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Curriculum Intent Statement for SCIENCE

At Chase Terrace Academy we aspire for all of our students to achieve greater things than they ever thought possible.

We pride ourselves on being a warm and welcoming school that places community at the heart of everything we do. Our ambitious curriculum is enriching and inclusive, providing challenge and breadth for all. This empowers our students to become compassionate, confident and creative individuals who are resilient, respectful and equipped with a desire to take up a fulfilling role in society and the wider world.

In Science we want to encourage our students to understand and value different cultures, countries and people as well as having an appreciation of how the world works and science in the media which can often be misinterpreted.

We aspire for our students to retain a sense of wonder about our vast and complex Universe. Future generations should be aware of how scientific and technological progress is changing the world, and to help the wider public understand it. It is important to ensure that these changes are heading in the right direction. In a democratic society, this means that everyone needs to have a basic understanding of science to make informed, responsible decisions about the future.

We provide the opportunity for those students with a particular passion for science to study single sciences. This gives students the scope to further broaden and deepen their scientific knowledge in preparation for study at A-level and beyond.

'Curriculum is designed to be ambitious & meet the needs' 'Develops skills for future learning & employment'

Outcomes: For competitive statistics and outcomes in-line and beyond National averages for KS4 courses – particularly Grade 7 & beyond. Destination figures which show student's passion for the subject.

Students to have a 'deeper' knowledge: teaching is designed to help students to remember in the long term the content they have been taught and to integrate new knowledge into larger concepts. Students confident to debate and discuss their knowledge of topics and respond to feedback in a way that is progressive.

Curriculum, implementation – How and what we do

Schemes of learning

- Revised curriculum at KS3 – mastery and deeper learning embedded into lessons including key command words working across the JTMAT.
- Literacy and numeracy activities incorporated into lessons and all schemes of learning as well as within our assessments particularly graphs and data.
- Science in the news built is incorporated into lessons as and when.
- Curriculum at KS4 is appropriate and engaging to students. Content is relevant to all learners and diverse.
- Transition unit completed in Year 9 to help prepare students for the KS4 course.
- Revision is woven into SOW to ensure content is retained in the long-term.
- Assessments are reviewed and amended where necessary to support outcomes and to ensure the 'deeper learning' approach.
- Knowledge organisers are updated every year in line with latest assessments and feedback from exam boards and examiners

Quality of marking and feedback

- Clear expectations and routines for student response to feedback (E.g. purple pens and QLA)
- Standardisation activities for mock assessments and book trawls carried out on a termly basis.
- Informal learning walks.
- Use of open-door policy.

Extra-curricular and intervention

- Quality first teaching to ensure gap is narrowed.
- Year 11 intervention held after school in line with the intervention programme.
- Year 10 intervention held afterschool in line towards the end of Y10 when capacity allows.

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Science Curriculum Implementation Plan

Science Overall Big Picture			
	Term 1	Term 2	Term 3
Year 7	• Lab Safety ↓ • Organisms 1 – Movement & Cells ↓ • Matter 1 – Particle Model ↓ • Forces 1 – Speed & Gravity ↓ • Assess / DIRT / RETEACH →	• Genes 1 – Variation ↓ • Matter 1 – Separating Mixtures ↓ • Energy 1 – Energy Costs & Transfer ↓ • Assess / DIRT / RETEACH →	• JTMAT End of Year Exam ↓ • Genes 1 – Plant Reproduction ↓ • Reactions 1 – Acids & Bases ↓ • Earth 1 – Earth Structure & Universe
Year 8	• Atoms, elements, compounds ↓ • Electricity & Magnetism ↓ • Nutrition & digestion ↓ • Assess / DIRT / RETEACH →	• Chemical reactions ↓ • Light & Sound ↓ • Respiration ↓ • Assess / DIRT / RETEACH →	• Chemical quantities ↓ • Pressure & speed ↓ • Plants & photosynthesis ↓ • Assess / DIRT / RETEACH →
Year 9	• Applied science skills ↓ • Energy ↓ • Atomic structure & Periodic Table ↓ • Cells ↓ • Assess / DIRT / RETEACH	• Cells (continued) ↓ • Atomic structure & radiation ↓ • Energy changes / formula / equations ↓ • Transport in cells (10)	• Energy changes (continued) ↓ • Transport in cells ↓ • Assess / DIRT / RETEACH ↓ • Applied science skills 2 (6)

