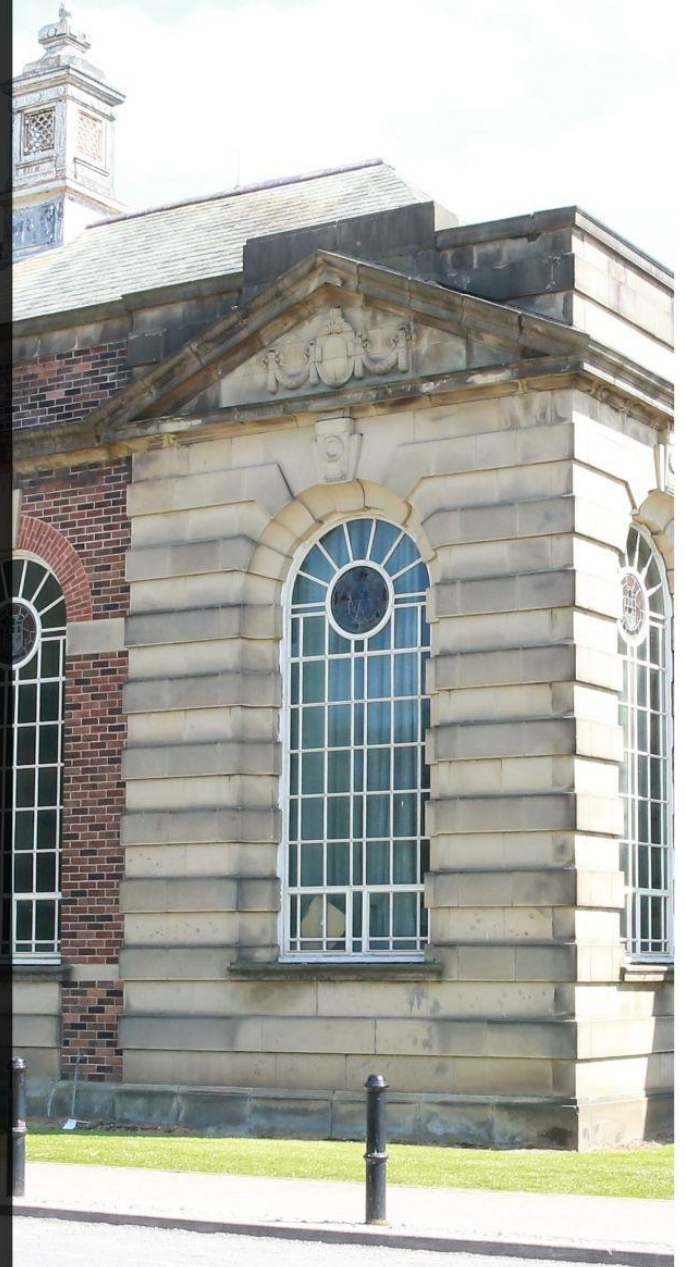




HUTTON GRAMMAR CHURCH OF ENGLAND SCHOOL

Science Curriculum
Information, Intent
and Map



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Intent:

The Science Curriculum at Hutton Grammar School allows our students to:

- Partake in a rigorous curriculum, with high expectations for all students to become inquisitive, independent learners who are highly motivated to achieve their full potential
- Develop into confident investigators who are able to question, analyse, evaluate and reflect. This is embodied in Proverbs 25:2.

“It is the glory of God to conceal things, but the glory of kings is to search things out”

- Be challenged to work both independently and collaboratively with others to solve problems; and develop practical, numeracy and literacy skills
- Become equipped with the scientific knowledge required to understand the uses and implications of science today and for the future

Science Programmes of Study: Key Stage 3 & 4 National Curriculum in England Purpose of Study

At Hutton Grammar School Science is taught at Key Stages 3 & 4 as discreet subjects: Chemistry, Biology and Physics

A high-quality science education provides the foundations for understanding the world through the specific disciplines of biology, chemistry and physics. Science has changed our lives and is vital to the world's future prosperity, and all pupils should be taught essential aspects of the knowledge, methods, processes and uses of science. Through building up a body of key foundational knowledge and concepts, pupils should be encouraged to recognise the power of rational explanation and develop a sense of excitement and curiosity about natural phenomena. They should be encouraged to understand how science can be used to explain what is occurring, predict how things will behave, and analyse causes.

