

A P Associates
educational consultants

Science Subject Leaders Resource Pack





Science SL Resource Pack

This, and subsequent resource packs, have been designed specifically to support the work of subject leaders for the foundation subjects (Art & Design; Computing; Design & Technology; Geography; History; MfL; Music; PE; PSHE, Science) in primary schools.

The structure of each resource pack follows the same format:

Part A: Resources & NC Requirements

This includes:

- a list of key websites, including those of the professional subject association;
- key publications to support the subject leader, and
- a brief statement of curriculum intent

Part B: Best practice as identified by Ofsted

This provides numerous examples of what were 'recently' described as best practice in teaching & learning in Science in primary schools. They provide excellent examples for sharing amongst class teachers as well as for subject leaders to audit their own school's provision against.

Part C: Science - Good (in 'old' money)

This outlines, albeit from 6 years ago, the last time that Ofsted wrote a set of subject specific criteria to complement the 'generic' whole school criteria in the then Inspection Framework. Whilst there is now a new Inspection Framework (May 2019) what was 'good' learning & teaching in Science (in this instance) in 2013 is clearly still 'good' Science learning & teaching today.

I have taken the criteria for 'good' as a starting point, not as a deficit model, i.e. not using 'outstanding' but, because I make the assumption that all teachers and pupils want to have a good days learning & teaching. If both a subject and senior leaders' evaluation is that provision meets the criteria for 'good' then there is every good reason to refer to the criteria for 'outstanding'. The subject specific criteria for Outstanding (from Dec 2013) are included in Annex 1.

Part D: Science: Quality of Education

This template includes the current 'good' criteria for the Quality of Education judgement along black columns for the SL / SLT to insert where they perceive is a best-fit with the 'old' subject specific criteria along with their own internal evidence.

As such it serves two purposes, one as a CPD activity to consider the match between the 'old' subject specific criteria and then 'new' criteria and secondly to benchmark / evaluate the school's provision against this.

Part E (exemplar) is my initial interpretation of a best-fit between the old and the new.

Annex 1: Science – Outstanding (in 'old' money)

Annex 2: Progression in Science: exemplar



Resource pack for Subject Leaders of: Science

Links:

Science Association

- Association of Science Education

<https://www.ase.org.uk>

(Membership for: School £130 / annum - Individual £90 / annum)

- Science Museum

www.sciencemuseum.org.uk

- Primary Science Quality Mark

<http://www.psqm.org.uk/what-is-psqm>

- STEM

<http://www.stem.org.uk>

Resources

- Great science leadership at primary school (Welcome Trust)

<https://welcome.ac.uk/sites/default/great-science-subject-leadership-welcome.pdf>

- Developing great science subject leadership: great ideas for primary science from schools that value science

<https://www.stem.org.uk/resources/elibrary/resource/229368/developing-great-science-subject-leadership-great-ideas-primary>

- Primary Science Leaders Survival Guide

<http://www.ase.org.uk/news/ase-news/primary-survival-guide/>

The scientific area of learning and experience is concerned with increasing pupils' knowledge and understanding of the natural world and the world as modified by human beings, and with developing skills and competencies associated with science as a process of enquiry. These include observing, selecting from the observations whatever is important, framing hypotheses, devising and conducting experiments, communicating in oral and symbolic forms and applying the knowledge and understanding gained to new situations.

Pupils need to be taught to organise the data gathered through observation and investigation conducted by themselves and others. They should look for relationships or patterns and try to explain them. They should be encouraged to seek alternative explanations, to select those which seem most probable and to test them by experiments.

Pupils should be encouraged to handle objects, to observe phenomena, to talk about these and to take part in enquiries through which skills related to science as a process can be developed.

The emphasis should be on considering real problems.



Science Programmes of Study for KS1 & 2

Purpose of study

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.

In order to achieve this, pupils need to work as successful scientists. This requires them to have the necessary skills for scientific enquiry. These skills should build upon opportunities for them to play, explore, create and engage in active learning.

It is important that there is a progression of the scientific skills that pupils are to develop throughout school. This ensures that they are not simply repeating the same skills again and again. As your pupils progress through school, they need to be able to use progressively more challenging skills to tackle the scientific problems they encounter.

To guarantee this happens, enquiry skills need to be carefully planned for.

*To support this please see this excellent resource '**Working Scientifically in the Primary Classroom**'. This has been produced by The Centre for Industry: Education Collaboration, and the original is available from:*

<http://www.ciec.org.uk/resources/working-scientifically.html>

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 nature, processes and methods of science

'Working scientifically' specifies the understanding of the nature, processes and methods of science for each year group. It should not be taught as a separate strand. The notes and guidance give examples of how 'working scientifically' might be embedded within the content of biology, chemistry and physics, focusing on the key features of scientific enquiry, so that pupils learn to use a variety of approaches to answer relevant scientific questions. These types of scientific enquiry should include: observing over time; pattern seeking; identifying, classifying and grouping; comparative and fair testing (controlled investigations); and researching using secondary sources. Pupils should seek answers to questions through collecting, analysing and presenting data. 'Working scientifically' will be developed further at key stages 3 and 4, once pupils have built up sufficient understanding of science to engage meaningfully in more sophisticated discussion of experimental design and control. 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. School curriculum The programmes of study for science are set out year-by-year for key stages 1 and 2. Schools are, however, only required to teach the relevant programme of study by the end of the key stage. Within each key stage, schools therefore have the flexibility to introduce content earlier or later than set out in the programme of study. In addition, schools can introduce key stage content during an earlier key stage if appropriate. All schools are also required to set out their school curriculum for science on a year-by-year basis and make this information available online.

Key Stage 1:

The principal focus of science teaching in key stage 1 is to enable pupils to experience and observe phenomena, looking more closely at the natural and humanly-constructed world around them. They should be encouraged to be curious and ask questions about what they notice. They should be helped to develop their understanding of scientific ideas by using different types of scientific enquiry to answer their own questions, including observing changes over a period of time, noticing patterns, grouping and classifying things, carrying out simple comparative tests, and finding things out using secondary sources of information. They should begin to use simple scientific language to talk about what they have found out and communicate their ideas to a range of audiences in a variety of ways. Most of the learning about science should be done through the use of first-hand practical experiences, but there should also be some use of appropriate secondary sources, such as books, photographs and videos. 'Working scientifically' is described separately in the programme of study, but must always be taught through and clearly related to the teaching of substantive science content in the programme of study. Throughout the notes and guidance, examples show how scientific methods and skills might be

linked to specific elements of the content. Pupils should read and spell scientific vocabulary at a level consistent with their increasing word reading and spelling knowledge at key stage 1.

Key stage 1 programme of study – years 1 and 2

Working scientifically

Statutory requirements 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.

Year 1 programme of study

Plants: Statutory requirements

Pupils should be taught to:

- ♣ 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.

