English

Reading

 read and appreciate the depth and power of the English literary heritage through:
 reading a wide range of high-quality, challenging, classic literature and extended literary non-fiction, such as essays, reviews and journalism. This writing should include whole texts. The range will include:
 at least one play by Shakespeare
 works from the 19th, 20th and 21st centuries
 poetry since 1789, including representative Romantic poetry
 re-reading literature and other writing as a basis for making comparisons
 choosing and reading books independently for challenge, interest and enjoyment.
 understand and critically evaluate texts through:
 reading in different ways for different purposes, summarising and synthesising ideas and information, and evaluating their usefulness for particular purposes
 drawing on knowledge of the purpose, audience for and context of the writing, including its social, historical and cultural context and the literary tradition to which it belongs, to inform evaluation
 identifying and interpreting themes, ideas and information
 exploring aspects of plot, characterisation, events and settings, the relationships between them and their effects
 seeking evidence in the text to support a point of view, including justifying inferences with evidence
 distinguishing between statements that are supported by evidence and those that are not, and identifying bias and misuse of evidence
 analysing a writer's choice of vocabulary, form, grammatical and structural features, and evaluating their effectiveness and impact
 making critical comparisons, referring to the contexts, themes, characterisation, style and literary quality of texts, and drawing on knowledge and skills from wider reading
 make an informed personal response, recognising that other responses to a text are possible and evaluating these.

Writing

 write accurately, fluently, effectively and at length for pleasure and information through:
 adapting their writing for a wide range of purposes and audiences: to describe, narrate, explain, instruct, give and respond to information, and argue
 selecting and organising ideas, facts and key points, and citing evidence, details and quotation effectively and pertinently for support and emphasis
 selecting, and using judiciously, vocabulary, grammar, form, and structural and organisational features, including rhetorical devices, to reflect audience, purpose and context, and using Standard English where appropriate
 make notes, draft and write, including using information provided by others [e.g. writing a letter from key points provided; drawing on and using information from a presentation]
 revise, edit and proof-read through:
 reflecting on whether their draft achieves the intended impact
 restructuring their writing, and amending its grammar and vocabulary to improve coherence, consistency, clarity and overall effectiveness
 paying attention to the accuracy and effectiveness of grammar, punctuation and spelling.1

Grammar and vocabulary
 consolidate and build on their knowledge of grammar and vocabulary through:
 studying their effectiveness and impact in the texts they read
 drawing on new vocabulary and grammatical constructions from their reading and listening, and using these consciously in their writing and speech to achieve particular effects
 analysing some of the differences between spoken and written language, including differences associated with formal and informal registers, and between Standard English and other varieties of English
 using linguistic and literary terminology accurately and confidently in discussing reading, writing and spoken language.

Spoken English
 speak confidently, audibly and effectively, including through:
 using Standard English when the context and audience require it
 working effectively in groups of different sizes and taking on required roles, including leading and managing discussions, involving others productively, reviewing and summarising, and contributing to meeting goals/deadlines
 listening to and building on the contributions of others, asking questions to clarify and inform, and challenging courteously when necessary
 planning for different purposes and audiences, including selecting and organising information and ideas effectively and persuasively for formal spoken presentations and debates
 listening and responding in a variety of different contexts, both formal and informal, and evaluating content, viewpoints, evidence and aspects of presentation
 improvising, rehearsing and performing play scripts and poetry in order to generate language and discuss language use and meaning, using role, intonation, tone, volume, mood, silence, stillness and action to add impact.

Mathematics

Working mathematically
Develop fluency
 consolidate their numerical and mathematical capability from key stage 3 and extend their understanding of the number system to include powers, roots {and fractional indices}
 select and use appropriate calculation strategies to solve increasingly complex problems, including exact calculations involving multiples of π {and surds}, use of standard form and application and interpretation of limits of accuracy
 consolidate their algebraic capability from key stage 3 and extend their understanding of algebraic simplification and manipulation to include quadratic expressions, {and expressions involving surds and algebraic fractions}
 extend fluency with expressions and equations from key stage 3, to include quadratic equations, simultaneous equations and inequalities
 move freely between different numerical, algebraic, graphical and diagrammatic representations, including of linear, quadratic, reciprocal, {exponential and trigonometric} functions
 use mathematical language and properties precisely.
Reason mathematically
 extend and formalise their knowledge of ratio and proportion, including trigonometric ratios, in working with measures and geometry, and in working with proportional relations algebraically and graphically

 extend their ability to identify variables and express relations between variables algebraically and graphically
 make and test conjectures about the generalisations that underlie patterns and relationships; look for proofs or counter-examples; begin to use algebra to support and construct arguments {and proofs}
 reason deductively in geometry, number and algebra, including using geometrical constructions
 interpret when the structure of a numerical problem requires additive, multiplicative or proportional reasoning
 explore what can and cannot be inferred in statistical and probabilistic settings, and express their arguments formally
 assess the validity of an argument and the accuracy of a given way of presenting information.