Aims

The national curriculum for science aims to ensure that all pupils:

- Develop scientific knowledge and conceptual understanding through the specific disciplines of biology, chemistry and physics
- Develop understanding of the nature, processes and methods of science through different types of science enquiries that help them to answer scientific questions about the world around them
- Are equipped with the scientific knowledge required to understand the uses and implications of science, today and for the future

Scientific knowledge and conceptual understanding

The programmes of study describe a sequence of knowledge and concepts. While it is important that pupils make progress, it is also vitally important that they develop secure understanding of each key block of knowledge and concepts in order to progress to the next stage. Insecure, superficial understanding will not allow genuine progression: pupils may struggle at key points of transition (such as between primary and secondary school), build up serious misconceptions, and/or have significant difficulties in understanding higher-order content.

Pupils should be able to describe associated processes and key characteristics in common language, but they should also be familiar with, and use, technical terminology accurately and precisely. They should build up an extended specialist vocabulary. They should also apply their mathematical knowledge to their understanding of science, including collecting, presenting and analysing data. The social and economic implications of science are important but, generally, they are taught most appropriately within the wider school curriculum: teachers will wish to use different contexts to maximise their pupils' engagement with and motivation to study science.

The principal focus of science teaching in key stage 3 is to develop a deeper understanding of a range of scientific ideas in the subject disciplines of biology, chemistry and physics. Pupils

should begin to see the connections between these subject areas and become aware of some of the big ideas underpinning scientific knowledge and understanding. Examples of these big ideas are the links between structure and function in living organisms, the particulate model as the key to understanding the properties and interactions of matter in all its forms, and the resources and means of transfer of energy as key determinants of all of these interactions. They should be encouraged to relate scientific explanations to phenomena in the world around them and start to use modelling and abstract ideas to develop and evaluate explanations.

Pupils should understand that science is about working objectively, modifying explanations to take account of new evidence and ideas and subjecting results to peer review. Pupils should decide on the appropriate type of scientific enquiry to undertake to answer their own questions and develop a deeper understanding of factors to be taken into account when collecting, recording and processing data. They should evaluate their results and identify further questions arising from them.

'Working scientifically' is described separately at the beginning of the programme of study, but must always be taught through and clearly related to substantive science content in the programme of study. Teachers should feel free to choose examples that serve a variety of purposes, from showing how scientific ideas have developed historically to reflecting modern developments in science.

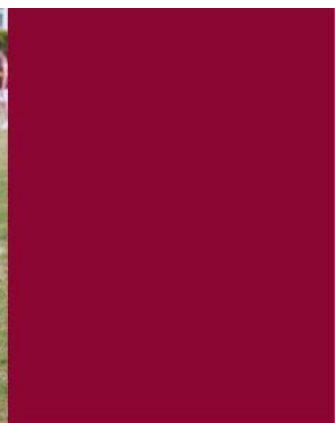
Pupils should develop their use of scientific vocabulary, including the use of scientific nomenclature and units and mathematical representations.

Spoken language

The national curriculum for science reflects the importance of spoken language in pupils' development across the whole curriculum – cognitively, socially and linguistically. The quality and variety of language that pupils hear and speak are key factors in developing their scientific vocabulary and articulating scientific concepts clearly and precisely. They must be assisted in making their thinking clear, both to themselves and others, and teachers should ensure that pupils build secure foundations by using discussion to probe and remedy their misconceptions.