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Year 10	• **Biology** – Organisation → Infection & Response → Bioenergetics → Review of Cells → Homeostasis • **Chemistry** – Review of atomic structure → Structure & bonding → Quantitative chemistry → Chemical changes → Energy changes review → Rates of reaction • **Physics** – Electricity → Particle model of matter → Review of atomic structure & radiation → Forces (part 1) • Required practical revision if needed
Year 11	• **Biology** – Homeostasis review → Inheritance → Ecology → Review → **Exams** • **Chemistry** – Rates review + equilibria → Organic → Chemical analysis → Earth's atmosphere → Using resources → Review → **Exams** • **Physics** – Forces → Waves → Electromagnetism → Static electricity → Space (single only) → Review → **Exams**
Year 12	**Biology** • Biological molecules → Cells → Organisms exchange substances with their environment → Genetic information, variation and relationships between organisms → Energy transfers in and between organisms (photosynthesis only) **Chemistry** • **Physical** – Atomic structure → Amount of substance → Bonding → Energetics → Kinetics → Equilibria → Redox → Kinetics → Equilibria • **Inorganic** – Periodicity → Group 2 → Group 7 • **Organic** – Nomenclature → Isomerism → Alkanes → Halogenoalkanes → Alkenes → Alcohols → Organic analysis **Physics** • Measurements and their errors → Particles and radiation → Mechanics and materials • Waves → Electricity
Year 13	**Biology** • Energy transfers in and between organisms (respiration only and energy in ecosystems only) → Organisms respond to changes in their internal and external environment→ Genetics, populations, evolution and ecosystems → The control of gene expression → Essay writing → **Revision & Exams**

	<u>Chemistry</u> • **Physical** – Thermodynamics → Rate equations → Equilibrium constants → Electrode potentials → Acids & Bases → **Revision & Exams** • **Inorganic** – Properties of period 3 → Transition metals → Reaction of ions in aqueous solution → **Revision & Exams** • **Organic** – Optical isomerism → Aldehydes & ketones → Acids & their derivatives → Aromatic chemistry → Amines → Polymers → Amino acids, proteins & DNA → Organic synthesis → Nuclear magnetic resonance → Chromatography → **Revision & Exams** **<u>Physics</u>** • Further mechanics → Thermal physics → Nuclear physics → **Revision & Exams** • Fields and their consequences → Medical physics → **Revision & Exams**

Physics Curriculum Implementation Plan

Physics			
	Term 1	Term 2	Term 3
Year 7	• Lab Safety • Forces 1 – Speed & Gravity	• Energy 1 – Energy Costs & Transfer	• Earth 1 – Earth Structure & Universe
Year 8	• Electricity & Magnetism	• Light & Sound	• Pressure & Speed
Year 9	• Applied science skills 1 • Energy	• Atomic structure & radiation • Applied science skills 2	
Year 10	• Electricity	• Particle Model of Matter • Waves	• Forces
Year 11	• Forces • Electromagnetism • Static electricity (single only) • Space (single only)	• Electromagnetism • Space (single science only) • Revision and exam preparation after half term	• Revision and exam preparation
Year 12	• Measurements and their errors • Particles and radiation • Waves	• Electricity • Mechanics and materials	
Year 13	• Further mechanics • Thermal physics • Nuclear physics	• Fields and their consequences • Medical physics	

