KEY KNOWLEDGE PROGRESSION OVERVIEW - Science

Features

At both key stages the knowledge progression takes full account of the national curriculum's strands of:

- Physics
- Chemistry
- Biology
- Working scientifically

Threaded throughout all science learning should be the opportunity for children to develop knowledge and understanding for all science disciplines including, biology, physics, chemistry and working scientifically, (as prescribed in the curriculum end points). This could include concepts such as:

- Animals including humans
- Evolution and inheritance
- Living things and their habitats
- Plants
- Forces
- Light
- Electricity
- Sound
- Materials
- States of matter
- Earth and space
- Working scientifically

KKPDs match the ambition of the National Curriculum. In some instances, knowledge specified within the KKPDs is more ambitious than the National Curriculum. For example:

- Knowledge of forces and their effects on objects begins in the EY (SPN.1 and SPR.1). Work on forces is only specified from Year 3 onwards in the NC.
- Knowledge of electricity begins in the EY studying electrical safety and sources of electricity (SPN.4 and SPR.3). Work on electricity is only specified from Year 4 onwards in the NC.
- When studying electricity in Year 6 pupils are exposed to the idea of parallel circuits in preparation for this study in Year 7 (SP7.3)

National Curriculum Aims:

- 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

- Substantive knowledge (**S**) is the truths or facts of a subject. Procedural knowledge (**P**) is the knowledge of how to do something. Disciplinary knowledge (**D**) is the knowledge, practices and traditions of a subject (that enable you to behave as a master of the subject e.g. as a scientist). These knowledge statements should be what pupils retain. In other words, this knowledge is within their long-term memory and will be remembered.
- Skills are dependent on specific knowledge. A skill is the capacity to perform and in order to perform a deep body of knowledge needs to be acquired and retained
- There are more assessments in science because the national curriculum specifies on a year-by-year basis what has to be taught. In addition, science is a core subject and should have more time devoted to it than non-core
- The working scientifically part does not conform with the knowledge-rich system as it is checking on pupils' ability to, amongst other things, carry out research, ask questions and carry out tests. The working scientifically statements should be assessed as an on-going feature of the science lessons, whilst the scientific knowledge should be assessed away from the point of teaching
- When considering pupils' improvement in subject specific vocabulary, pupils could be provided with a knowledge organiser which contains the relevant words used for science for their age group

National Curriculum Subject Content

Strand	Working Scientifically

KEY KNOWLEDGE PROGRESSION OVERVIEW - Science

Key Stage 1	During years 1 and 2, pupils should be taught to use the following practical scientific methods, processes and skills through the teaching of the programme of study content: • asking simple questions and recognising that they can be answered in different ways • observing closely, using simple equipment • performing simple tests • identifying and classifying • using their observations and ideas to suggest answers to questions • gathering and recording data to help in answering questions ***For specific examples of these refer to the National Curriculum document***
Lower Key Stage 2	During years 3 and 4, pupils should be taught to use the following practical scientific methods, processes and skills through the teaching of the programme of study content: • asking relevant questions and using different types of scientific enquiries to answer them • setting up simple practical enquiries, comparative and fair tests • making systematic and careful observations and, where appropriate, taking accurate measurements using standard units, using a range of equipment, including thermometers and data loggers • gathering, recording, classifying and presenting data in a variety of ways to help in answering questions • recording findings using simple scientific language, drawings, labelled diagrams, keys, bar charts, and tables • reporting on findings from enquiries, including oral and written explanations, displays or presentations of results and conclusions • using results to draw simple conclusions, make predictions for new values, suggest improvements and raise further questions • identifying differences, similarities or changes related to simple scientific ideas and processes • using straightforward scientific evidence to answer questions or to support their findings
Upper Key Stage 2	During years 5 and 6, pupils should be taught to use the following practical scientific methods, processes and skills through the teaching of the programme of study content: • planning different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary • taking measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate • recording data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graphs • using test results to make predictions to set up further comparative and fair tests • reporting and presenting findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations • identifying scientific evidence that has been used to support or refute ideas or arguments ***For specific examples of these refer to the National Curriculum document***
Year 7	During Year 7 & 8 pupils should be taught to apply the working scientifically content across all three disciplines, pupils should be taught to: • 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 • 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 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

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	• 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

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National Curriculum Subject Content						
Strand	Biology		Chemistry		Physics	
Year 1	**Animals, including humans**	• *identify and name a variety of common animals including fish, amphibians, reptiles, birds and mammals* • *identify and name a variety of common animals that are carnivores, herbivores and omnivores* • *describe and compare the structure of a variety of common animals (fish, amphibians, reptiles, birds and mammals, including pets)* • *identify, name, draw and label the basic parts of the human body and say which part of the body is associated with each sense*	**Everyday Materials**	• *distinguish between an object and the material from which it is made* • *identify and name a variety of everyday materials, including wood, plastic, glass, metal, water, and rock* • *describe the simple physical properties of a variety of everyday materials* • *compare and group together a variety of everyday materials on the basis of their simple physical properties*	**Seasonal Change**	• *observe changes across the four seasons* • *observe and describe weather associated with the seasons and how day length varies*