Animals, including humans: Statutory requirements

Pupils should be taught to:

- ♣ 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: Statutory requirements

Pupils should be taught to:

- ♣ 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 changes: Statutory requirements

Pupils should be taught to:

- ♣ observe changes across the four seasons
- ♣ observe and describe weather associated with the seasons and how day length varies.

Year 2 programme of study

Living things and their habitats: Statutory requirements

Pupils should be taught to:

- ♣ 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 microhabitats
- ♣ 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.

Plants: Statutory requirements

Pupils should be taught to:

- ♣ 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.

Animals, including humans: Statutory requirements

Pupils should be taught to:

- ♣ 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.

Uses of everyday materials: Statutory requirements

Pupils should be taught to:

- ♣ 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.

Lower key stage 2 – years 3 and 4

The principal focus of science teaching in lower key stage 2 is to enable pupils to broaden their scientific view of the world around them.

They should do this through exploring, talking about, testing and developing ideas about everyday phenomena and the relationships between living things and familiar environments, and by beginning to develop their ideas about functions, relationships and interactions. They should ask their own questions about what they observe and make some decisions about which types of scientific enquiry are likely to be the best ways of answering them, including observing changes over time, noticing patterns, grouping and classifying things, carrying out simple comparative and fair tests and finding things out using secondary sources of information. They should draw simple conclusions and use some scientific language, first, to talk about and, later, to write about what they have found out. ‘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. Throughout the notes and guidance, examples show how scientific methods and skills might be linked to specific elements of the

content. Pupils should read and spell scientific vocabulary correctly and with confidence, using their growing word reading and spelling knowledge.

Lower key stage 2 programme of study

Working scientifically: Statutory requirements

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.

Year 3 programme of study

Plants: Statutory requirements

Pupils should be taught to:

- ♣ 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.

Animals, including humans: Statutory requirements

Pupils should be taught to:

- ♣ 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: Statutory requirements

Pupils should be taught to:

- ♣ 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.

Light: Statutory requirements

Pupils should be taught to:

- ♣ 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.

Forces and magnets: Statutory requirements

Pupils should be taught to:

- ♣ 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.

Year 4 programme of study**Living things and their habitats: Statutory requirements**

Pupils should be taught to:

- ♣ 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.

Animals, including humans: Statutory requirements

Pupils should be taught to:

- ♣ 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.

States of matter: Statutory requirements

Pupils should be taught to:

- ♣ 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.

Sound: Statutory requirements

Pupils should be taught to:

- ♣ 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.

Electricity: Statutory requirements

Pupils should be taught to:

- ♣ 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
- ♣ recognise some common conductors and insulators, and associate metals with being good conductors.

Upper key stage 2 – years 5 and 6

The principal focus of science teaching in upper key stage 2 is to enable pupils to develop a deeper understanding of a wide range of scientific ideas. They should do this through exploring and talking about their ideas; asking their own questions about scientific phenomena; and analysing functions, relationships and interactions more systematically. At upper key stage 2, they should encounter more abstract ideas and begin to recognise how these ideas help them to understand and predict how the world operates. They should also begin to recognise that scientific ideas change and develop over time. They should select the most appropriate ways to answer science questions using different types of scientific enquiry, including observing changes over different periods of time, noticing patterns, grouping and classifying things, carrying out comparative and fair tests and finding things out using a wide range of secondary sources of information. Pupils should draw conclusions based on their data and observations, use evidence to justify their ideas, and use their scientific knowledge and understanding to explain their findings. 'Working and thinking 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. Throughout the notes and guidance, examples show how scientific methods and skills might be linked to specific elements of the content. Pupils should read, spell and pronounce scientific vocabulary correctly.

Upper key stage 2 programme of study

Working scientifically: Statutory requirements

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.

Living things and their habitats: Statutory requirements

Pupils should be taught to:

- ♣ 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.

Animals, including humans: Statutory requirements

Pupils should be taught to:

- ♣ describe the changes as humans develop to old age.

Properties and changes of materials Statutory requirements

Pupils should be taught to:

- ♣ 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.

Earth and space: Statutory requirements

Pupils should be taught to:

- ♣ 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.

Forces: Statutory requirements

Pupils should be taught to:

- ♣ 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.

Year 6 programme of study

Living things and their habitats: Statutory requirements

Pupils should be taught to:

- ♣ describe how living things are classified into broad groups according to common observable characteristics and based on similarities and differences, including microorganisms, plants and animals
- ♣ give reasons for classifying plants and animals based on specific characteristics.

Animals including humans: Statutory requirements

Pupils should be taught to:

- ♣ 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.

Evolution and inheritance: Statutory requirements

Pupils should be taught to:

- ♣ 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.

Light: Statutory requirements

Pupils should be taught to:

- ♣ 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.

Electricity: Statutory requirements

Pupils should be taught to:

- ♣ 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.



Initial subject self-evaluation

Summary:
The key strengths in:
<i>Teaching, learning & assessment in Science are:</i>
<i>The Science Curriculum are:</i>
The main areas we need to develop in:
<i>Teaching, learning & assessment in Science are:</i>
<i>The Science curriculum are:</i>

Signed:

Date:



Part B: Best practice as identified by Ofsted

The last time Ofsted reported specifically on Successful Science: an evaluation of science education in England 2007-2010¹ (2012), they stated that:

Primary schools should:

- ensure that pupils are engaged in scientific enquiry, including practical work, and are developing enquiry skills. They should be providing a balanced programme of science education for all year groups that develops science knowledge and understanding and has a significant focus on developing skills
- make provision for effective continuing professional development to support and extend teachers' knowledge, understanding and skills in science and their confidence in teaching it
- invest in developing the role of the science coordinator to provide effective, sustained leadership in the subject and promote improvements in teaching and learning.

Good progress and standards were most often associated with:

- good leadership and management
- effective continuing professional development
- the improved use of assessment
- a clear focus on science work that included a significant component of scientific enquiry and investigation.

Recognising the outstanding

This section of the report exemplifies outstanding science lessons. The text is taken from inspectors' direct observations of lessons and the examples cover a range of topics and year groups.

Primary example 1: Reception class

During their time sitting on the carpet, the teacher engages the children in describing the mini-beasts they had seen in their investigation of the school's grounds. In pairs the children talk about their mini-beasts and then share their ideas with the whole class.

The teacher brings the teaching assistants into the conversation and they remind the children of their experiences. This helps them to arrive at an understanding of the wide range of living things in their environment. A sense of ownership and care for the environment is generated.

The teacher shows a video of a butterfly and its way of life. The presentation is interactive on the whiteboard and teacher skilfully uses questions and the children's answers to establish what was alive during the observation and the characteristics of living things. The children's level of interest and engagement is very high

¹ Successful Science: an evaluation of science education in England 2007-2010 (2011)

The teaching is animated and enthusiastic and the teacher has a detailed knowledge of the needs of individual children. She shows the class the caterpillars that they observed during the previous week and the children can see how much they have grown. Careful prompts from the teacher are effective in helping the children cooperatively to relate the characteristics of living things to their observations of the caterpillars. During this time the teacher works with individuals or small groups to promote further thought to extend their learning. The teaching assistants are similarly engaged in a purposeful way.