Physics Curriculum Implementation Plan

Physics				
Knowledge and Skills – Students will be taught to…	Reading, Oracy, Literacy and Numeracy	Formative Assessment	Summative Assessment	Link to GCSE Content
Throughout their Physics journey students will learn to analyse patterns, draw conclusions, present data, read, understand and respond to information, justify opinions, collect data, plan variables, test hypotheses, estimate and minimise risks, examine consequences, review theories and interrogate sources of information. **Intro into Science** • Lab safety & hazards • The scientific method **Forces 1 – Speed & Gravity** ○ how to calculate speed from data collected about distance and time taken ○ How to use the formula speed = distance / time ○ How to define and calculate the AVERAGE SPEED for a journey and be able to state reasons why speeds may vary in a journey e.g. traffic lights ○ What a Distance-Time graph is and be able to draw for a journey ○ How to describe the motion of an object relative to the shape of the Distance-Time graph e.g. horizontal line = stationary ○ That the direction of a force can be displayed by a free body diagram. This is drawn to scale ○ Resultant forces are the overall force (a single force) once all forces (size and direction) are considered ○ What acceleration means	**Reading:** • Regular use of on screen sources and science news articles in lessons. • Research and online reading • Science revision guides **Recommended reading:** Frozen Planet – Alistair Fothergill Horrible Science (collection of books) – Nick Arnold Longitude – Dava Sobel Nightwatch – Terence Dickinson Planet Earth – Alistair Fothergill The Planets – Dava Sobel Science: The Definitive Visual Guide – Adam Hart Davis (Dorling Kingsley) Wonders of the Universe - Brian Cox WOW: The Visual Encyclopaedia – Dorling Kingsley	Questioning in lessons Whole class feedback during lessons Regular verbal feedback Peer and self-assessment of written work Low stakes quizzing Exit strategies	4 end of unit assessments based on all previous work which continues to build on ideas from previous topics completed in the academic year to inform reports. At the end of each year students will sit an end of year exam covering all the key ideas from the current year and some topics from previous years.	Most of the topics in year 7&8 are designed to maintain student's natural curiosity, develop practical skills and also to provide solid foundations of the concepts they will meet at GCSE In year 9 students revisit and build upon some of the key ideas in science (e.g. cells, particles and energy) to provide a solid foundation for the concepts they will meet in year 10 & 11 (e.g. cells, particles, chemical reactions, energy & forces). All set questions are GCSE style. Range of language based skills to prepare for GCSE.

○ How acceleration can be shown on a Distance-Time graph and velocity – time graph ○ That resultant forces (non-zero) will lead to a change in speed of an object. ○ How to describe the motion of two moving objects in the same direction – RELATIVE MOTION ○ That forces can be a pulling force, pushing force or turning force **P2 – Energy Costs & Transfer** • Energy resources can be defined as, and grouped into renewable and non-renewable • Non-renewable resources are a resource that can't be replaced and can be used up • Renewable can be replaced and won't run out • Solar, wind, waves, geothermal and biomass are examples of renewable energy resources • Fossil fuels (coal, oil and gas) are non-renewable energy sources • We use these energy sources to generate electricity • The advantages and disadvantages of each energy source in generating electricity • We pay for our electricity based on the amount of energy transferred • The cost of household electricity is calculated using the formula, cost = power (kW) x time (hours) x price (per kWh) • That energy is needed to allow things to happen in the world around us • Energy is measured in Joules (J), with kilojoules using the pre-fix kilo means '1000'	Oxygen – Nick Lane **Numeracy:** • Standard form (not in yr7&8) this is introduced in year 9 to set a basis for GCSE ideas they meet in yr 10 & 11. • Graphing & scales • Averages • The idea of uncertainties is met in year that build on the ideas of averages met in Yr 7 & KS2 • Formula & balancing equations • Using and rearranging equations is briefly met in yr 8 and built upon in the following years **Literacy & Oracy:** • Encourage group discussion and debate. • Communicate ideas clearly & effectively. • Make sure spelling and punctuation is accurate.			

• That energy cannot be created or destroyed, only transferred from one store to another. Total energy is conserved • Energy can be stored in a range of different energy stores • *Chemical, Kinetic, Thermal, Elastic Potential, Gravitational Potential,* • Energy can be transferred in 4 different ways - *Mechanical work (force), Heating, Radiation (In the form of light waves and sound waves), Electrical work* • How to represent energy transfers of simple devices through an energy transfer diagram or use/ interpret a Sankey diagram • That energy can be wasted, and wasted energy is dissipated into a 'spread out' / non-usable form • That energy transfers are designed to reduce energy waste (increase efficiency) and provide examples (e.g. friction) • How to provide solutions to prevent energy loss (e.g. insulation) • That energy from food (chemical store) is displayed on food labels. It is given in kilojoules (kJ) and calories **P3 – Earth Structure & Universe** • Seasons, day & night • Phases of the moon • Planets • Solar System and ET • Our place in the Universe • Crater investigation				