KEY KNOWLEDGE PROGRESSION OVERVIEW - Science

	Plants	• *identify and name a variety of common wild and garden plants, including deciduous and evergreen trees* • *identify and describe the basic structure of a variety of common flowering plants, including trees*				

KEY KNOWLEDGE PROGRESSION OVERVIEW - Science

National Curriculum Subject Content					
Strand	**Biology**		**Chemistry**		**Physics**
Year 2	**All living things and their habitats**	• *explore and compare the differences between things that are living, dead, and things that have never been alive* • *identify that most living things live in habitats to which they are suited and describe how different habitats provide for the basic needs of different kinds of animals and plants, and how they depend on each other* • *identify and name a variety of plants and animals in their habitats, including micro-habitats* • *describe how animals obtain their food from plants and other animals, using the idea of a simple food chain, and identify and name different sources of food*	**Everyday Materials**	• *identify and compare the suitability of a variety of everyday materials, including wood, metal, plastic, glass, brick, rock, paper and cardboard for particular uses* • *find out how the shapes of solid objects made from some materials can be changed by squashing, bending, twisting and stretching*	
	Animals, including humans	• *notice that animals, including humans, have offspring which grow into adults* • *find out about and describe the basic needs of animals, including humans, for survival (water, food and air)* • *describe the importance for humans of exercise, eating the right amounts of different types of food, and hygiene*			

KEY KNOWLEDGE PROGRESSION OVERVIEW - Science

	Plants	• *observe and describe how seeds and bulbs grow into mature plants* • *find out and describe how plants need water, light and a suitable temperature to grow and stay healthy*				

National Curriculum Subject Content						
Strand	**Biology**		**Chemistry**		**Physics**	
Year 3	**Animals, including humans**	• *identify that animals, including humans, need the right types and amount of nutrition, and that they cannot make their own food; they get nutrition from what they eat* • *identify that humans and some other animals have skeletons and muscles for support, protection and movement*	**Rocks**	• *compare and group together different kinds of rocks on the basis of their appearance and simple physical properties* • *describe in simple terms how fossils are formed when things that have lived are trapped within rock* • *recognise that soils are made from rocks and organic matter*	**Forces**	• *compare how things move on different surfaces* • *notice that some forces need contact between two objects, but magnetic forces can act at a distance* • *observe how magnets attract or repel each other and attract some materials and not others* • *compare and group together a variety of everyday materials on the basis of whether they are attracted to a magnet, and identify some magnetic materials* • *describe magnets as having two poles* • *predict whether two magnets will attract or repel each other, depending on which poles are facing*

KEY KNOWLEDGE PROGRESSION OVERVIEW - Science

	Plants	• *identify and describe the functions of different parts of flowering plants: roots, stem/trunk, leaves and flowers* • *explore the requirements of plants for life and growth (air, light, water, nutrients from soil, and room to grow) and how they vary from plant to plant* • *investigate the way in which water is transported within plants* • *explore the part that flowers play in the life cycle of flowering plants, including pollination, seed formation and seed dispersal*			**Light**	• *recognise that they need light in order to see things and that dark is the absence of light* • *notice that light is reflected from surfaces* • *recognise that light from the sun can be dangerous and that there are ways to protect their eyes* • *recognise that shadows are formed when the light from a light source is blocked by an opaque object* • *find patterns in the way that the size of shadows change*
National Curriculum Subject Content						
Strand	**Biology**		**Chemistry**		**Physics**	
Year 4	**All living things and their habitats**	• *recognise that living things can be grouped in a variety of ways* • *explore and use classification keys to help group, identify and name a variety of living things in their local and wider environment* • *recognise that environments can change and that this can sometimes pose dangers to living things*	**States of Matter**	• *compare and group materials together, according to whether they are solids, liquids or gases* • *observe that some materials change state when they are heated or cooled, and measure or research the temperature at which this happens in degrees Celsius (°C)* • *identify the part played by evaporation and condensation in the water cycle and associate the rate of evaporation with temperature*	**Electricity**	• *identify common appliances that run on electricity* • *construct a simple series electrical circuit, identifying and naming its basic parts, including cells, wires, bulbs, switches and buzzers* • *identify whether or not a lamp will light in a simple series circuit, based on whether or not the lamp is part of a complete loop with a battery* • *recognise that a switch opens and closes a circuit and associate this with whether or not a lamp lights in a simple series circuit*