Attainment targets

By the end of key stage 3, pupils are expected to know, apply and understand the matters, skills and processes specified in the relevant programme of study



Subject Content in Key Stage 3

Working scientifically

Through the content across all three disciplines, pupils should be taught the following –

1. Scientific Attitudes

- Pay attention to objectivity and concern for accuracy, precision, repeatability and reproducibility.
- Understand that scientific methods and theories develop as earlier explanations are modified to take account of new evidence and ideas, together with the importance of publishing results and peer review.
- Evaluate risks

2. Experimental skills and investigations

- Ask questions and develop a line of enquiry based on observations of the real world, alongside prior knowledge and experience.
- make predictions using scientific knowledge and understanding
- Select, plan and carry out the most appropriate types of scientific enquiries to test predictions, including identifying independent, dependent and control variables, where appropriate
- Use appropriate techniques, apparatus, and materials during fieldwork and laboratory work, paying attention to health and safety
- Make and record observations and measurements using a range of methods for different investigations; and evaluate the reliability of methods and suggest possible improvements
- Apply sampling techniques

3. Analysis and evaluation

- Apply mathematical concepts and calculate results
- Present observations and data using appropriate methods, including tables and graphs
- Interpret observations and data, including identifying patterns and using observations, measurements and data to draw conclusions
- Present reasoned explanations, including explaining data in relation to predictions and hypotheses
- Evaluate data, showing awareness of potential sources of random and systematic error
- Identify further questions arising from their results

4. Measurement

- Understand and use SI units and IUPAC (International Union of Pure and Applied Chemistry) chemical nomenclature
- Use and derive simple equations and carry out appropriate calculations
- Undertake basic data analysis including simple statistical techniques

Subject Content in Key Stage 4

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 every day 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: KS3 National Curriculum

Pupils should be taught about:

Structure and function of living organisms

Cells and organisation
Cells as the fundamental unit of living organisms, including how to observe, interpret and record cell structure using a light microscope.
The functions of the cell wall, cell membrane, cytoplasm, nucleus, vacuole, mitochondria and chloroplasts.
The similarities and differences between plant and animal cells.
The role of diffusion in the movement of materials in and between cells.
The structural adaptations of some unicellular organisms.
The hierarchical organisation of multicellular organisms: from cells to tissues to organs to systems to organisms.
The skeletal and muscular systems
The structure and functions of the human skeleton, to include support, protection, movement and making blood cells.
Biomechanics – the interaction between skeleton and muscles, including the measurement of force exerted by different muscles.
The function of muscles and examples of antagonistic muscles.
Nutrition and digestion
Content of a healthy human diet: carbohydrates, lipids (fats and oils), proteins, vitamins, minerals, dietary fibre and water, and why each is needed.
Calculations of energy requirements in a healthy daily diet.
The consequences of imbalances in the diet, including obesity, starvation and deficiency diseases.
The tissues and organs of the human digestive system, including adaptations to function and how the digestive system digests food (enzymes simply as biological catalysts).
The importance of bacteria in the human digestive system.
Plants making carbohydrates in their leaves by photosynthesis and gaining mineral nutrients and water from the soil via their roots.
Gas exchange systems
The structure and functions of the gas exchange system in humans, including adaptations to function.
The mechanism of breathing to move air in and out of the lungs, using a pressure model to explain the movement of gases, including simple measurements of lung volume.
The impact of exercise, asthma and smoking on the human gas exchange system.
The role of leaf stomata in gas exchange in plants.
Reproduction
Reproduction in humans (as an example of a mammal), including the structure and function of the male and female reproductive systems, menstrual cycle (without details of hormones), gametes, fertilisation, gestation and birth, to include the effect of maternal lifestyle on the foetus through the placenta.
Reproduction in plants, including flower structure, wind and insect pollination, fertilisation, seed and fruit formation and dispersal, including quantitative investigation of some dispersal mechanisms.
Health
The effects of recreational drugs (including substance misuse) on behaviour, health and life processes.