A session of summarising questions and answers leads to pupils demonstrating the caterpillar/butterfly life cycle to reinforce their knowledge and understanding. A child is dressed in a cagoule to represent the 'skin' of the caterpillar and is then wrapped in toilet paper to represent the cocoon. When the pupil breaks out of the cocoon the back of the costume shows the wings of the butterfly. To reinforce the learning, the teacher then takes on the role of the child and the pupils become the teacher in explaining the life cycle of the butterfly.

Key features

- * High levels of engagement
- * Vigilance from the teacher in monitoring progress
- * Very good use of guided discussion between children
- * Very effective questioning to elicit ideas, to engage pupils and check understanding
- * Very clear progression of ideas; a very well-planned sequence of learning
- * Good individual intervention and extension
- * Very effective class management, including the deployment of teaching assistants.

Primary example 2: Year 3

The lesson begins with an effective question and answer session in which pupils describe what they know about light. This clarifies the pupils' understanding of key vocabulary such as 'translucent', 'opaque' and 'transparent'. There are high levels of response, application and attention.

The teacher uses a penguin puppet to ask about shadows of objects in relation to an overhead projector, discussing size, shape, position and clarity. The pupils have recently been learning about energy and how the environment can be harmed by the poor management of energy. A pupil comments on the heat from the overhead projector and the teacher takes the opportunity to consolidate the pupils' thinking on energy and conservation; not wasting electricity; noise and heat as waste energy from such devices; and the dangers of overheating by poor use.

More discussion follows on what can be seen or not seen in a shadow, and talk of shades of grey, not just black and white, shows that light is dispersed in the atmosphere. The pupils then move around a series of well-planned and well-resourced activities at different stations in the room. Pupils' levels of application and good collaboration are very high. The teacher is very effective at monitoring progress and managing activities so that all the pupils visit all the work stations, consolidating and extending their knowledge and understanding of light.

Key features

- * very good classroom management, combined with very good relationships, result in high levels of application
- * effective explanations
- * excellent questions used to check understanding, promote thinking and engage pupils
- * very careful and effective development of vocabulary and its accurate use
- * the creation of a positive environment for learning science

Primary example 3: Year 5

Pupils collaborate well on an investigative task about friction. They are working on the question, 'Which is the best shoe for gripping the floor?' Pupils have been planning their investigation, taking decisions on what to measure, the equipment needed and the procedures they will carry out. The teacher has worked with the teaching assistant to plan and anticipate the range of activities that might be proposed. The assessment strategy for the activity was also agreed with the teaching assistant. The teacher and the teaching assistant have considered the 'knowledge and understanding' content of the activity and the science skills, such as the consideration of variables and the need for accurate measurement. The pupils work in groups of four and discuss their plans.

Discussions with pupils show that they understand fair testing clearly and can describe why they chose to carry out the investigation in the way they planned. Their attitudes to science work are very positive. They cite 'doing practical' as one of the things they enjoy most. They have considered the different surfaces on which they do not want the shoe to slip. They demonstrate their understanding of the need for accuracy and the purpose of repeating procedures and measurements to raise reliability. They choose a scale for measurement that will be most appropriate and they agree on their roles in the procedure.

Overall, the groups investigate a good range of variables and measurements and the outcomes are shared effectively with others. The process is very well managed by the teacher. A plenary discussion demonstrates the pupils' good and developing knowledge and understanding of forces, friction, surface area, changing mass to change force, and the range of variables considered.

Key features

- * a very well-planned lesson in which the teaching assistant was fully aware of lesson objectives and assessment goals
- * teacher vigilant in monitoring progress
- * excellent collaboration; pupils take on roles and work constructively with each other
- * pupils were taking decisions rationally and with understanding of scientific enquiry
- * pupils were planning confidently and were selecting appropriate equipment; they were not simply following instructions: they knew what they were doing and why
- * very good assessment procedures, coordinated between teacher and teaching assistant
- * procedures carried out accurately: the pupils understood the need to repeat measurements and calculate averages to make the findings more reliable
- * a very effective plenary session, in which the pupils were learning from each other's work, leading to good understanding of the range of knowledge elicited by this practical work.

Primary example 4: Year 6

The pupils' behaviour is excellent, they are engaged well. The teacher teaches enthusiastically and confidently through a well-planned lesson. She uses ICT effectively to illustrate a view of the future as she sets the scene to learn about evolution. The simulation shows the world in five million years' time.

She uses questions and answers well, with many of the questions directed at individuals for specific reasons: keeping attention, building self-confidence, encouraging, and checking understanding. She explores ideas such as plate tectonics through the effective ICT presentation. Evolution and adaptations are talked about with high levels of interaction with pupils. They make suggestions and answer questions confidently.

Pupils then carry out a 'beak experiment' very successfully. They use forceps of different shapes as model beaks to tackle four different samples of living things: small seeds, walnuts, apples, worms. They work in groups and their enjoyment of the activity is very evident. They discuss spontaneously how the shape of the beak affects what they can do with it and hence affirm the ideas of adaptation, the shape of the beak affecting how successful they were at feeding on particular food items.

Finally, pupils watch a video of an evolving lizard that lives on the salt flats, catching flies on its frills and so on. Pupils not only enjoy the video but they readily identify the key features of the lizard and how these help it to survive in that environment.

Key features

- * A very well prepared lesson
- * Very confident and enthusiastic teaching
- * A well-sequenced series of activities that engaged pupils effectively
- * Imaginative practical work that built skills, knowledge and understanding effectively
- * Very good-quality resources including well-researched and relevant video clips.

From satisfactory to good and beyond

The following examples are descriptions of satisfactory science lessons. Suggestions are made about how the lesson might be improved to raise the quality to at least good.

Primary example 1: Reception Class

The teacher begins to outline the activities for the morning. During their time sitting on the carpet, the children are restless and their attention is only satisfactory. The range of activities is quite prescribed and there is little evidence of the teacher using suggestions the children make. There are two teaching assistants who do little to encourage the children's engagement with what the teacher is explaining.

The class splits into different activity groups: work on floating and sinking, use of computer programs, and water play, filling plastic bottles and plastic containers of different shapes and sizes. The experiences are well-planned but not carried out fully in practice. The teaching assistants are not taking a full part in the learning activities but tend to child-mind and concentrate on mopping up water spills and so on. The children are active and engaged for much of the time. In the main, they are focused on the tasks they have been set. They are learning but the pace is only moderate. There is some good development of language because the teacher interacts with the children during their activities. There is no plenary work by the teacher in the groups, so the learning is not shared as well as it might be.