P4 – Electricity & Magnetism • Circuit symbols • Electrical current • Voltage / potential difference • Series & parallel circuits • Earth's magnetic field • Electromagnets **P5 – Light & Sound** • Light sources • Reflection • Refraction • Dispersion • Colour • How Sounds travel and making sounds • Sound Waves • How we hear • Echoes **P6 - Forces, Pressure & Moments** • Types of force • Balanced and unbalanced forces • Pressure and moments **Applied Science Skills 1** • Averages • Writing methods • Graph skills • Data analysis • Conclusions & evaluations				

Particle Model of Matter • Particle model • Density • Change of state • Internal energy • Specific heat capacity & latent heat **Applied Science Skills 2** • Averages • Writing methods • Graph skills • Data analysis • Conclusions & evaluations **Atomic Structure** • Models of the atoms (plum pudding & nuclear model) • Isotopes • Radioactive decay • Types of radiations and their dangers • Half life **Energy** • Energy stores & Systems • **Electricity** • Circuit symbols • Current & voltage • The **Forces**				

• Scalar & vector quantities • S **Waves** • Transverse & longitudinal waves • A **Magnetism & Electromagnetism** • Magnetic fields & magnetic poles • The motor effect • **Space Physics (single physics only)** • Our solar system • Life cycle of a star				

Key Stage 5

Physics				
Knowledge and Skills – Students will be taught to…	Reading, Oracy, Literacy and Numeracy	Formative Assessment	Summative Assessment	Link to GCSE Content
Module 3.1 - Measurements and their errors Content in this section is a continuing study for a student of physics. A working knowledge of the specified fundamental (base) units of measurement is vital. Likewise, practical work	Students should be able to identify random and systematic errors and suggest ways to reduce or remove them. Students should understand the link between the number	Questioning in lessons Whole class feedback during lessons	This module is embedded in all modules of work so is not explicitly assessed in a summative way.	The content here is grounded in mathematical skills developed at GCSE, both in maths and science.

in the subject needs to be underpinned by an awareness of the nature of measurement errors and of their numerical treatment. The ability to carry through reasonable estimations is a skill that is required throughout the course and beyond.	of significant figures in the value of a quantity and its associated uncertainty. Students should be able to combine uncertainties in cases where the measurements that give rise to the uncertainties are added, subtracted, multiplied, divided, or raised to powers. Students should be able to estimate approximate values of physical quantities to the nearest order of magnitude. Students should be able to use these estimates together with their knowledge of physics to produce further derived estimates also to the nearest order of magnitude	Regular verbal feedback Peer and self-assessment of written work HWk Additional support activities to address individual areas of weakness.	At the end of each module and at the key assessment points in the year, students will sit an end of year exam covering all the key ideas from the current year and some topics from previous years. Module one is a key component of these assessments.	There is nothing students can't and haven't done before mathematically, however they may never have applied those skills in such as way e.e % and absolute uncertainties. Constant reminders and reinforcement is the key to progress.

Physics				
Knowledge and Skills – Students will be taught to…	Reading, Oracy, Literacy and Numeracy	Formative Assessment	Summative Assessment	Link to GCSE Content
Module 3.2 – Particles and radiation This section introduces students both to the fundamental properties of matter, and to electromagnetic radiation and quantum phenomena. Teachers may wish to begin with this topic to provide a new interest and knowledge dimension beyond GCSE. Through a study of these topics, students become aware of the way ideas develop and evolve in physics. They will appreciate the importance of international collaboration in the development of new experiments and theories in this area of fundamental research.	Students will use a range of mathematical skills as set out in appendix 1. In particular, module two provides specific opportunity for reinforcement of: Use of prefixes for small and large distance measurements. Use prefixes when expressing wavelength values. Conversion of prefixes in to standard form.	Questioning in lessons Whole class feedback during lessons Regular verbal feedback Peer and self-assessment of written work HWk Additional support activities to address individual areas of weakness.	At the end of each module and at the key assessment points in the year, students will sit an end of year exam covering all the key ideas from the current year and some topics from previous years. Module one is a key component of these assessments.	Simple 'Bohr model' of an atom in terms of protons, neutrons, electrons, and the relative masses of these particles. The idea of ions and isotopes. 'Atomic number' is used at GCSE and 'proton number, Z' is used at A-level. 'Mass number' is referred to in GCSE and 'nucleon number' in A-level. Evidence for the nucleus (Rutherford) and specific charge of nuclei, ions and protons/electrons and the concept of a nuclide with symbolic representation. A general appreciation of radioactive substances, the three types of radiation and their properties, safety, hazards, background and half life is assumed at A-level. Nuclear equation for α–decay is required. the equation for β–decay (now

				including the neutrino) is also required. Mathematical definition of half-life and manipulation of exponential decay equations are all required at A-level, along with knowledge of natural logs (may not have done this in maths at the point of teaching) Knowledge of the fissile substances used in thermal reactors and that the process involves the nucleus and neutrons as is the fact that fusion involves nuclei 'joining' at high temperatures.