Material cycles and energy

Photosynthesis
The reactants in, and products of, photosynthesis, and a word summary for photosynthesis.
The dependence of almost all life on Earth on the ability of photosynthetic organisms, such as plants and algae, to use sunlight in photosynthesis to build organic molecules that are an essential energy store and to maintain levels of oxygen and carbon dioxide in the atmosphere.
The adaptations of leaves for photosynthesis.
Cellular respiration
Aerobic and anaerobic respiration in living organisms, including the breakdown of organic molecules to enable all the other chemical processes necessary for life.
A word summary for aerobic respiration.
The process of anaerobic respiration in humans and micro-organisms, including fermentation, and a word summary for anaerobic respiration.
The differences between aerobic and anaerobic respiration in terms of the reactants, the products formed and the implications for the organism. Interactions and interdependencies.
Relationships in an ecosystem
The interdependence of organisms in an ecosystem, including food webs and insect pollinated crops.
The importance of plant reproduction through insect pollination in human food security.
How organisms affect, and are affected by, their environment, including the accumulation of toxic materials.

Genetics and evolution

Inheritance, chromosomes, DNA and genes
Heredity as the process by which genetic information is transmitted from one generation to the next
A simple model of chromosomes, genes and DNA in heredity, including the part played by Watson, Crick, Wilkins and Franklin in the development of the DNA model.
Differences between species.
The variation between individuals within a species being continuous or discontinuous, to include measurement and graphical representation of variation.
The variation between species and between individuals of the same species means some organisms compete more successfully, which can drive natural selection.
Changes in the environment may leave individuals within a species, and some entire species, less well adapted to compete successfully and reproduce, which in turn may lead to extinction.
The importance of maintaining biodiversity and the use of gene banks to preserve hereditary material.

Subject content: Biology: KS4 National Curriculum

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.

Curriculum Map: Biology

Year	Half Term 1	Half Term 2	Half Term 3	Half Term 4	Half Term 5	Half Term 6
7	Transition Unit Working scientifically	Cells	Reproduction	Reproduction	Body Systems	Body Systems
8	The Skeleton and Movement	Food and nutrition	Food and nutrition	Ecosystem processes	Ecosystem processes	Investigations
9	Adaptation and Inheritance	Adaptation and Inheritance	Health and Lifestyle 2	Health and Lifestyle 2	Cells (GCSE)	Mitosis (GCSE)
We follow the AQA Biology GCSE specification and GCSE Trilogy Specification						
10	Cell Transport Organisation and the digestive system	Animal transport Non-communicable diseases	Plant Transport Communicable diseases	Communicable diseases Photosynthesis	Photosynthesis Respiration	Nervous system
11	Hormones Plant hormones	Homeostasis Reproduction	DNA, genetics and evolution	Ecology	Focus on Required Practical's	GCSE Examinations

Subject content: Chemistry: KS3 National Curriculum

Pupils should be taught about:

The particulate nature of matter

The properties of the different states of matter (solid, liquid and gas) in terms of the particle model, including gas pressure.

Changes of state in terms of the particle model.

Atoms, elements and compounds

A simple (Dalton) atomic model.

Differences between atoms, elements and compounds.

Chemical symbols and formulae for elements and compounds.

Conservation of mass changes of state and chemical reactions. Pure and impure substances.

The concept of a pure substance.

Mixtures, including dissolving.

Diffusion in terms of the particle model.

Simple techniques for separating mixtures: filtration, evaporation, distillation and chromatography.

The identification of pure substances.

Chemical reactions

Chemical reactions as the rearrangement of atoms.

Representing chemical reactions using formulae and using equations

Combustion, thermal decomposition, oxidation and displacement reactions.

Defining acids and alkalis in terms of neutralisation reactions.

The pH scale for measuring acidity/alkalinity; and indicators.

Reactions of acids with metals to produce a salt plus hydrogen.

Reactions of acids with alkalis to produce a salt plus water.

What catalysts do.

Energetics

Energy changes on changes of state (qualitative).

Exothermic and endothermic chemical reactions (qualitative).

The Periodic Table

The varying physical and chemical properties of different elements.