Areas for improvement

- * The session needed more structured interaction between the adults and children. The children naturally enjoyed the exploration activity but the interaction with adults to talk about what was happening and to encourage more focused observations was limited.
- * The teaching assistants should have been better briefed, so that they had a clear understanding of their role in promoting learning and were able to raise the quality of the learning by more effective intervention. Their limited contribution was the weakest feature of the session.
- * Developing the children's language should have been a priority for all the adults in the class. This was proceeding well for the children who had the teacher's attention but the teaching

assistants were under-deployed in this area and did not engage children as much as they could have done.

* The children's ideas and suggestions could have been better exploited. Opportunities to evaluate and build on their ideas could have had a positive impact on promoting their engagement and guiding learning.

Primary example 2: Year 2

At the start of the lesson, many pupils respond to the teacher's question and answer session but not all pay good attention. Vocabulary such as 'photosynthesis' arises but there is no overt checking of understanding by the teacher. Clearly, some pupils have used the word and associate it with plants making food from sunshine. For some their understanding is not secure and this is not recognised or challenged by the teacher. During the questions and answers, the teacher describes the roots 'taking up food'. This is inaccurate and can lead to misconceptions, as it is water and minerals/nutrients that are taken from the soil by the roots. Pupils' attitudes are good and most are keen to answer the teacher's questions. The notion of fair testing is understood by many and their responses to questions, expressed in their own language, indicate good understanding.

There is an ICT display of seasonal pictures with different forms and stages of life, which provides a rolling presentation of living things and growth.

The class is organised into groups efficiently and the teacher uses ICT effectively to set out procedures and instructions for the work to be done. She elicits their ideas well but does not respond effectively to a couple of the more inventive ideas that she was not expecting. The pupils set up apparatus to investigate water absorption, but the equipment provided is not well-matched to the activity; for example, one-litre jugs are used for measuring 100ml. Spillages and inaccuracies are not challenged and nor are the pupils spotting the problem that this poses. The teacher's main concern seems to be to complete the activity, and there is insufficient focus on the quality of the practical work and the refining of the pupils' thinking. They enjoy the work and behave responsibly, even if the accuracy and the pace of learning are only satisfactory.

Areas for improvement

* The lesson would have been more effective if the teacher had had a clearer understanding of what the pupils already knew or did not know about plants and the way that they make food. Assessment for learning techniques could have informed her of areas of misunderstanding, as could initial discussions between pupils, working in pairs or small groups.

* Although it is challenging to do so, the teacher needed to ensure that she used scientific terms accurately. Consulting the science coordinator before each unit of work to check the key vocabulary and its meaning is an effective way of doing this. Some schemes of work have key words highlighted to alert teachers to their accurate use. The problems in science can often involve words where the common meaning is different from the more precise scientific usage.

* The practical equipment used should have been appropriate to the task, allowing pupils to make sufficiently accurate measurements.

* The teacher herself clearly did not have an adequate understanding of the need for accuracy.

Primary example 3: Year 4/5

The pupils are working on planning an investigation of materials suitable for making a model ship. The work is set within a theme involving Tudor ships. The teacher leads a class discussion on fair testing, changing variables and measuring. This goes on for too long and pupils begin to lose interest.

The class is split into groups depending on their attainment. The different groups have different questions to tackle related to the strength, flexibility and floating properties of the materials. The pupils are using a standard planning sheet to provide focus and minimise the language required to plan their work. When the pupils move on to their own planning, many find it difficult, particularly in setting up a fair test.

The materials provided include a cardboard cereal box, a foil tray, a length of wood, cardboard tubes, felt and other materials. All these are of different sizes and shapes and no means is provided of cutting the materials to the same shape and size. Some pupils are puzzled by this and teacher passes over the questions they ask about it. The teaching assistant does some very good work with a group of low-attaining pupils by asking pertinent questions and giving clear guidance to move their ideas along. The teacher circulates around the groups, checking on their progress but a few groups struggle to come up with a plan for an investigation they can undertake. The teacher's lack of direction does not help the pupils to make suitable progress and it allows some less-committed pupils to wander off-task.

Areas for improvement

- * The lesson illustrated the challenge of combining science and design and technology. * A lack of understanding of this combination led to inappropriate materials and equipment being deployed in a task that frustrated pupils. The science learning objectives needed to be clearer.
- * A better approach to the notion of fair testing would have been to start with a well-structured class discussion in order to pick off issues one by one, to develop a common understanding of the challenge and identify a number of strategies to tackle the problem. The provision of different questions to different groups, with the assumption that a fair test could be applied to them all, showed a misunderstanding of the subject's demands.
- * Although the teaching assistant's contribution to the pupils she worked with was good, this was on her own initiative. The whole class could have benefited from support being better allocated across the different groups.
- * The pupils needed more judicious use of instruction and direction when they were unclear about how to proceed. This would have helped their confidence and made it possible for them to work more constructively. The teacher's withholding of direction and her lack of response to questions were not effective in getting pupils to think.

Primary example 4: Year 6

The theme of the lesson is the rate at which a solid dissolves. The teacher asks the pupils to put their ideas about the variables involved on sticky notes and to place them on laminated cards, in groups, to see how many and what types of variables are identified. Some confusion begins as the pupils start work. Out of the six groups, two have not understood the challenge and are reinforcing misunderstanding through their discussions with one another. Teaching assistants had watched the initial 'start up' but do not challenge the misunderstandings sufficiently and it is some time before the teacher gets round to all six groups.

The pupils are well-motivated and keen to take on the task. They have satisfactory practical skills. There is confusion among some of them as to what they are to measure; some are measuring the independent variable rather than the dependent variable. The idea behind the practical work is sound and simple, but the execution is weaker than it could be because the teacher and teaching assistants are not tuning pupils into the work with sufficient clarity, and intervention is limited by the inefficient deployment of the teaching assistants.

While learning is progressing satisfactorily, the rate could be quicker. The phrasing of the questions to investigate is difficult for some pupils and the teaching assistants become more active in helping pupils to clarify their ideas and language as the lesson proceeds. The teacher refers to dissolving, inaccurately, as a change of state. Some pupils decide to measure how much sugar is added to the water by measuring the volume of sugar. The teacher uses 'volume' in talking to these pupils while with others she refers correctly to the 'mass' of sugar, and pupils set about measuring the sugar by using electronic scales. Some pupils do not understand what the difference is between mass and volume and this also leads to some confusion.

Areas for improvement

- * The teacher could have taken more time to clarify the pupils' thinking about and understanding of the task before they started on it.
- * A whole-class session of question and answer would have clarified pupils' prior knowledge and understanding. This would have helped the teacher to determine how well individuals understood. She could then have worked with the weaker pupils to promote their understanding while encouraging the higher attainers to 'get on with it'.
- * The teaching assistants should have been briefed more clearly about the lesson's learning priorities. They were under-deployed initially, although they eventually focused appropriately on groups and individuals who were struggling with organising language, ideas and equipment.
- * The teacher's inaccurate use of some scientific vocabulary could have been a stumbling block to effective learning. Whenever practicable, teachers should check their own understanding, for example with the science leader.



