vibrations can be measured quantitatively<br>-Explain resonance and describe the effects of damping on the sharpness of resonance<br>-Describe examples of these effects in mechanical systems and situations involving stationary waves<br>-Investigate the factors that determine the resonant frequency of a driven system<br>**Developing from Y12**<br>-student who take maths will already be aware of the radian as a unit of angular measurement<br>-students will have also used the radian indirectly when discussing phase difference during the Y12 Waves topic | Over the course of the topic students will develop their ability to:<br>-perform calculations using the radian as a unit of angle (including trigonometric functions<br>-sketch graphs of displacement, velocity and acceleration of oscillating objects. Use the gradient of one graph to derive the next.<br>-prove an exponential relationship using the example of decay of amplitude due to damping<br>-students plan an experiment to determine the spring constant of a spring through measurement of its period of oscillation, having identified key variables & reduced uncertainty through trialling the experiment and having researched and fully referenced source of information<br>-students follow a method to determine “g” by measuring the period of a pendulum at different lengths, estimating the uncertainty of measured values and “g”<br><br>**Developing from Y12**<br>-students will have experience of using one graph to derive another through graphing motion (distance/velocity/acceleration time graphs in Mechanics) | - |

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| **Year 12 Summer 2**<br><br>**Thermal Physics** | Describe internal energy as the sum of the randomly distributed kinetic energies and potential energies of the particles in a body<br>Explain how the internal energy of a system is increased when energy is transferred to it by heating or when work is done on it (and vice versa)<br>Explain that during a change of state the potential energies of the particle ensemble are changing but not the kinetic energies.<br>Describe gas laws as experimental relationships between p, V, T and the mass of the gas<br>Explain the concept of absolute zero of temperature.<br>Use the ideal gas equation: pV = nRT for n moles and pV = NkT for N molecules<br>Recall that work done = pΔV<br>Investigate Boyle's law (constant temperature) and Charles's law (constant pressure) for a gas<br>Explain Brownian motion as evidence for existence of atoms<br>Explain the relationships between p, V and T in terms of a simple molecular model<br>Explain that the gas laws are empirical in nature whereas the kinetic theory model arises from theory<br>Explain that for an ideal gas internal energy is the kinetic energy of the atoms<br>Explain how knowledge and understanding of the behaviour of a gas has changed over time<br><br>**Developing from KS4**<br>Students are developing on basic definitions and understanding of particle model thermodynamics from KS3, explaining more in depth and using situations where any of the three quantities could be changed. | Over the course of the topic students will develop their ability to:<br>- Complete calculations involving transfer of energy and continuous flow<br>- Use the ideal gas equation: pV = nRT for n moles and pV = NkT for N molecules<br>- Recall and use the following concepts: Avogadro constant NA, molar gas constant R, Boltzmann constant k, molar mass and molecular mass.<br>- Use and derive the equation pV = ⅓Nm (crms) 2<br>- Use the equation average molecular kinetic energy = 1/2 m(crms)2 = 3/2 kT = 3RT /2NA<br><br>**Developing from KS4**<br>- Use the equations Q = mc Δ Θ, Q = ml<br>- Use a simple algebraic approach for conservation of momentum<br>-Quantifying previously qualitative concepts | -various examples of hydraulic systems in use<br>-Benefits of ice to cool things due to state change<br>-Understanding of energy usages in heating and cooling systems |

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| **Year 13 Autumn 1/2**<br><br>**Fields** | P7.1: Fields<br>Describe the concept of a force field as a region in which a body experiences a non-contact force<br>Recognise that a force field can be represented as a vector, the direction of which must be determined by inspection<br>Describe how force fields arise from the interaction of mass, of static charge, and between moving charges<br>Explain the similarities and differences between gravitational and electrostatic forces<br>P7.2: Gravitational fields<br>Describe what gravity is<br>Be able to estimate the gravitational force between a variety of objects<br>Be able to represent a gravitational field by gravitational field lines<br>Define gravitational potential, including zero value at infinity<br>Describe what gravitational potential difference is<br>Explain what equipotential surfaces are and explain why no work is done when moving along an