Solve problems
 develop their mathematical knowledge, in part through solving problems and evaluating the outcomes, including multi-step problems
 develop their use of formal mathematical knowledge to interpret and solve problems, including in financial contexts
 make and use connections between different parts of mathematics to solve problems
 model situations mathematically and express the results using a range of formal mathematical representations, reflecting on how their solutions may have been affected by any modelling assumptions
 select appropriate concepts, methods and techniques to apply to unfamiliar and non -routine problems; interpret their solution in the context of the given problem.

Number
In addition to consolidating subject content from key stage 3, pupils should be taught to:
 apply systematic listing strategies, {including use of the product rule for counting}
 {estimate powers and roots of any given positive number}
 calculate with roots, and with integer {and fractional} indices
 calculate exactly with fractions, {surds} and multiples of π; {simplify surd expressions involving squares [for example 12 4 3 4 3 2 3 = × = × =
×
] and rationalise denominators}
 calculate with numbers in standard form A 10n, where $1 \leq A < 10$ and n is an integer
 {change recurring decimals into their corresponding fractions and vice versa}
 identify and work with fractions in ratio problems
 apply and interpret limits of accuracy when rounding or truncating, {including upper and lower bounds}.

Algebra
In addition to consolidating subject content from key stage 3, pupils should be taught to:
• simplify and manipulate algebraic expressions (including those involving surds {and algebraic fractions}) by:
 factorising quadratic expressions of the form $x2 + bx + c$
$ax2 + bx + c$
, including the difference of two squares; {factorising quadratic expressions of the form }
 simplifying expressions involving sums, products and powers, including the laws of indices

 know the difference between an equation and an identity; argue mathematically to show algebraic expressions are equivalent, and use algebra to support and construct arguments {and proofs}
 where appropriate, interpret simple expressions as functions with inputs and outputs; {interpret the reverse process as the 'inverse function'; interpret the succession of two functions as a 'composite function'}
 use the form
=+ymxc to identify parallel {and perpendicular} lines; find the equation of the line through two given points, or through one point with a given gradient
 identify and interpret roots, intercepts and turning points of quadratic functions graphically; deduce roots algebraically {and turning points by completing the square}
 recognise, sketch and interpret graphs of linear functions, quadratic functions, simple cubic functions, the reciprocal function y = 1
x
y = cos x
with x ≠ 0, {the exponential function
y = kx
y = sin x
for positive values of k, and the trigonometric functions (with arguments in degrees) , and y = tan x for angles of any size}
 {sketch translations and reflections of the graph of a given function}
 plot and interpret graphs (including reciprocal graphs {and exponential graphs}) and graphs of non-standard functions in real contexts, to find approximate solutions to problems such as simple kinematic problems involving distance, speed and acceleration
 {calculate or estimate gradients of graphs and areas under graphs (including quadratic and other non-linear graphs), and interpret results in cases such as distance-time graphs, velocity-time graphs and graphs in financial contexts}
 {recognise and use the equation of a circle with centre at the origin; find the equation of a tangent to a circle at a given point}
 solve quadratic equations {including those that require rearrangement} algebraically by factorising, {by completing the square and by using the quadratic formula}; find approximate solutions using a graph
 solve two simultaneous equations in two variables (linear/linear {or linear/quadratic}) algebraically; find approximate solutions using a graph
 {find approximate solutions to equations numerically using iteration}
 translate simple situations or procedures into algebraic expressions or formulae; derive an equation (or two simultaneous equations), solve the equation(s) and interpret the solution
 solve linear inequalities in one {or two} variable{s}, {and quadratic inequalities in one variable}; represent the solution set on a number line, {using set notation and on a graph}
 recognise and use sequences of triangular, square and cube numbers, simple arithmetic progressions, Fibonacci type sequences, quadratic sequences, and simple geometric progressions (r n where n is an integer, and r is a positive rational number {or a surd}) {and other sequences}
 deduce expressions to calculate the nth term of linear {and quadratic} sequences.