Physics				
Knowledge and Skills – Students will be taught to…	Reading, Oracy, Literacy and Numeracy	Formative Assessment	Summative Assessment	Link to GCSE Content
Module 3.3 – Waves GCSE studies of wave phenomena are extended through a development of knowledge of the characteristics, properties, and applications of travelling waves and stationary waves. Topics treated include refraction, diffraction, superposition and interference	General mathematical skills as set out in Appendix 1. In particular, using the gradient of a graph to determine a value of a constant in the general form of y-mx + c.	Questioning in lessons Whole class feedback during lessons Regular verbal feedback Peer and self-assessment of written work HWk Additional support activities to address individual areas of weakness.	Mini-assessments at key learning points within the module. At the end of each module and at the key assessment points in the year, students will sit an end of year exam covering all the key ideas from the current year and some topics from previous years. Module one is a key component of these assessments.	From GCSE: Longitudinal and transverse waves, their nature and properties, including speed of electromagnetic waves in a vacuum. The wave equations $v = f\lambda$. Refraction of waves at an interface and diffraction, refractive index/Snell's law and total internal reflection (critical angle) Single slit diffraction, Longitudinal nature of sound waves and the requirement of a medium. .

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Physics				
Knowledge and Skills – Students will be taught to…	Reading, Oracy, Literacy and Numeracy	Formative Assessment	Summative Assessment	Link to GCSE Content
Module 3.4 – Mechanics and materials Vectors and their treatment are introduced followed by development of the student's knowledge and understanding of forces, energy and momentum. The section continues with a study of materials considered in terms of their bulk properties and tensile strength. As with earlier topics, this section and also the following section Electricity would provide a good starting point for students who prefer to begin by consolidating work	General mathematical skills as set out in Appendix 1. In particular, use of trigonometry and Pythagoras theorem in vector work, scale drawing and measurement with vectors, svt graphs and their interpretation as a way of representing motion, calculating gradients from a graph to determine a constant and application of knowledge to problem solving situations.	Questioning in lessons Whole class feedback during lessons Regular verbal feedback Peer and self-assessment of written work HWk Additional support activities to address individual areas of weakness.	Mini-assessments at key learning points within the module. At the end of each module and at the key assessment points in the year, students will sit an end of year exam covering all the key ideas from the current year and some topics from previous years. Module one is a key component of these assessments.	From GCSE: The outcome of resultant forces through vector addition and the concept of equilibrium (resultant force=zero) for parallel forces, including acceleration in the direction of the resultant force. *F = ma*, Newton's three laws are required. Motion in a straight line and definitions of velocity and acceleration, including graphical representation for uniform straight line motion to determine acceleration and distance travelled. One *suvat* equation was met. Idea of equilibrium (balanced forces: *mg* and resistive forces). Knowledge of why there is a terminal speed(velocity). Interpretation of υ-t graphs for objects falling under gravity with drag forces present is also included. Definition of a moment and the principle of moments, including the idea of equilibrium/stability.

				Understanding of Hooke's law and expressions in terms of a spring constant, k (or stiffness at A-level). Mathematical expressions of force and extension: F=ke (GCSE) and F=kΔL (A-level) including elastic, strain and potential energy stored are also included The terms work, energy and power (including the Joule and *kW*) as well as the conservation of energy including the equation for work done. Definition of power in terms of energy/work transformed per second and the equations for *PE* and *KE*. Momentum and conservation of momentum, including the concept of a 'closed system', for collisions and explosions.