KEY KNOWLEDGE PROGRESSION OVERVIEW - Science

						• *recognise some common conductors and insulators, and associate metals with being good conductors*
	Animals, including humans	• *describe the simple functions of the basic parts of the digestive system in humans* • *identify the different types of teeth in humans and their simple functions* • *construct and interpret a variety of food chains, identifying producers, predators and prey*			**Sound**	• *identify how sounds are made, associating some of them with something vibrating* • *recognise that vibrations from sounds travel through a medium to the ear* • *find patterns between the pitch of a sound and features of the object that produced it* • *find patterns between the volume of a sound and the strength of the vibrations that produced it* • *recognise that sounds get fainter as the distance from the sound source increases*
National Curriculum Subject Content						
Strand	**Biology**		**Chemistry**		**Physics**	

KEY KNOWLEDGE PROGRESSION OVERVIEW - Science

Year 5	**All living things and their habitats**	• *describe the differences in the life cycles of a mammal, an amphibian, an insect and a bird* • *describe the life process of reproduction in some plants and animals*	**Properties and changes in materials**	• *compare and group together everyday materials on the basis of their properties, including their hardness, solubility, transparency, conductivity (electrical and thermal), and response to magnets* • *know that some materials will dissolve in liquid to form a solution, and describe how to recover a substance from a solution* • *use knowledge of solids, liquids and gases to decide how mixtures might be separated, including through filtering, sieving and evaporating* • *give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials, including metals, wood and plastic* • *demonstrate that dissolving, mixing and changes of state are reversible changes* • *explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda*	**Forces**	• *explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object* • *identify the effects of air resistance, water resistance and friction, that act between moving surfaces* • *recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect*
	Animals, including humans	• *describe the changes as humans develop to old age*			**Earth and Space**	• *describe the movement of the Earth, and other planets, relative to the Sun in the solar system* • *describe the movement of the Moon relative to the Earth* • *describe the Sun, Earth and Moon as approximately spherical bodies* • *use the idea of the Earth's rotation to explain day and night and the apparent movement of the sun across the sky*

KEY KNOWLEDGE PROGRESSION OVERVIEW - Science

National Curriculum Subject Content						
Strand	Biology		Chemistry		Physics	
Year 6	**Animals, including humans**	• *identify and name the main parts of the human circulatory system, and describe the functions of the heart, blood vessels and blood* • *recognise the impact of diet, exercise, drugs and lifestyle on the way their bodies function* • *describe the ways in which nutrients and water are transported within animals, including humans*			**Electricity**	• *associate the brightness of a lamp or the volume of a buzzer with the number and voltage of cells used in the circuit* • *compare and give reasons for variations in how components function, including the brightness of bulbs, the loudness of buzzers and the on/off position of switches* • *use recognised symbols when representing a simple circuit in a diagram*
	All living things and their habitats	• *describe how living things are classified into broad groups according to common observable characteristics and based on similarities and differences, including micro-organisms, plants and animals* • *give reasons for classifying plants and animals based on specific characteristics*			**Light**	• *recognise that light appears to travel in straight lines* • *use the idea that light travels in straight lines to explain that objects are seen because they give out or reflect light into the eye* • *explain that we see things because light travels from light sources to our eyes or from light sources to objects and then to our eyes* • *use the idea that light travels in straight lines to explain why shadows have the same shape as the objects that cast them*
	Evolution and inheritance	• *recognise that living things have changed over time and that fossils provide information about living things that inhabited the Earth millions of years ago* • *recognise that living things produce offspring of the same kind, but normally offspring vary and are not identical to their parents* • *identify how animals and plants are adapted to suit their environment in different ways and that adaptation may lead to evolution*				

KEY KNOWLEDGE PROGRESSION OVERVIEW - Science

National Curriculum Subject Content						
Strand	**Biology**		**Chemistry**		**Physics**	
Year 7	**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 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* • *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* • *the difference between chemical and physical change* • *the differences in arrangements, in motion and in closeness of particles explaining changes of state, shape and density, the anomaly of ice-water transition*	**Energy changes & transfers**	• *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* • *energy as a quantity that can be quantified and calculated; the total energy has the same value before and after a change*

KEY KNOWLEDGE PROGRESSION OVERVIEW - Science

	Systems of the Body	• *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* • *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*	**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*	**Forces and Motion**	• *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 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* • *gravity forces acting at a distance on Earth and in space, forces between magnets and forces due to static electricity* • *magnetic poles, attraction and repulsion* • *magnetic fields by plotting with compass, representation by field lines*

KEY KNOWLEDGE PROGRESSION OVERVIEW - Science

		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*				• *Earth's magnetism, compass and navigation* • *the magnetic effect of a current, electromagnets, D.C. motors (principles only)* • *forces being needed to cause objects to stop or start moving, or to change their speed or direction of motion (qualitative only)* • *change depending on direction of force and its size*
	Material cycles and energy	• *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*	**Chemical 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*	**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* • *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*

KEY KNOWLEDGE PROGRESSION OVERVIEW - Science

	Interactions and interdependencies	• *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*			***Electricity and electromagnetism***	• *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)*
					Space physics	• *gravity force, weight = mass x gravitational field strength (g), on Earth g=10 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*