equipotential surface<br>Explain the significance of the negative sign in potential energy<br>Describe orbital period and speed related to radius of circular orbit; ab derive $T^2 \propto r^3$<br>Estimate various parameters of planetary orbits, eg kinetic energy of a planet in orbit and Calculate total energy of an orbiting satellite, escape velocity and describe synchronous orbits<br>Describe the use of satellites in low orbits and geostationary orbits, to include plane and radius of geostationary orbit<br>P3: Electric fields<br>Describe what the permittivity of free space is, $\varepsilon_0$, Recall that air can be treated as a vacuum when calculating force between charges<br>Recall that for a charged sphere, charge may be considered to be at the centre<br>Compare magnitude of gravitational and electrostatic forces between subatomic particles<br>Estimate the magnitude of the electrostatic force between various charge configurations<br>Be able to represent electric fields by electric field lines and explain electric field strength<br>Describe the trajectory of moving charged particle entering a uniform electric field initially at right angles<br>Investigate the patterns of various field configurations using conducting paper (2D) or electrolytic tank (3D)<br>Define absolute electric potential, including zero value at infinity, and of electric potential difference<br>Explain what equipotential surfaces are and explain why no work is done when moving charge along an equipotential surface<br>P4: Capacitance<br>Define capacitance and use the equation: $C = Q/V$, Describe the dielectric action in a capacitor by $C = A\varepsilon_0\varepsilon_r/d$<br>Define relative permittivity and dielectric constant<br>Describe the action of a simple polar molecule that rotates in the presence of an electric field<br>Investigate the relationship between C and the dimensions of a parallel-plate capacitor<br>Interpret the area under a graph of charge against pd $E = ½ QV = ½ CV^2 = ½ Q^2/C$<br>Draw corresponding graphs for Q, V and I against time for charging and discharging<br>Calculate time constants RC including their determination from graphical data | Over the course of the topic students will develop their ability to:<br>- Use the equation $F = Gm_1m_2/r^2$ for magnitude of force between point masses where G is the gravitational constant<br>- Use the equation $g = F/m$ with g as force per unit mass, $g = GM/r^2$ for magnitude of g in a radial field, work done in moving mass for m given by $\Delta W = m\Delta V$, $V = -GM/r$ for V in a radial field, $g = -\Delta V/\Delta r$ for V related to g<br>- Draw graphical representations of variations in fields and find values from the area under and gradient of the line<br>- Use logarithmic plots<br>- Use the equation $F = 1/4\pi\varepsilon_0 \times Q_1Q_2/r^2$ for the force between two charges in a vacuum,: $E = F/Q$, where where E is the force per unit charge, $E = V/d$, for magnitude of E in a uniform field, $E = 1/4\pi\varepsilon_0 \times Q/r^2$, for magnitude of E in a uniform field, $\Delta W = Q\Delta V$ for work done in moving charge Q, $V = 1/4\pi\varepsilon_0 \times Q/r^2$ for magnitude of V in a radial field, $E = \Delta V/\Delta r$ to related V to E<br>- Derive the equation: $Fd = Q\Delta V$ from work done for moving charge between plates<br>- Determine the relative permittivity of a dielectric using a parallel-plate capacitor<br>- Use the equation: $T½ = 0.69RC$ for time to halve, $Q = Q_0e^{-t/RC}$ for quantitative treatment of capacitor discharge (corresponding equations for V and I), Use the equation: $Q = Q_0$ | -Uses of satellites<br>-Uses of capacitors<br>-fields nature of forces and impact on scientific thinking, brief discussion of nature of gravity |

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| | Investigate the charge and discharge of capacitors<br>P5: Magnetic fields<br>Describe force on a current-carrying wire in a magnetic field: F = BIl when field is perpendicular to current<br>Describe and use Fleming's left hand rule, Explain magnetic flux density B and give a definition for the tesla<br>Investigate how the force on a wire varies with flux density, current and length of wire using a top pan balance<br>Describe force on charged particles moving in a magnetic field, Recall the direction of force on positive and negative charged particles, Describe the circular path of particles in application in devices such as the cyclotron<br>Explain the terms: magnetic flux density ϕ = BA, and flux linkage Nϕ,<br>Describe flux and flux linkage passing through a rectangular coil rotated in a magnetic field<br>Investigate, the effect on magnetic flux linkage of varying the angle between a search coil and magnetic field direction<br>Describe simple experimental phenomena for electromagnetic induction, Describe and apply Faraday's and Lenz's laws for electromagnetic induction<br>Describe applications such as a straight