Ratio, proportion and rates of change
In addition to consolidating subject content from key stage 3, pupils should be taught to:
 compare lengths, areas and volumes using ratio notation and/or scale factors; make links to similarity (including trigonometric ratios)

 convert between related compound units (speed, rates of pay, prices, density, pressure) in numerical and algebraic contexts
 understand that X is inversely proportional to Y is equivalent to X is proportional to 1 Y
; {construct and} interpret equations that describe direct and inverse proportion
 interpret the gradient of a straight line graph as a rate of change; recognise and interpret graphs that illustrate direct and inverse proportion
 {interpret the gradient at a point on a curve as the instantaneous rate of change; apply the concepts of instantaneous and average rate of change (gradients of tangents and chords) in numerical, algebraic and graphical contexts}
 set up, solve and interpret the answers in growth and decay problems, including compound interest {and work with general iterative processes}.

Geometry and measures

In addition to consolidating subject content from key stage 3, pupils should be taught to:
 interpret and use fractional {and negative} scale factors for enlargements
 {describe the changes and invariance achieved by combinations of rotations, reflections and translations}
 identify and apply circle definitions and properties, including: centre, radius, chord, diameter, circumference, tangent, arc, sector and segment
 {apply and prove the standard circle theorems concerning angles, radii, tangents and chords, and use them to prove related results}
 construct and interpret plans and elevations of 3D shapes
 interpret and use bearings
 calculate arc lengths, angles and areas of sectors of circles
 calculate surface areas and volumes of spheres, pyramids, cones and composite solids
 apply the concepts of congruence and similarity, including the relationships between lengths, {areas and volumes} in similar figures
 apply Pythagoras' Theorem and trigonometric ratios to find angles and lengths in right-angled triangles {and, where possible, general triangles} in two {and three} dimensional figures
 know the exact values of sin cos θ θ and
θ = 00 , 300 , 450 and 600
sin sin sin
a b c
A B C
= =
for θ = 00 , 300 , 450, 600 and 900 ; know the exact value of tanθ
a2=b22+−c2bccosA
Area = 1 sin
2
ab C
for
 {know and apply the sine rule, , and cosine rule, , to find unknown lengths and angles}
 {know and apply to calculate the area, sides or angles of any triangle}
 describe translations as 2D vectors
 apply addition and subtraction of vectors, multiplication of vectors by a scalar, and diagrammatic and column representations of vectors; {use vectors to construct geometric arguments and proofs}.

Probability

In addition to consolidating subject content from key stage 3, pupils should be taught to:

 apply the property that the probabilities of an exhaustive set of mutually exclusive events sum to one

 use a probability model to predict the outcomes of future experiments; understand that empirical unbiased samples tend towards theoretical probability distributions, with increasing sample size

 calculate the probability of independent and dependent combined events, including using tree diagrams and other representations, and know the underlying assumptions

 {calculate and interpret conditional probabilities through representation using expected frequencies with two-way tables, tree diagrams and Venn diagrams}.

Statistics

In addition to consolidating subject content from key stage 3, pupils should be taught to:

 infer properties of populations or distributions from a sample, whilst knowing the limitations of sampling

 interpret and construct tables and line graphs for time series data

 {construct and interpret diagrams for grouped discrete data and continuous data, i.e. histograms with equal and unequal class intervals and cumulative frequency graphs, and know their appropriate use}

 interpret, analyse and compare the distributions of data sets from univariate empirical distributions through:

 appropriate graphical representation involving discrete, continuous and grouped data, {including box plots}

 appropriate measures of central tendency (including modal class) and spread {including quartiles and inter-quartile range}

 apply statistics to describe a population

 use and interpret scatter graphs of bivariate data; recognise correlation and know that it does not indicate causation; draw estimated lines of best fit; make predictions; interpolate and extrapolate apparent trends whilst knowing the dangers of so doing.

Science

Working scientifically

Through the content across all three disciplines, students should be taught so that they develop understanding and first-hand experience of:

1. The development of scientific thinking

• the ways in which scientific methods and theories develop over time

• using a variety of concepts and models to develop scientific explanations and understanding

• appreciating the power and limitations of science and considering ethical issues which may arise

• explaining everyday and technological applications of science; evaluating associated personal, social, economic and environmental implications; and making decisions based on the evaluation of evidence and arguments

• evaluating risks both in practical science and the wider societal context, including perception of risk

• recognising the importance of peer review of results and of communication of results to a range of audiences.