Part C: Science: Quality of Education – Good (in old money²)

Achievement

- Pupils regularly work independently, often taking the initiative in individual work and when working with others.
- They show confidence and competence in the full range of stage-appropriate practical work, including planning and carrying out science investigations in groups or individually.
- Pupils use their scientific knowledge and understanding well in most situations to give accurate explanations or solve challenging problems requiring appropriate control of several variables, and report their findings clearly using accurate scientific language.
- They research science issues using different sources of information. They demonstrate some originality in their approach, coming up with new ideas on how to tackle a problem or display data. They show imagination in forming hypotheses and in the way they go about their science work.
- Pupils enjoy science and apply themselves well. They are able to explain the subject's value and show an appreciation of the impact of science on society, themselves and its contribution to life in a technological age.
- Over time, the proportion of male and female pupils that progress to post-16 science studies is similar to the proportions nationally.

Teaching

- The value of science is explained through the use of a range of relevant contexts, which also exemplify its impact on society. These examples engage pupils' interest, maintain curiosity and hone their understanding of research and the application of scientific skills.
- Pupils engage well in practical work, including fieldwork. Teachers have a confident level of specialist expertise which they use well in planning and teaching their subject, using accurate assessment of individual pupils' prior knowledge and understanding.
- Further discussion is prompted by informed responses to pupils' questions. Pupils have frequent opportunities for research using books and the internet. They are taught how to summarise and present their research as part of developing their literacy and communication skills.
- Teachers have a clear understanding of progression in science skills, knowledge and understanding and how the 'big ideas' of science can be understood through

² Taken from the Subject Specific Guidance (Ofsted 2013)

increasingly demanding details and concepts. As a result, they use an appropriate range of resources and teaching strategies to promote good learning across all aspects of the subject.

- Teachers give pupils many opportunities to show and apply their own knowledge, skills and understanding of science, and give extended explanations.

Curriculum

- The curriculum is broad, balanced and well informed by current research and development in science education. It meets the learning needs of all groups of pupils and ensures effective continuity and progression, including in scientific enquiry and pupils' understanding of how science works.

- Planned experiences for learning promote progress within and between year groups, and maintain a good balance between all four areas of the science National Curriculum. In primary schools, the key ideas are regularly reinforced over time through practical work.

- Good links are forged with other subjects and the wider community to provide a range of enrichment activities that promote pupils' learning and engagement with science.

- Good advice and guidance on progression in science beyond compulsory education is embedded in the curriculum....,

- Opportunities to promote spiritual, moral, social and cultural development are systematically planned and delivered to ensure every pupil benefits.

Leadership

- Leaders are well informed by current developments in the subject and are aware of developments in science education, including in other schools and by national agencies and associations.

- Pupil progress in science is tracked during the year with feedback from this used to drive intervention and extension activities.

- Subject reviews, self-evaluation and improvement planning are successfully focused on raising attainment and improving the provision for science. They are carried out systematically and the outcomes communicated effectively to all science staff so that there is a common understanding of priorities.

- There are shared common purposes among those involved in teaching science. Teachers have good opportunities to share practice among themselves and have access to subject training within and beyond the boundaries of the school, where appropriate. Science reflects wider whole-school priorities including consistent application of literacy and numeracy policies.

- Science leaders ensure that health and safety information is up-to-date and understood by colleagues.



Part D: Science: Quality of Education

INTENT		
NEW HANDBOOK	EVIDENCE	OLD SUBJECT CRITERIA
<p>Leaders adopt or construct a curriculum that is ambitious and designed to give all pupils, particularly disadvantaged pupils and including pupils with SEND, the knowledge and cultural capital they need to succeed in life. This is either the national curriculum or a curriculum of comparable breadth and ambition. <i>[If this is not yet fully the case, it is clear from leaders' actions that they are in the process of bringing this about.]</i></p>		
<p>The school's curriculum is coherently planned and sequenced towards cumulatively sufficient knowledge and skills for future learning and employment. <i>[If this is not yet fully the case, it is clear from leaders' actions that they are in the process of bringing this about.]</i></p>		
<p>The curriculum is successfully adapted, designed or developed to be ambitious and meet the needs of pupils with SEND, developing their knowledge, skills and abilities to apply what they know and can do with increasing fluency and independence. <i>[If this is not yet fully the case, it is clear from leaders' actions that they are in the process of bringing this about.]</i></p>		

IMPLEMENTATION		
NEW HANDBOOK	EVIDENCE	OLD SUBJECT CRITERIA
<p>Teachers have good knowledge of the subject(s) and courses they teach. Leaders provide effective support for those teaching outside their main areas of expertise.</p>		
<p>Teachers present subject matter clearly, promoting appropriate discussion about the subject matter being taught. They check pupils' understanding systematically, identify misconceptions accurately and provide clear, direct feedback. In so doing, they respond and adapt their teaching as necessary without unnecessarily elaborate or individualised approaches.</p>		
<p>Over the course of study, teaching is designed to help pupils to remember long term the content they have been taught and to integrate new knowledge into larger ideas.</p>		
<p>Teachers and leaders use assessment well, for example to help pupils embed and use knowledge fluently, or to check understanding and inform teaching. Leaders understand the limitations of assessment and do not use it in a way that creates unnecessary burdens on staff or pupils.</p>		
<p>Teachers create an environment that focuses on pupils. The textbooks and other teaching materials that teachers select – in a way that does not create unnecessary workload for staff – reflect the school's ambitious intentions for the course of study. These materials clearly support the</p>		

intent of a coherently planned curriculum, sequenced towards cumulatively sufficient knowledge and skills for future learning and employment.		
The work given to pupils is demanding and matches the aims of the curriculum in being coherently planned and sequenced towards cumulatively sufficient knowledge.		
Reading is prioritised to allow pupils to access the full curriculum offer.		
A rigorous and sequential approach to the reading curriculum develops pupils' fluency, confidence and enjoyment in reading. At all stages, reading attainment is assessed and gaps are addressed quickly and effectively for all pupils. Reading books connect closely to the phonics knowledge pupils are taught when they are learning to read.		
The sharp focus on ensuring that younger children gain phonics knowledge and language comprehension necessary to read, and the skills to communicate, gives them the foundations for future learning.		
Teachers ensure that their own speaking, listening, writing and reading of English support pupils in developing their language and vocabulary well.		

IMPACT		
NEW HANDBOOK	EVIDENCE	OLD SUBJECT CRITERIA
Pupils develop detailed knowledge and skills across the curriculum and, as a result, achieve well. This is reflected in results from national tests and examinations that meet government expectations, or in the qualifications obtained.		
Pupils are ready for the next stage of education, employment or training. They have the knowledge and skills they need and, where relevant, they gain qualifications that allow them to go on to destinations that meet their interests and aspirations and the intention of their course of study. Pupils with SEND achieve the best possible outcomes.		
Pupils' work across the curriculum is of good quality.		
Pupils read widely and often, with fluency and comprehension appropriate to their age. They are able to apply mathematical knowledge, concepts and procedures appropriately for their age.		