conductor moving in a magnetic field<br>Recall Sinusoidal voltages and currents, root mean square, peak and peak-to-peak values for sinusoidal waveforms only<br>Apply the calculation of mains electricity peak and peak-to-peak voltage values<br>Use an oscilloscope as a dc and ac voltmeter, to measure time intervals and frequencies, and to display ac waveforms<br>Describe and explain the production of eddy currents and causes of inefficiencies in a transformer<br>Describe the transmission of electrical power at high voltage including calculations of power loss in transmission lines<br>**<u>Developing from KS4</u>**<br>Developing a basic understanding of these forces from GCSE and a brief introduction to fields and combining these together to give a deeper understanding of these forces and fields in general. Knowledge of the shape of sinusoidal waves and definitions for ac and dc current linked to induction | (1 – e– t/RC) for quantitative treatment of capacitor charge<br>- ε = BANωsin ωt for emf induced in a coil rotating uniformly in a magnetic field, Irms = I0/√2 ; Vrms = V0/ √2<br><br>**<u>Developing from Year 12</u>**<br>- Use forces calculated in mechanics style calculations to describe the movement of particles in fields | |

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| **Year 13**<br>**Autumn 2**<br>**Nuclear Physics** | By the end of the topic students will be able to:<br>-Describe the qualitative study of Rutherford scattering & how knowledge and understanding of the structure of the nucleus has changed over time<br>-Describe the properties and experimental identification using simple absorption experiments for α, β and γ radiation<br>-Describe and explain the applications & hazards of exposure for humans to α, β and γ radiation & how to handle sources safely<br>-Recall the inverse-square law for γ radiation: I = k/x2 and use experiments for verification of inverse-square law<br>-Define background radiation giving examples of its origins and experimental elimination from calculations.<br>-Discuss applications e.g. use of technetium-99m as a γ source in medical diagnosis & evaluate the balance between risk and benefits in the uses of radiation in medicine<br>-Describe the random nature of radioactive decay; constant decay probability of a given nucleus<br>-Use the equations: Δ N/ Δ t = − ʎN; N = N0e − ʎt and A = ʎN<br>-Use modelling to describe constant decay probability<br>-Investigate the decay equation (including the use of experimental data, dice simulations etc) and a variety of analytical methods<br>-Use the equation: A = A0e−ʎ & the half life equation: T ½ = ln2/ʎ<br>-Determine half-life from graphical decay data including decay curves and log graphs<br>-Draw graphs of N against Z for stable nuclei<br>-Describe possible decay modes of unstable nuclei including α, β+, β− and electron capture, including changes in N and Z caused by radioactive decay and representation in simple decay equations<br>-Interpret nuclear energy level diagrams & recall the existence of nuclear excited states; γ ray emission;<br>-Estimate nuclear radius from closest approach of alpha particles and determination of radius from electron diffraction and use the Coulomb equation for the closest approach estimate<br>-Describe how the nuclear radius depends on the nucleon number & derive R = R0A1/3 from experimental data and interpret the of equation as evidence for constant density of nuclear material<br>-Calculate nuclear density and describe the graph of intensity against angle for electron diffraction by a nucleus<br>-Recall that E = mc2 applies to all energy changes<br>-Complete simple calculations involving mass difference and binding energy<br>-Recall and use the Atomic mass unit, u and conversion of units; 1 u = 931.5 MeV<br>-Describe and explain fission and fusion processes<br>-Complete simple calculations from nuclear masses of energy released in fission and fusion reactions<br>-Draw graphs of average binding energy per nucleon against nucleon number | Over the course of the topic students will develop their ability to:<br>-describe a method for determining which radiation is being emitted by a sample<br>-determining half-life graphically<br>-Represent exponential functions graphically (making them fit y=mx+c)<br>-perform calculations and manipulate equations involving exponential/logarithmic functions<br>-research and complete a risk assessment for handling radioactive sources<br>-follow a method to carry out an investigation to prove the inverse square law applies to gamma decay<br><br>**Developing from Y12**<br>-students will already be able to determine half life from graphs, having studied it at KS4 | - |