2. Experimental skills and strategies

• using scientific theories and explanations to develop hypotheses
• planning experiments to make observations, test hypotheses or explore phenomena
• applying a knowledge of a range of techniques, apparatus, and materials to select those appropriate both for fieldwork and for experiments
• carrying out experiments appropriately, having due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations
• recognising when to apply a knowledge of sampling techniques to ensure any samples collected are representative
• making and recording observations and measurements using a range of apparatus and methods
• evaluating methods and suggesting possible improvements and further investigations.

3. Analysis and evaluation

• applying the cycle of collecting, presenting and analysing data, including:
• presenting observations and other data using appropriate methods
• translating data from one form to another
• carrying out and representing mathematical and statistical analysis
• representing distributions of results and making estimations of uncertainty
• interpreting observations and other data, including identifying patterns and trends, making inferences and drawing conclusions
• presenting reasoned explanations, including relating data to hypotheses
• being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error
• communicating the scientific rationale for investigations, including the methods used, the findings and reasoned conclusions, using paper-based and electronic reports and presentations.

4. Vocabulary, units, symbols and nomenclature

• developing their use of scientific vocabulary and nomenclature
• recognising the importance of scientific quantities and understanding how they are determined
• using SI units and IUPAC chemical nomenclature unless inappropriate
• using prefixes and powers of ten for orders of magnitude (e.g. tera, giga, mega, kilo, centi, milli, micro and nano)
• interconverting units
• using an appropriate number of significant figures in calculations.

Subject content – Biology

Biology is the science of living organisms (including animals, plants, fungi and microorganisms) and their interactions with each other and the environment. The study of biology involves collecting and interpreting information about the natural world to identify patterns and relate possible cause and effect. Biology is used to help humans improve their own lives and to understand the world around them.

Students should be helped to understand how, through the ideas of biology, the complex and diverse phenomena of the natural world can be described in terms of a number of key ideas which are of universal application, and which can be illustrated in the separate topics set out below.

These ideas include:
• life processes depend on molecules whose structure is related to their function
• the fundamental units of living organisms are cells, which may be part of highly adapted structures including tissues, organs and organ systems, enabling life processes to be performed more effectively
• living organisms may form populations of single species, communities of many species and ecosystems, interacting with each other, with the environment and with humans in many different ways
• living organisms are interdependent and show adaptations to their environment
• life on Earth is dependent on photosynthesis in which green plants and algae trap light from the Sun to fix carbon dioxide and combine it with hydrogen from water to make organic compounds and oxygen
• organic compounds are used as fuels in cellular respiration to allow the other chemical reactions necessary for life
• the chemicals in ecosystems are continually cycling through the natural world
• the characteristics of a living organism are influenced by its genome and its interaction with the environment
• evolution occurs by the process of natural selection and accounts both for biodiversity and how organisms are all related to varying degrees.
Students should be taught about:

Cell biology
• cells as the basic structural unit of all organisms; adaptations of cells related to their functions; the main sub-cellular structures of eukaryotic and prokaryotic cells
• stem cells in animals and meristems in plants
• enzymes
• factors affecting the rate of enzymatic reactions
• the importance of cellular respiration; the processes of aerobic and anaerobic respiration
• carbohydrates, proteins, nucleic acids and lipids as key biological molecules.

Transport systems
• the need for transport systems in multicellular organisms, including plants
• the relationship between the structure and functions of the human circulatory system.
Health, disease and the development of medicines
• the relationship between health and disease
• communicable diseases including sexually transmitted infections in humans (including HIV/AIDs)
• non-communicable diseases
• bacteria, viruses and fungi as pathogens in animals and plants
• body defences against pathogens and the role of the immune system against disease
• reducing and preventing the spread of infectious diseases in animals and plants
• the process of discovery and development of new medicines
• the impact of lifestyle factors on the incidence of non-communicable diseases.

Coordination and control
• principles of nervous coordination and control in humans
• the relationship between the structure and function of the human nervous system
• the relationship between structure and function in a reflex arc
• principles of hormonal coordination and control in humans
• hormones in human reproduction, hormonal and non-hormonal methods of contraception

• homeostasis.

Photosynthesis
• photosynthesis as the key process for food production and therefore biomass for life
• the process of photosynthesis
• factors affecting the rate of photosynthesis.