The principles underpinning the Mendeleev Periodic Table.

The Periodic Table: periods and groups; metals and non-metals.

How patterns in reactions can be predicted with reference to the Periodic Table.

The properties of metals and non-metals.

The chemical properties of metal and non-metal oxides with respect to acidity.

Materials

The order of metals and carbon in the reactivity series.

The use of carbon in obtaining metals from metal oxides.

Properties of ceramics, polymers and composites (qualitative).

Earth and atmosphere

The composition of the Earth.

The structure of the Earth.

The rock cycle and the formation of igneous, sedimentary and metamorphic rocks.

Earth as a source of limited resources and the efficacy of recycling.

The carbon cycle.

The composition of the atmosphere.

The production of carbon dioxide by human activity and the impact on climate.



Subject content: Chemistry: KS4 National Curriculum

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.

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.

Curriculum Map: Chemistry

Year	Half Term 1	Half Term 2	Half Term 3	Half Term 4	Half Term 5	Half Term 6
7	Transition Unit Working Scientifically	Particles and their behaviour	Elements, atoms and compounds	Elements, atoms and compounds	Acids and Alkalis	Acids and Alkalis
8	Chemical Reactions	Chemical Reactions	Separation	Separation	The Earth	The Earth
9	Reactions of acids	Reactivity Series and Displacement Reaction	Energy Changes	Ceramics, composites and polymers	Atomic Structure	The Periodic Table
We follow the AQA GCSE Chemistry and GCSE Trilogy specification.						
10	Bonding Structures and Properties	The Atmosphere	Chemical Changes	Energy Changes	Energy Changes/ Rates	Rate and extent of Chemical reactions
11	Quantitative Chemistry	Organic Chemistry	Chemical Analysis	Using Resources	Completion of Using Resources Focus on Required practical skills and Working Scientifically	GCSE Examinations

Subject content: Physics: KS3 National Curriculum

Pupils should be taught about:

Energy Calculation of fuel uses and costs in the domestic context
Comparing energy values of different foods (from labels) (kJ).
Comparing power ratings of appliances in watts (W, kW).
Comparing amounts of energy transferred (J, kJ, and kW hour).
Domestic fuel bills, fuel use and costs.
Fuels and energy resources.

Energy changes and transfers
Simple machines give bigger force but at the expense of smaller movement (and vice versa): product of force and displacement unchanged.
Heating and thermal equilibrium: temperature difference between two objects leading to energy transfer from the hotter to the cooler one, through contact (conduction) or radiation; such transfers tending to reduce the temperature difference: use of insulators.
Other processes that involve energy transfer: changing motion, dropping an object, completing an electrical circuit, stretching a spring, metabolism of food, burning fuels.

Changes in systems
Energy as a quantity that can be quantified and calculated; the total energy has the same value before and after a change.
Comparing the starting with the final conditions of a system and describing increases and decreases in the amounts of energy associated with movements, temperatures, changes in positions in a field, in elastic distortions and in chemical compositions.
Using physical processes and mechanisms, rather than energy, to explain the intermediate steps that bring about such changes.

Motion and forces

Describing motion
Speed and the quantitative relationship between average speed, distance and time (speed = distance ÷ time).
The representation of a journey on a distance-time graph.
Relative motion: trains and cars passing one another.
Forces
Forces as pushes or pulls, arising from the interaction between two objects.
Using force arrows in diagrams, adding forces in one dimension, balanced and unbalanced forces.
Moment as the turning effect of a force.
Forces: associated with deforming objects; stretching and squashing – springs; with rubbing and friction between surfaces, with pushing things out of the way; resistance to motion of air and water.
Forces measured in newtons, measurements of stretch or compression as force is changed.
Force-extension linear relation; Hooke's Law as a special case.
Work done and energy changes on deformation.
Non-contact forces: gravity forces acting at a distance on Earth and in space, forces between magnets and forces due to static electricity.