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| | -Identify, on a plot, the regions where nuclei will release energy when undergoing fission/fusion<br>-Describe how knowledge of the physics of nuclear energy allows society to use science to inform decision making<br>-Describe fission as induced by thermal neutrons; possibility of a chain reaction due to critical mass<br>-Explain the functions of the moderator, control rods, and coolant in a thermal nuclear reactor.<br>-Describe simple a mechanical model of moderation by elastic collisions<br>-Recall factors affecting the choice of materials for the moderator, control rods and coolant and give examples of materials used<br>-Describe safety aspects of fuel used, remote handling of fuel, shielding, emergency shut-down<br>-Describe safety aspects of production, remote handling, and storage of radioactive waste materials.<br>-Evaluate the of balance between risk and benefits in the development of nuclear power | | |

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| **Year 13**<br>**Spring 1**<br><br>**Magnetism** | By the end of the topic students will be able to:<br>-Describe force on a current-carrying wire in a magnetic field: F = BIl when field is perpendicular to current<br>-Describe and use Fleming's left hand rule<br>-Explain magnetic flux density B and give a definition for the tesla<br>-Describe force on charged particles moving in a magnetic field, using F = BQv when the field is perpendicular to velocity<br>-Recall the direction of force on positive and negative charged particles<br>-Describe the circular path of particles in application in devices such as the cyclotron<br>-Explain the terms: magnetic flux density ϕ = BA, and flux linkage Nϕ, where B is normal to A and N is the number of turns cutting the flux<br>-Describe flux and flux linkage passing through a rectangular coil rotated in a magnetic field as flux linkage Nϕ = BANcosθ<br>-Describe simple experimental phenomena for electromagnetic induction<br>-Describe and apply Faraday's and Lenz's laws for electromagnetic induction<br>-Use the equation: ε = N Δ ϕ/Δ for magnitude of induced emf = rate of change of flux linkage<br>-Describe applications such as a straight conductor moving in a magnetic field<br>-Use the equation: ε = BANωsin ωt for emf induced in a coil rotating uniformly in a magnetic field<br>Recall Sinusoidal voltages and currents, root mean square, peak and peak-to-peak values for sinusoidal waveforms only<br>-Use the equation: Irms = I0/√2 ; Vrms = V0/ √2<br>-Apply the calculation of mains electricity peak and peak-to-peak voltage values<br>-Use an oscilloscope as a dc and ac voltmeter, to measure time intervals and frequencies, and to display ac waveforms<br>-Use the following transformer equation: Ns/Np = Vs / Vp<br>-Use the equation: IsVs/IpVp to calculate transformer efficiency<br>-Describe and explain the production of eddy currents and causes of inefficiencies in a transformer<br>-Describe the transmission of electrical power at high voltage including calculations of power loss in transmission lines<br><br>**Developing from KS4**<br>Students will have studied the basic ideas behind much of this topic through the P7 Magnetism & Electromagnetism course studied in Year, though nowhere near to the depth they cover it here. | Over the course of the topic students will develop their ability to:<br>-Plan and carry out an investigation how the force on a wire varies with flux density, current and length of wire using a top pan balance, having risk assessed and researched/referenced sources of possible methods<br>-Plan and design a suitable set up to enable them to Investigate, the effect on magnetic flux linkage of varying the angle between a search coil and magnetic field direction, including the correct use of an oscilloscope to determine the p.d. output of the coil<br><br>**Developing from Y12**<br>-student will have researched/referenced sources many times and should now be adept at planning/risk assessment. | -the battle between Tesla and Eddison as to where electrical energy should be supplied as direct of alternating current |

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| **Year 13**<br>**SPRING ½**<br><br>**Astrophysics** | By the end of the topic students will be able to:<br>-Recall that astronomical telescope consisting of two converging lenses<br>-Draw ray diagrams to show the image formation in normal adjustment<br>-Describe angular magnification in normal adjustment and use the equations: M = angle subtended by image at eye/ angle subtended by object at unaided eye M = fo/fe<br>-Describe Cassegrain arrangement using a parabolic concave primary mirror and convex secondary mirror for reflecting telescopes<br>-Draw ray diagram to show path of rays through the reflecting telescope up to the eyepiece<br>-Discuss the relative merits of reflectors and refractors including a qualitative treatment of spherical and chromatic aberration<br>-Recall what single dish radio telescopes, I-R, U-V and X-ray telescopes are and discuss the similarities and differences of radio telescopes compared to optical telescopes (Inc. structure, positioning and use)<br>-Compare