Part E: Science: Quality of Education (Exemplar)

INTENT		
NEW HANDBOOK	EVIDENCE	OLD SUBJECT CRITERIA
<p>Leaders adopt or construct a curriculum that is ambitious and designed to give all pupils, particularly disadvantaged pupils and including pupils with SEND, the knowledge and cultural capital they need to succeed in life. This is either the national curriculum or a curriculum of comparable breadth and ambition. <i>[If this is not yet fully the case, it is clear from leaders' actions that they are in the process of bringing this about.]</i></p>		<p>Leaders are well informed by current developments in the subject and are aware of developments in science education, including in other schools and by national agencies and associations.</p> <p>The curriculum is broad, balanced and well informed by current research and development in science education. It meets the learning needs of all groups of pupils and ensures effective continuity and progression, including in scientific enquiry and pupils' understanding of how science works.</p>
<p>The school's curriculum is coherently planned and sequenced towards cumulatively sufficient knowledge and skills for future learning and employment. <i>[If this is not yet fully the case, it is clear from leaders' actions that they are in the process of bringing this about.]</i></p>		<p>Planned experiences for learning promote progress within and between year groups, and maintain a good balance between all four areas of the science National Curriculum. In primary schools, the key ideas are regularly reinforced over time through practical work. In secondary schools, sufficient time and high-quality practical resources to teach science through practical investigation and illustration are provided, with the result that students are motivated to study the subject further at 16 and 18.</p> <p>Good advice and guidance on progression in science beyond compulsory education is embedded in the curriculum, and pathways do not limit progression, particularly if vocational subjects are taken at Key Stage 4.</p>

<p>The curriculum is successfully adapted, designed or developed to be ambitious and meet the needs of pupils with SEND, developing their knowledge, skills and abilities to apply what they know and can do with increasing fluency and independence. <i>[If this is not yet fully the case, it is clear from leaders' actions that they are in the process of bringing this about.]</i></p>		
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IMPLEMENTATION		
NEW HANDBOOK	EVIDENCE	OLD SUBJECT CRITERIA
<p>Teachers have good knowledge of the subject(s) and courses they teach. Leaders provide effective support for those teaching outside their main areas of expertise.</p>		<p>Teachers have a clear understanding of progression in science skills, knowledge and understanding and how the 'big ideas' of science can be understood through increasingly demanding details and concepts. As a result, they use an appropriate range of resources and teaching strategies to promote good learning across all aspects of the subject.</p> <p>There are shared common purposes among those involved in teaching science. Teachers have good opportunities to share practice among themselves and have access to subject training within and beyond the boundaries of the school, where appropriate. Science reflects wider whole-school priorities including consistent application of literacy and numeracy policies.</p>
<p>Teachers present subject matter clearly, promoting appropriate discussion about the subject matter being taught. They check pupils' understanding systematically, identify misconceptions accurately and provide clear, direct feedback. In so doing, they respond and adapt their teaching as necessary without unnecessarily elaborate or individualised approaches.</p>		<p>Teachers give pupils many opportunities to show and apply their own knowledge, skills and understanding of science, and give extended explanations.</p> <p>Pupils enjoy science and apply themselves well. They are able to explain the subject's value and show an appreciation of the impact of science on society, themselves and its contribution to life in a technological age.</p>
<p>Over the course of study, teaching is designed to help pupils to remember long term the content they have been taught and to integrate new knowledge into larger ideas.</p>		<p>They research science issues using different sources of information. They demonstrate some originality in their approach, coming up with new ideas on how to tackle a problem or display data. They show imagination in forming hypotheses and in the way they go about their science work.</p> <p>They show confidence and competence in the full range of stage-appropriate practical work,</p>

		including planning and carrying out science investigations in groups or individually.
Teachers and leaders use assessment well, for example to help pupils embed and use knowledge fluently, or to check understanding and inform teaching. Leaders understand the limitations of assessment and do not use it in a way that creates unnecessary burdens on staff or pupils.		Pupil progress in science is tracked during the year with feedback from this used to drive intervention and extension activities.
Teachers create an environment that focuses on pupils. The textbooks and other teaching materials that teachers select – in a way that does not create unnecessary workload for staff – reflect the school’s ambitious intentions for the course of study. These materials clearly support the intent of a coherently planned curriculum, sequenced towards cumulatively sufficient knowledge and skills for future learning and employment.		Pupils use their scientific knowledge and understanding well in most situations to give accurate explanations or solve challenging problems requiring appropriate control of several variables, and report their findings clearly using accurate scientific language.
The work given to pupils is demanding and matches the aims of the curriculum in being coherently planned and sequenced towards cumulatively sufficient knowledge.		Pupils regularly work independently, often taking the initiative in individual work and when working with others.
Reading is prioritised to allow pupils to access the full curriculum offer.		
A rigorous and sequential approach to the reading curriculum develops pupils’ fluency, confidence and enjoyment in reading. At all stages, reading attainment is assessed and gaps are addressed quickly and effectively for all pupils. Reading books connect closely to the phonics		

knowledge pupils are taught when they are learning to read.		
The sharp focus on ensuring that younger children gain phonics knowledge and language comprehension necessary to read, and the skills to communicate, gives them the foundations for future learning.		
Teachers ensure that their own speaking, listening, writing and reading of English support pupils in developing their language and vocabulary well.		

IMPACT		
NEW HANDBOOK	EVIDENCE	OLD SUBJECT CRITERIA
<p>Pupils develop detailed knowledge and skills across the curriculum and, as a result, achieve well. This is reflected in results from national tests and examinations that meet government expectations, or in the qualifications obtained.</p>		<p>They show confidence and competence in the full range of stage-appropriate practical work, including planning and carrying out science investigations in groups or individually.</p> <p>Pupils use their scientific knowledge and understanding well in most situations to give accurate explanations or solve challenging problems requiring appropriate control of several variables, and report their findings clearly using accurate scientific language.</p> <p>Pupils enjoy science and apply themselves well. They are able to explain the subject's value and show an appreciation of the impact of science on society, themselves and its contribution to life in a technological age.</p>
<p>Pupils are ready for the next stage of education, employment or training. They have the knowledge and skills they need and, where relevant, they gain qualifications that allow them to go on to destinations that meet their interests and aspirations and the intention of their course of study. Pupils with SEND achieve the best possible outcomes.</p>		<p>Over time, the proportion of male and female pupils that progress to post-16 science studies is similar to the proportions nationally.</p>
<p>Pupils' work across the curriculum is of good quality.</p>		<p>Opportunities to promote spiritual, moral, social and cultural development are systematically planned and delivered to ensure every pupil benefits.</p>
<p>Pupils read widely and often, with fluency and comprehension appropriate to their age. They are able to apply mathematical knowledge, concepts and procedures appropriately for their age.</p>		<p>Good links are forged with other subjects and the wider community to provide a range of enrichment activities that promote pupils' learning and engagement with science.</p>



Annex 1: Science – Outstanding (in ‘old’ money)

Achievement

- Pupils show exceptional independence; they are able to think for themselves and raise their own questions about science knowledge, understanding and scientific enquiry.
- They are confident and competent in the full range of stage-related practical skills, taking the initiative in planning, carrying out, recording and evaluating their own scientific investigations.
- Pupils frequently use their scientific knowledge and understanding very effectively in written and verbal explanations, solving challenging problems and reporting scientific findings formally.
- They work constructively with other pupils, demonstrating common understanding in discrete well-focused roles, with all playing a part in successful investigations.
- Pupils show high levels of originality, imagination and innovation in their understanding and application of their knowledge and skills.
- Their practical work incorporates a variety of contexts, including fieldwork.
- Pupils research contemporary issues and understand the impact of science on society.
- They develop a sense of passion and commitment to science, showing strong application and enthusiasm to learn more through scientific endeavour.
- Over time, the proportion of male and female pupils that progress to post-16 science studies is similar to the proportions nationally.