Waves

Observed waves
Waves on water as undulations which travel through water with transverse motion; these waves can be reflected, and add or cancel – superposition.
Sound waves
Frequencies of sound waves, measured in hertz (Hz); echoes, reflection and absorption of sound.
Sound needs a medium to travel, the speed of sound in air, in water, in solids.
Sound produced by vibrations of objects, in loud speakers, detected by their effects on microphone diaphragm and the ear drum; sound waves are longitudinal.
Auditory range of humans and animals.
Energy and waves
Pressure waves transferring energy; use for cleaning and physiotherapy by ultra-sound; waves transferring information for conversion to electrical signals by microphone.
Light waves
The similarities and differences between light waves and waves in matter.
Light waves travelling through a vacuum; speed of light.
The transmission of light through materials: absorption, diffuse scattering and specular reflection at a surface.
Use of ray model to explain imaging in mirrors, the pinhole camera, the refraction of light and action of convex lens in focusing (qualitative); the human eye.
Light transferring energy from source to absorber leading to chemical and electrical effects; photo-sensitive material in the retina and in cameras.
Colours and the different frequencies of light, white light and prisms (qualitative only); differential colour effects in absorption and diffuse reflection.

Electricity and electromagnetism

Current electricity
Electric current, measured in amperes, in circuits, series and parallel circuits, currents add where branches meet and current as flow of charge.
Potential difference, measured in volts, battery and bulb ratings; resistance, measured in ohms, as the ratio of potential difference (p.d.) to current.
Differences in resistance between conducting and insulating components (quantitative).
Static electricity
Separation of positive or negative charges when objects are rubbed together: transfer of electrons, forces between charged objects.
The idea of electric field, forces acting across the space between objects not in contact.
Magnetism
Magnetic poles, attraction and repulsion.
Magnetic fields by plotting with compass, representation by field lines.
Earth's magnetism, compass and navigation.
The magnetic effect of a current, electromagnets, D.C. motors (principles only).

Matter

Physical changes
Conservation of material and of mass, and reversibility, in melting, freezing, evaporation, sublimation, condensation, dissolving.
Similarities and differences, including density differences, between solids, liquids and gases.
Brownian motion in gases.
Diffusion in liquids and gases driven by differences in concentration.

The difference between chemical and physical changes.

Particle model

The differences in arrangements, in motion and in closeness of particles explaining changes of state, shape and density, the anomaly of ice-water transition.

Atoms and molecules as particles.

Energy in matter

Changes with temperature in motion and spacing of particles.

Internal energy stored in materials.