Physics				
Knowledge and Skills – Students will be taught to…	Reading, Oracy, Literacy and Numeracy	Formative Assessment	Summative Assessment	Link to GCSE Content
Module 3.5 – Electricity This section builds on and develops earlier study of these phenomena from GCSE. It provides opportunities for the development of practical skills at an early stage in the course and lays the groundwork for later study of the many electrical applications that are important to society.	General mathematical skills as set out in Appendix 1. In particular, calculating gradients from a graph to determine a constant and application of knowledge to problem solving situations.	Questioning in lessons Whole class feedback during lessons Regular verbal feedback Peer and self-assessment of written work HWk Additional support activities to address individual areas of weakness.	Mini-assessments at key learning points within the module. At the end of each module and at the key assessment points in the year, students will sit an end of year exam covering all the key ideas from the current year and some topics from previous years. Module one is a key component of these assessments.	Circuit symbols; the terms, I, Q, V; and the definitions of current, voltage (PD), and work done in a circuit. The concept of resistance ($R=VI$), and I-V characteristics for ohmic and non-ohmic components, and series/parallel circuits is common to both.

Physics				
Knowledge and Skills – Students will be taught to…	Reading, Oracy, Literacy and Numeracy	Formative Assessment	Summative Assessment	Link to GCSE Content
Module 3.6 – Further mechanics and thermal physics The earlier study of mechanics is further advanced through a consideration of circular motion and simple harmonic motion (the harmonic oscillator). A further section allows the thermal properties of materials, the properties and nature of ideal gases, and the molecular kinetic theory to be studied in depth.	General mathematical skills as set out in Appendix 1. In particular, calculating gradients and using intercepts from a y=mx+c graph to determine a constant and application of knowledge to problem solving situations. Graphs and their interpretation as a way of representing circular motion.	Questioning in lessons Whole class feedback during lessons Regular verbal feedback Peer and self-assessment of written work HWk Additional support activities to address individual areas of weakness.	Mini-assessments at key learning points within the module. At the end of each module and at the key assessment points in the year, students will sit an end of year exam covering all the key ideas from the current year and some topics from previous years. Module one is a key component of these assessments.	From GCSE: Above and beyond references cited in Module 4, knowledge of centripetal forces, their origins and how these forces depend on mass, speed and radius. The definition of centre of mass and stability in general is assumed as are the general properties of a simple pendulum. Basic model of constantly moving atoms, molecules and particles, as well as the different energy states of solid, liquid and gases. $Q = mc\Delta T$ Definition of SHC and measurement as well as ideas about cooling by evaporation. Latent heating and cooling curve graphs.

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Physics				
Knowledge and Skills – Students will be taught to…	Reading, Oracy, Literacy and Numeracy	Formative Assessment	Summative Assessment	Link to GCSE Content
Module 3.7 - Fields and their consequences The concept of field is one of the great unifying ideas in physics. The ideas of gravitation, electrostatics and magnetic field theory are developed within the topic to emphasise this unification. Many ideas from mechanics and electricity from earlier in the course support this and are further developed. Practical applications considered include: planetary and satellite orbits, capacitance and capacitors, their charge and discharge through resistors, and electromagnetic induction. These topics have considerable impact on modern society.	General mathematical skills as set out in Appendix 1. In particular, calculating gradients and using intercepts from a y=mx+c graph to determine a constant and application of knowledge to problem solving situations. Graphs and their interpretation as a way of representing fields. Application of knowledge to problem solving situations. Use of log plots.	Questioning in lessons Whole class feedback during lessons Regular verbal feedback Peer and self-assessment of written work HWk Additional support activities to address individual areas of weakness.	Mini-assessments at key learning points within the module. At the end of each module and at the key assessment points in the year, students will sit an end of year exam covering all the key ideas from the current year and some topics from previous years. Module one is a key component of these assessments.	From GCSE: Magnetic field around bar magnet and solenoid. Motor effect. FLH rule. Generation of electricity. AC/DC. National grid. Transformers and transformer equation.