Teaching

- Teachers expect each pupil to operate as a scientist, engaging fully in practical work using science skills, knowledge and understanding to inform their work.
- Pupils are aided in moving beyond the limits of the National Curriculum or examination specification in order to maintain curiosity.
- Answers to pupils’ questions are accurate and effective at stimulating further thought. Their confidence extends to all areas of science taught, and in secondary schools, not just in their specialist subject. This stimulates pupils’ inquisitiveness.
- Teachers have a very clear understanding of how science is learnt best, using the scientific phenomenon itself as the core focus of lessons. This includes scientific investigation and practical work, including fieldwork; research using a range of resources; evaluation; discussion; and opportunities for pupils to deliver high-quality presentations.
- Pupils’ active participation in their learning secures outstanding progress across all aspects of the subject because teachers use a very wide range of innovative and imaginative resources including local contexts, along with well-chosen teaching strategies.

Curriculum

- The imaginative and stimulating science curriculum is skilfully designed to match the full range of pupils' needs and to ensure highly effective continuity and progression in their learning. The curriculum equips pupils in all year groups with an excellent balance of subject knowledge and understanding, and the skills of scientific enquiry, across the three main areas of biology, chemistry and physics.
- An excellent range of learning opportunities involves pupils frequently in scientific enquiry, practical work, fieldwork, research, use of ICT, individual and group work, discussions, modelling and evaluation.
- The contexts in which science is taught are relevant to pupils' lives, capture their interest and reflect current science from the worlds of industry, research and other science-based endeavours such as health care.
- The non-statutory entitlement for all pupils with Key Stage 3 science attainment at Level 6 and above that would benefit from the study of triple science GCSEs is met.
- There are productive links with other subjects in the school, including with mathematics, design technology and English.
- Excellent links with other agencies and the wider community provide a wide range of enrichment activities to promote pupils' learning and engagement, such as science-based clubs and visits to sites where science is at the heart of the activities. Regular visits by science professionals who share their relevant experiences should relate to pupils' experiences of science in lessons.
- Rigorous planning for pupils' spiritual, moral, social and cultural development ensures that all pupils experience the full wonder of the universe and develop a responsible attitude to environmental protection.

Leadership

- Leadership is informed by a high level of science expertise and vision and is improving the performance and practice of members of the department (secondary) or school as a whole (primary).
- Pupil progress in science is tracked frequently, with feedback from this used to drive intervention and extension activities.
- Science teaching embraces whole-school policies on literacy and numeracy and the subject systematically contributes strongly to improving these aspects.
- There is a strong track record of innovation and this is recognised and shared in the department to promote raising standards. Subject review, self-evaluation and improvement planning are well-informed by current good practice in science education. This should involve participation in debate and developments with other science providers in a wider area.
- Subject leadership inspires confidence and whole-hearted commitment from pupils and colleagues. There are effective strategies to delegate subject responsibilities where appropriate, share good practice and secure high-quality professional development in the subject.
- Continuing professional development is well targeted and thoroughly evaluated for its impact on maintaining pupils' curiosity. It includes up-to-date training for technical support staff, and a current understanding of health and safety matters relating to science teaching.
- Resources, including teaching time, practical facilities and staff professional development, match the ambition and expectations of staff for high achievement and the future success of pupils in science.



Annex 2: Progression in Science: exemplar

	How science works (Scientific enquiry)	Organisms, their behaviour and the environment	Materials, their properties and the earth	Energy, forces and space
A	<p>Pupils respond to prompts to suggest practical ways to find answers to questions.</p> <p>They make observations about features of objects, living things and events. They communicate their findings in ways such as talking about their work in everyday terms, or through drawings or by completing pictograms.</p>	<p>Pupils use their knowledge related to organisms, their behaviour and the environment to recognise, identify and describe a range of common plants, animals and natural events. They name and describe external parts or features of plants, such as leaf colour; humans, such as head, arm; and other animals, such as coat colour. They use that evidence to identify plants or animals and make links between science and everyday objects and experiences.</p>	<p>Pupils use their knowledge related to materials, their properties and the Earth, to recognise, and describe some common materials, and their sensory properties, such as the texture and appearance of soils. They communicate their descriptions and observations in terms of these properties. They recognise evidence that has been used to answer a question such as identifying similar materials and make links between science and everyday objects and experiences such as waterproof materials being used to keep things dry.</p>	<p>Pupils use their knowledge related to energy, forces and space to describe some changes in light, sound or movement, that result from actions, such as those caused by pushing and pulling objects or switching on an electrical circuit. They recognise that light and sound come from a variety of sources, such as the Sun or a musical instrument. They recognise evidence that has been used to answer a question, such as how a musical instrument makes a noise, and make links between science and everyday objects and experiences such as the Sun being a light source.</p>
B	<p>Pupils respond to suggestions and make their own suggestions, with help, about how to collect relevant data and answer questions.</p> <p>They find information by using texts, with help. They follow direct instructions in order to stay safe. They make observations and measurements to compare living things, objects and events, using equipment provided for them. They record findings using prepared tables and communicate observations using scientific vocabulary. They say whether what happened was what they</p>	<p>Pupils use their knowledge related to organisms, their behaviour and the environment to describe plants and animals, the places they are found and the basic conditions they need in order to survive. They recognise and describe similarities and differences between the plants, humans and other animals they observe, using these to sort them into groups. They use questions based on their own ideas and evidence such as finding different types of plants and animals in different places. They identify science in everyday</p>	<p>Pupils use their knowledge related to materials, their properties and the Earth to identify a range of common materials and some of their properties. They recognise, and describe similarities and differences between the materials they observe, using these to sort them into groups. They recognise and describe ways in which some materials are changed by heating or cooling or by processes such as bending or stretching. They suggest answers to questions, such as the best material to reflect light, based on their own</p>	<p>Pupils use their knowledge related to energy, forces and space to recognise, describe and compare a range of properties and effects of light, sound, forces, and electricity, such as the ways in which devices work in different electrical circuits, the brightness or colour of lights, the loudness of sounds or the speed or direction of different objects. They suggest answers to questions such as which sound is loudest based on their own ideas and evidence. They identify science in everyday contexts and say whether it is helpful, for example electricity in domestic appliances.</p>