Ecosystems
• levels of organisation within an ecosystem
• some abiotic and biotic factors which affect communities; the importance of interactions between organisms in a community
• how materials cycle through abiotic and biotic components of ecosystems
• the role of microorganisms (decomposers) in the cycling of materials through an ecosystem
• organisms are interdependent and are adapted to their environment
• the importance of biodiversity
• methods of identifying species and measuring distribution, frequency and abundance of species within a habitat
• positive and negative human interactions with ecosystems.

Evolution, inheritance and variation
• the genome as the entire genetic material of an organism
• how the genome, and its interaction with the environment, influence the development of the phenotype of an organism
• the potential impact of genomics on medicine
• most phenotypic features being the result of multiple, rather than single, genes
• single gene inheritance and single gene crosses with dominant and recessive phenotypes
• sex determination in humans
• genetic variation in populations of a species
• the process of natural selection leading to evolution
• the evidence for evolution
• developments in biology affecting classification
• the importance of selective breeding of plants and animals in agriculture
• the uses of modern biotechnology including gene technology; some of the practical and ethical considerations of modern biotechnology.

Subject content – Chemistry
Chemistry is the science of the composition, structure, properties and reactions of matter, understood in terms of atoms, atomic particles and the way they are arranged and link together. It is concerned with the synthesis, formulation, analysis and characteristic properties of substances and materials of all kinds.
Students should be helped to appreciate the achievements of chemistry in showing how the complex and diverse phenomena of both the natural and man-made worlds can be described in terms of a number of key ideas which are of universal application, and which can be illustrated in the separate topics set out below. These ideas include:
• matter is composed of tiny particles called atoms and there are about 100 different naturally-occurring types of atoms called elements
• elements show periodic relationships in their chemical and physical properties
• these periodic properties can be explained in terms of the atomic structure of the elements
• atoms bond either by transferring electrons from one atom to another or by sharing electrons

• the shapes of molecules (groups of atoms bonded together) and the way giant structures are arranged is of great importance in terms of the way they behave
• reactions can occur when molecules collide and do so at different rates due to differences in molecular collisions
• chemical reactions take place in only three different ways:
• proton transfer
• electron transfer
• electron sharing
• energy is conserved in chemical reactions so can therefore be neither created nor destroyed.

Students should be taught about:

Atomic structure and the Periodic Table

• a simple model of the atom consisting of the nucleus and electrons, relative atomic mass, electronic charge and isotopes
• the number of particles in a given mass of a substance
• the modern Periodic Table, showing elements arranged in order of atomic number
• position of elements in the Periodic Table in relation to their atomic structure and arrangement of outer electrons
• properties and trends in properties of elements in the same group
• characteristic properties of metals and non-metals
• chemical reactivity of elements in relation to their position in the Periodic Table.

Structure, bonding and the properties of matter

• changes of state of matter in terms of particle kinetics, energy transfers and the relative strength of chemical bonds and intermolecular forces
• types of chemical bonding: ionic, covalent, and metallic
• bulk properties of materials related to bonding and intermolecular forces
• bonding of carbon leading to the vast array of natural and synthetic organic compounds that occur due to the ability of carbon to form families of similar compounds, chains and rings
• structures, bonding and properties of diamond, graphite, fullerenes and graphene.

Chemical changes

• determination of empirical formulae from the ratio of atoms of different kinds
• balanced chemical equations, ionic equations and state symbols
• identification of common gases
• the chemistry of acids; reactions with some metals and carbonates
• pH as a measure of hydrogen ion concentration and its numerical scale
• electrolysis of molten ionic liquids and aqueous ionic solutions
• reduction and oxidation in terms of loss or gain of oxygen.

Energy changes in chemistry

• Measurement of energy changes in chemical reactions (qualitative)
• Bond breaking, bond making, activation energy and reaction profiles (qualitative).

Rate and extent of chemical change

• factors that influence the rate of reaction: varying temperature or concentration, changing the surface area of a solid reactant or by adding a catalyst
• factors affecting reversible reactions.

Chemical analysis

• distinguishing between pure and impure substances
• separation techniques for mixtures of substances: filtration, crystallisation, chromatography, simple and fractional distillation

• quantitative interpretation of balanced equations
• concentrations of solutions in relation to mass of solute and volume of solvent.