Physics				
Knowledge and Skills – Students will be taught to…	Reading, Oracy, Literacy and Numeracy	Formative Assessment	Summative Assessment	Link to GCSE Content
Module 3.8 – Further mechanics and thermal physics This section builds on the work of Particles and radiation to link the properties of the nucleus to the production of nuclear power through the characteristics of the nucleus, the properties of unstable nuclei, and the link between energy and mass. Students should become aware of the physics that underpins nuclear energy production and also of the impact that it can have on society.	General mathematical skills as set out in Appendix 1. In particular, using graphs to determine a constant and application of knowledge to problem solving situations. Log and esp' natural log functions.	Questioning in lessons Whole class feedback during lessons Regular verbal feedback Peer and self-assessment of written work HWk Additional support activities to address individual areas of weakness.	Mini-assessments at key learning points within the module. At the end of each module and at the key assessment points in the year, students will sit an end of year exam covering all the key ideas from the current year and some topics from previous years. Module one is a key component of these assessments.	From GCSE: See module 3.2

Physics				
Knowledge and Skills – Students will be taught to…	Reading, Oracy, Literacy and Numeracy	Formative Assessment	Summative Assessment	Link to GCSE Content
Module 3.8 – Option topic Tbc when chosen.	General mathematical skills as set out in Appendix 1. In particular, using graphs to determine a constant and application of knowledge to problem solving situations. Log and esp' natural log functions.	Questioning in lessons Whole class feedback during lessons Regular verbal feedback Peer and self-assessment of written work HWk Additional support activities to address individual areas of weakness.	Mini-assessments at key learning points within the module. At the end of each module and at the key assessment points in the year, students will sit an end of year exam covering all the key ideas from the current year and some topics from previous years. Module one is a key component of these assessments.	From GCSE:

Appendix 1.

Mathematical requirements and exemplifications

6.1 Arithmetic and numerical computation

	Mathematical skills	Exemplification of mathematical skill in the context of A-level Physics
MS 0.1	Recognise and make use of appropriate units in calculations	Students may be tested on their ability to: • identify the correct units for physical properties such as $m\ s^{-1}$, the unit for velocity • convert between units with different prefixes eg cm^3 to m^3
MS 0.2	Recognise and use expressions in decimal and standard form	Students may be tested on their ability to: • use physical constants expressed in standard form such as $c = 3.00 \times 10^8 m\ s^{-1}$
MS 0.3	Use ratios, fractions and percentages	Students may be tested on their ability to: • calculate efficiency of devices • calculate percentage uncertainties in measurements
MS 0.4	Estimate results	Students may be tested on their ability to: • estimate the effect of changing experimental parameters on measurable values
MS 0.5	Use calculators to find and use power, **exponential and logarithmic functions**	Students may be tested on their ability to: • **solve for unknowns in decay problems such as** $N = N_0 e^{-\lambda t}$
MS 0.6	Use calculators to handle sin x, cos x, tan x when x is expressed in degrees or radians	Students may be tested on their ability to: • calculate the direction of resultant vectors

6.2 Handling data

	Mathematical skills	Exemplification of mathematical skill in the context of A-level Physics
MS 1.1	Use an appropriate number of significant figures	Students may be tested on their ability to: • report calculations to an appropriate number of significant figures given raw data quoted to varying numbers of significant figures • understand that calculated results can only be reported to the limits of the least accurate measurement
MS 1.2	Find arithmetic means	Students may be tested on their ability to: • calculate a mean value for repeated experimental readings
MS 1.3	Understand simple probability	Students may be tested on their ability to: • understand probability in the context of radioactive decay
MS 1.4	Make order of magnitude calculations	Students may be tested on their ability to: • evaluate equations with variables expressed in different orders of magnitude
MS 1.5	Identify uncertainties in measurements and use simple techniques to determine uncertainty when data are combined by addition, subtraction, multiplication, division and raising to powers	Students may be tested on their ability to: • determine the uncertainty where two readings for length need to be added together

6.3 Algebra

	Mathematical skills	Exemplification of mathematical skill in the context of A-level Physics
MS 2.1	Understand and use the symbols: =, <, <<, >>, >, ∝, ≈, Δ	Students may be tested on their ability to: • recognise the significance of the symbols in the expression $F \propto \frac{\Delta p}{\Delta t}$
MS 2.2	Change the subject of an equation, including non-linear equations	Students may be tested on their ability to: • rearrange $E = mc^2$ to make m the subject
MS 2.3	Substitute numerical values into algebraic equations using appropriate units for physical quantities	Students may be tested on their ability to: • calculate the momentum p of an object by substituting the values for mass m and velocity v into the equation $p = mv$
MS 2.4	Solve algebraic equations, including quadratic equations	Students may be tested on their ability to: • solve kinematic equations for constant acceleration such as $v = u + at$ and $s = ut + \frac{1}{2}at^2$
MS 2.5	**Use logarithms in relation to quantities that range over several orders of magnitude**	Students may be tested on their ability to: • **recognise and interpret real world examples of logarithmic scales**