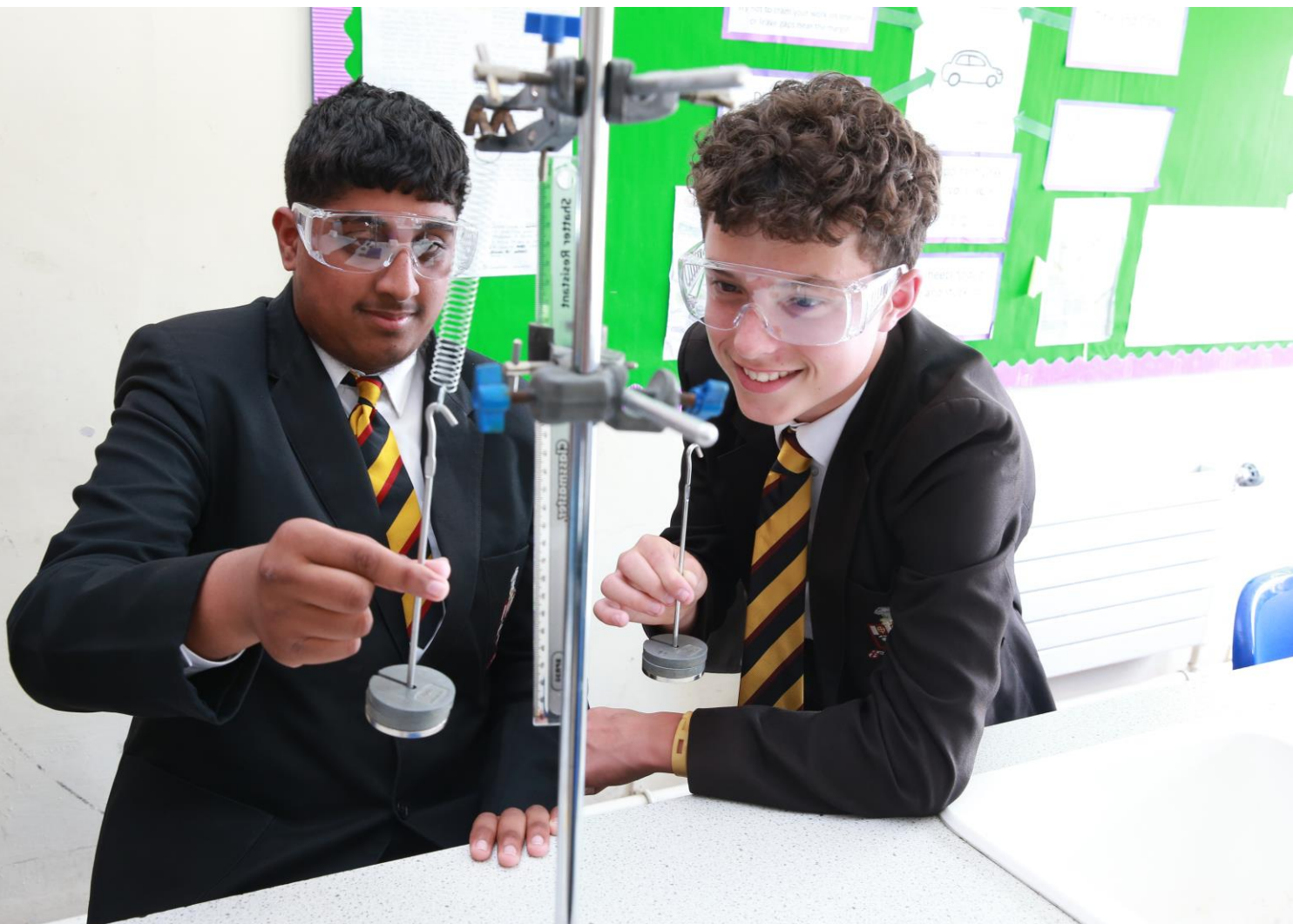
Space physics

Gravity force, weight = mass x gravitational field strength (g), on Earth $g=10 \text{ N/kg}$, different on other planets and stars; gravity forces between Earth and Moon, and between Earth and Sun (qualitative only).

Our Sun as a star, other stars in our galaxy, other galaxies.

The seasons and the Earth's tilt, day length at different times of year, in different hemispheres.

The light year as a unit of astronomical distance.



Subject content: Physics: KS4 National Curriculum

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.

Students should be taught about:

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.

Curriculum Map: Physics

Year	Half Term 1	Half Term 2		Half Term 3	Half Term 4		Half Term 5	Half Term 6
7	Working scientifically	Forces		Light	Light		Sound	Sound
8	Earth and Space	Earth and Space		Electricity	Magnetism		Heat and temperature	Heat and temperature
9	Motion	Pressure		Energy resources	Energy resources		Work and energy stores	Energy, efficiency and appliances
We follow the AQA GCSE Physics and GCSE Trilogy specifications								
10	Energy transfer by heating	Electric circuits		Molecules and matter	Radioactivity		Forces in balance	Motion
	Energy transfer by heating	Electric circuits		Electric circuits	Mains electricity		Molecules and matter	Radioactivity
11	Force and motion	Force and pressure Wave properties		Electromagnetic waves Light	Electromagnetism Space		Revision	GCSE Examinations
	Forces in balance Motion	Force and motion		Wave properties Electromagnetic waves	Electromagnetism		Revision	GCSE Examinations