the resolving and collecting powers of radio telescopes<br>-Describe the advantages of large diameter telescopes for minimum angular resolution of telescope<br>-Use the equation: Rayleigh criterion, θ ≈ ʎ/D<br>-Recall that collecting power is proportional to diameter 2<br>-Compare the eye and CCD as detectors in terms of quantum efficiency, resolution, and convenience<br>-Recall how stars are classified by luminosity and that the apparent magnitude, m<br>-Recall and describe the Hipparcos scale and that the dimmest visible stars have a magnitude of 6 and that a difference of 1 on the magnitude scale is equal to an intensity ratio of 2.51<br>-Discuss the relationship between brightness and apparent magnitude<br>Recall that brightness is a subjective scale of measurement<br>-Describe what a Parsec and a lightyear are<br>For absolute magnitude define M, in relation to m: m – M = 5 log d/10<br>-Recall how stars are classified by temperature and black-body radiation<br>-Apply Stefan's law and Wien's displacement law, using the equations: ʎmaxT = constant = 2.9 × 10−3 m K and P = σAT4<br>-Recall the assumption that a star is a black body and the general shape of black-body curves, and use of Wien's displacement law to estimate black-body temperature of sources<br>-Describe the spectral classes OBAFGKM in terms of colour, temperature and prominent absorption line, what the Hertzsprung-Russell (HR) diagram shows and the general shape: main sequence, dwarfs and giants, using axis scales range from –10 to +15 (absolute magnitude) and 50 000 K to 2 500 K (temperature) or OBAFGKM (spectral class)<br>-Recall the position of the Sun on the HR diagram | Over the course of the topic students will develop their ability to:<br>-draw accurate and precise ray diagrams including a diagram represent refracting telescopes in the normal adjustment and the Cassegrain arrangement.<br>Perform calculations involving the logarithmic relationship be between absolute magnitude and distance including changing the subject of the equation<br>-explain how detail how new evidence caused us to change our theory of the formation and evolution of the universe and how it new evidence had shown the theory to be incomplete<br>**Developing from KS4**<br>-student will have already be able to draw basic ray diagrams involving lenses through completing the lenses section of P6 Waves in Year 11 | -This history of how the competing theories of the universe have evolved over time<br>-the size and scale of the universe<br>-How the development of the telescope changed our entire world view including the conflict with the Catholic creation story which dominated at the time |

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| | -Describe stellar evolution: path of a star similar to our Sun on the HR diagram from formation to white dwarf<br><br>-Define properties: rapid increase in absolute magnitude of supernovae; composition and density of neutron stars; escape velocity > c for black holes.<br>-Recall that gamma ray bursts are due to the collapse of supergiant stars to form neutron stars or black holes<br><br>-Compare energy output with total energy output of the Sun<br>-Describe the use of type 1a supernovae as standard candles to determine distances<br>-Discuss controversy concerning accelerating Universe and dark energy and recall the light curve of typical type 1a supernovae<br>-Recall that supermassive black holes are at the centre of galaxies and calculate the radius of the event horizon for a black hole using Schwarzschild radius (Rs), $R_s \approx 2GM/c^2$<br>-Describe the Doppler effect and apply $\Delta f/f = v/c$ and $z = \Delta\lambda/\lambda = -v/c$ for $v \ll c$ to optical and radio frequencies.<br>-Complete calculations on binary stars viewed in the plane of orbit<br>-Describe what galaxies and quasars are Define quasars as the most distant measurable objects, the discovery of quasars as bright radio sources and the formation of quasars from active supermassive black hole. Recall that quasars show large optical red shifts; estimation involving distance and power output<br><br>-Define and use Hubble's law, including the following equation: $v = Hd$ for red shift<br>-Make simple interpretations for expansion of universe; estimation of age of universe, assuming H is constant and evaluate qualitative data for Big Bang theory including evidence from cosmological microwave background radiation, and relative abundance of H & He<br>-Discuss the difficulties in the direct detection of exoplanets<br>-Describe how detection techniques, limited to variation in Doppler shift (radial velocity method) and the transit method<br><br><br>**<u>Developing from KS4</u>**<br>Students will have studied the ideas behind the big bang theory and the life cycle of stars through completing the P8 Space Physics topic in Year 10 (and earlier through KS2/3 science) and the basics of lenses through P6 Waves in Year 11 | | |