Chemical and allied industries
• life cycle assessment and recycling to assess environmental impacts associated with all the stages of a product's life
• the viability of recycling of certain materials
• carbon compounds, both as fuels and feedstock, and the competing demands for limited resources
• fractional distillation of crude oil and cracking to make more useful materials
• extraction and purification of metals related to the position of carbon in a reactivity series.
Earth and atmospheric science
• evidence for composition and evolution of the Earth's atmosphere since its formation
• evidence, and uncertainties in evidence, for additional anthropogenic causes of climate change
• potential effects of, and mitigation of, increased levels of carbon dioxide and methane on the Earth's climate
• common atmospheric pollutants: sulphur dioxide, oxides of nitrogen, particulates and their sources
• the Earth's water resources and obtaining potable water.

Subject content – Physics
Physics is the science of the fundamental concepts of field, force, radiation and particle structures, which are inter-linked to form unified models of the behaviour of the material universe. From such models, a wide range of ideas, from the broadest issue of the development of the universe over time to the numerous and detailed ways in which new technologies may be invented, have emerged. These have enriched both our basic understanding of, and our many adaptations to, our material environment.

Students should be helped to understand how, through the ideas of physics, the complex and diverse phenomena of the natural world can be described in terms of a number of key ideas which are of universal application and which can be illustrated in the separate topics set out below. These ideas include:
• the use of models, as in the particle model of matter or the wave models of light and of sound
• the concept of cause and effect in explaining such links as those between force and acceleration, or between changes in atomic nuclei and radioactive emissions
• the phenomena of 'action at a distance' and the related concept of the field as the key to analysing electrical, magnetic and gravitational effects
• that differences, for example between pressures or temperatures or electrical potentials, are the drivers of change
• that proportionality, for example between weight and mass of an object or between force and extension in a spring, is an important aspect of many models in science.

Energy
• energy changes in a system involving heating, doing work using forces, or doing work using an electric current: calculating the stored energies and energy changes involved
• power as the rate of transfer of energy
• conservation of energy in a closed system, dissipation
• calculating energy efficiency for any energy transfers

• renewable and non-renewable energy sources used on Earth, changes in how these are used.

Forces
• forces and fields: electrostatic, magnetic, gravity
• forces as vectors
• calculating work done as force x distance; elastic and inelastic stretching
• pressure in fluids acts in all directions: variation in Earth's atmosphere with height, with depth for liquids, up-thrust force (qualitative).

Forces and motion
• speed of sound, estimating speeds and accelerations in everyday contexts
• interpreting quantitatively graphs of distance, time, and speed
• acceleration caused by forces; Newton's First Law
• weight and gravitational field strength
• decelerations and braking distances involved on roads, safety.

Wave motion
• amplitude, wavelength, frequency, relating velocity to frequency and wavelength
• transverse and longitudinal waves
• electromagnetic waves, velocity in vacuum; waves transferring energy; wavelengths and frequencies from radio to gamma-rays
• velocities differing between media: absorption, reflection, refraction effects
• production and detection, by electrical circuits, or by changes in atoms and nuclei
• uses in the radio, microwave, infra-red, visible, ultra-violet, X-ray and gamma-ray regions, hazardous effects on bodily tissues.

Electricity
• measuring resistance using p.d. and current measurements
• exploring current, resistance and voltage relationships for different circuit elements; including their graphical representations
• quantity of charge flowing as the product of current and time
• drawing circuit diagrams; exploring equivalent resistance for resistors in series
• the domestic a.c. supply; live, neutral and earth mains wires, safety measures
• power transfer related to p.d. and current, or current and resistance.

Magnetism and electromagnetism
• exploring the magnetic fields of permanent and induced magnets, and the Earth's magnetic field, using a compass
• magnetic effects of currents, how solenoids enhance the effect
• how transformers are used in the national grid and the reasons for their use.

The structure of matter
• relating models of arrangements and motions of the molecules in solid, liquid and gas phases to their densities
• melting, evaporation, and sublimation as reversible changes
• calculating energy changes involved on heating, using specific heat capacity; and those involved in changes of state, using specific latent heat
• links between pressure and temperature of a gas at constant volume, related to the motion of its particles (qualitative).

Atomic structure
• the nuclear model and its development in the light of changing evidence

• masses and sizes of nuclei, atoms and small molecules
• differences in numbers of protons, and neutrons related to masses and identities of nuclei, isotope characteristics and equations to represent changes
• ionisation; absorption or emission of radiation related to changes in electron orbits
• radioactive nuclei: emission of alpha or beta particles, neutrons, or gamma-rays, related to changes in the nuclear mass and/or charge
• radioactive materials, half-life, irradiation, contamination and their associated hazardous effects, waste disposal
• nuclear fission, nuclear fusion and our Sun’s energy

Space physics

• the main features of the solar system.