6.4 Graphs

	Mathematical skills	Exemplification of mathematical skill in the context of A-level Physics
MS 3.1	Translate information between graphical, numerical and algebraic forms	Students may be tested on their ability to: • calculate Young modulus for materials using stress–strain graphs
MS 3.2	Plot two variables from experimental or other data	Students may be tested on their ability to: • plot graphs of extension of a wire against force applied
MS 3.3	Understand that $y = mx + c$ represents a linear relationship	Students may be tested on their ability to: • rearrange and compare $v = u + at$ with $y = mx + c$ for velocity–time graph in constant acceleration problems
MS 3.4	Determine the slope and intercept of a linear graph	Students may be tested on their ability to: • read off and interpret intercept point from a graph eg the initial velocity in a velocity–time graph
MS 3.5	Calculate rate of change from a graph showing a linear relationship	Students may be tested on their ability to: • calculate acceleration from a linear velocity–time graph
MS 3.6	Draw and use the slope of a tangent to a curve as a measure of rate of change	Students may be tested on their ability to: • draw a tangent to the curve of a displacement–time graph and use the gradient to approximate the velocity at a specific time
MS 3.7	Distinguish between instantaneous rate of change and average rate of change	Students may be tested on their ability to: • understand that the gradient of the tangent of a displacement–time graph gives the velocity at a point in time which is a different measure to the average velocity
MS 3.8	Understand the possible physical significance of the area between a curve and the x axis and be able to calculate it or estimate it by graphical methods as appropriate	Students may be tested on their ability to: • recognise that for a capacitor the area under a voltage–charge graph is equivalent to the energy stored
MS 3.9	Apply the concepts underlying calculus (but without requiring the explicit use of derivatives or integrals) by solving equations involving rates of change, eg $\frac{\Delta x}{\Delta t} = -\lambda x$ using a graphical method or spreadsheet modelling	Students may be tested on their ability to: • determine g from distance-time plot for projectile motion
MS 3.10	Interpret logarithmic plots	Students may be tested on their ability to: • **obtain time constant for capacitor discharge by interpreting plot of log *V* against time**

	Mathematical skills	Exemplification of mathematical skill in the context of A-level Physics
MS 3.11	**Use logarithmic plots to test exponential and power law variations**	Students may be tested on their ability to: • **use logarithmic plots with decay law of radioactivity / charging and discharging of a capacitor**
MS 3.12	Sketch relationships which are modelled by $y = k/x$, $y = kx^2$, $y = k/x^2$, $y = kx$, $y = \sin x$, $y = \cos x$, **$y = e^{\pm x}$, and $y = \sin^2 x$, $y = \cos^2 x$ as applied to physical relationships**	Students may be tested on their ability to: • **sketch relationships between pressure and volume for an ideal gas**

6.5 Geometry and trigonometry

	Mathematical skills	Exemplification of mathematical skill in the context of A-level Physics
MS 4.1	Use angles in regular 2D and 3D structures	Students may be tested on their ability to: • interpret force diagrams to solve problems
MS 4.2	Visualise and represent 2D and 3D forms including two-dimensional representations of 3D objects	Students may be tested on their ability to: • draw force diagrams to solve mechanics problems
MS 4.3	Calculate areas of triangles, circumferences and areas of circles, surface areas and volumes of rectangular blocks, cylinders and spheres	Students may be tested on their ability to: • calculate the area of the cross–section to work out the resistance of a conductor given its length and resistivity
MS 4.4	Use Pythagoras' theorem, and the angle sum of a triangle	Students may be tested on their ability to: • calculate the magnitude of a resultant vector, resolving forces into components to solve problems
MS 4.5	Use sin, cos and tan in physical problems	Students may be tested on their ability to: • resolve forces into components
MS 4.6	Use of small angle approximations including $\sin\theta \approx \theta$, $\tan\theta \approx \theta$, $\cos\theta \approx 1$ for small θ where appropriate	Students may be tested on their ability to: • calculate fringe separations in interference patterns
MS 4.7	Understand the relationship between degrees and radians and translate from one to the other	Students may be tested on their ability to: • convert angle in degrees to angle in radians