	expected and, when prompted, suggest different ways they could have done things.	contexts and say whether it is helpful, for example ways of growing vegetables for food.	ideas and evidence. They identify science in everyday contexts and say whether it is helpful, for example ice melting.	
C	Pupils respond to suggestions and put forward their own ideas about how to investigate an idea or find answers to questions. They recognise why it is important to collect data to investigate ideas and answer questions, and use texts to find information. They begin to recognise risks with help. They make relevant observations and measure quantities, such as length or mass, selecting and using a range of simple equipment. They carry out fair tests with some help, recognising and explaining what makes them fair. They record findings in a variety of ways, including tables or charts. They give explanations for observations and for patterns in measurements they have made and recorded. They communicate in a scientific way what they have found out and suggest improvements in their work.	Pupils use knowledge and understanding of organisms, their behaviour and the environment, such as the basic life processes of growth and reproduction, to describe similarities, differences and changes in the plants, animals, and non-living things they observe. They use simple scientific ideas with evidence they have collected to give explanations of their observations, linking cause and effect, for example lack of light or water affecting plant growth and the ways in which animals or plants are suited to their environments. They recognise and explain the purpose of a variety of scientific and technological developments in their everyday lives, for example medicines helping people get better when they are ill.	Pupils use knowledge and understanding of materials, their properties and the Earth to sort materials into groups in a variety of ways, according to their properties. They explain the ways in which some materials are suited to specific purposes such as glass for windows or copper for electrical cables. They classify changes in materials as reversible, such as water freezing, and non-reversible, such as baking of cakes. They use simple scientific ideas with evidence they have collected to give explanations of their observations, linking cause and effect, for example the evaporation of water. They recognise and explain the purpose of a variety of scientific and technological developments in their everyday lives, for example sustainable packaging.	Pupils use their knowledge and understanding of energy, forces and space to link cause and effect in their observations of the properties and effects of light, sound, forces, and electricity, such as a bulb failing to light because of a break in an electrical circuit, or a push or pull changing the speed or direction of a moving object. They begin to make generalisations such as sounds getting fainter the further the listener is from the source. They use simple scientific ideas with evidence they have collected to give explanations of their observations, linking cause and effect, for example using a switch to turn off a light bulb in an electrical circuit. They recognise and explain the purpose of a variety of scientific and technological developments in their everyday lives, for example streamlining and air resistance.
D	Pupils decide on an appropriate approach, including using a fair test to answer a question, and select suitable equipment and information from that provided. They select and use methods that are adequate for the task. Following instructions, they take action to control obvious risks to themselves. They make a series of observations and measurements and vary one factor while keeping	Pupils describe some processes and phenomena related to organisms, their behaviour and the environment, drawing on scientific knowledge and understanding and using appropriate terminology, for example using food chains to describe feeding relationships between plants and animals in a habitat. They recognise that evidence can support or refute scientific ideas, such as in the identification and	Pupils describe some processes and phenomena related to materials, their properties and the Earth, drawing on scientific knowledge and understanding and using appropriate terminology, for example separation methods. They recognise that evidence can support or refute scientific ideas, such as the classification of reactions as reversible and irreversible. They recognise some applications and	Pupils describe some processes and phenomena related to energy, forces and space, drawing on scientific knowledge and understanding and using appropriate terminology, for example the observed position of the sun in the sky over the course of a day. They recognise that evidence can support or refute scientific ideas, such as sounds being heard through a variety of materials. They recognise some applications and

	<p>others the same. They record their observations, comparisons and measurements using tables and bar charts and begin to plot points to form simple graphs. They interpret data containing positive and negative numbers. They begin to relate their conclusions to patterns in data, including graphs, and to scientific knowledge and understanding. They communicate their conclusions using appropriate scientific language. They suggest improvements in their work, giving reasons.</p>	<p>grouping of living things. They recognise some applications and implications of science, such as the use of predators to control pest populations.</p>	<p>implications of science, such as the safe use of acids and alkalis.</p>	<p>implications of science, such as the use of electrical components to make electrical devices.</p>
E	<p>Pupils decide appropriate approaches to a range of tasks, including selecting sources of information and apparatus. They select and use methods to obtain data systematically. They recognise hazard symbols and make, and act on, simple suggestions to control obvious risks to themselves and others. They use line graphs to present data, interpret numerical data and draw conclusions from them. They analyse findings to draw scientific conclusions that are consistent with the evidence. They communicate these using scientific and mathematical conventions and terminology. They evaluate their working methods to make practical suggestions for improvements.</p>	<p>Pupils describe processes and phenomena related to organisms, their behaviour and the environment, drawing on abstract ideas and using appropriate terminology, for example the main functions of plant and animal organs and how these functions are essential. They explain processes and phenomena, in more than one step or using a model, such as the main stages of the life cycles of humans and flowering plants. They apply and use knowledge and understanding in familiar contexts, such as different organisms being found in different habitats because of differences in environmental factors. They recognise that both evidence and creative thinking contribute to the development of scientific ideas, such as the classification of living things. They describe applications and implications of science, such as solving some of the health problems that arise</p>	<p>Pupils describe processes and phenomena related to materials, their properties and the Earth, drawing on abstract ideas and using appropriate terminology, for example the weathering of rocks. They explain processes and phenomena, in more than one step or using a model, such as the deposition of sediments and their formation into rocks. They apply and use knowledge and understanding in familiar contexts, such as identifying changes of state. They recognise that both evidence and creative thinking contribute to the development of scientific ideas, such as basing separation methods for mixtures on physical and chemical properties. They describe applications and implications of science, such as the uses of metals based on their specific properties or the benefits and drawbacks of the use of fossil fuels.</p>	<p>Pupils describe processes and phenomena related to energy, forces and space, drawing on abstract ideas and using appropriate terminology, for example 'balanced forces'. They explain processes and phenomena, in more than one step or using a model, such as the length of a day or a year. They apply and use knowledge and understanding in familiar contexts. They recognise that both evidence and creative thinking contribute to the development of scientific ideas, such as objects being seen when light from them enters the eye. They describe applications and implications of science, such as the ways sound can be produced and controlled, for example in musical instruments.</p>

		when organ damage occurs.		
F	<p>Pupils identify an appropriate approach in investigatory work, selecting and using sources of information, scientific knowledge and understanding. They select and use methods to collect adequate data for the task, measuring with precision, using instruments with fine scale divisions, and identify the need to repeat measurements and observations. They recognise a range of familiar risks and take action to control them. They record data and features effectively, choosing scales for graphs and diagrams. They analyse findings to draw conclusions that are consistent with the evidence and use scientific knowledge and understanding to explain them and account for any inconsistencies in the evidence. They manipulate numerical data to make valid comparisons and draw valid conclusions. They communicate qualitative and quantitative data effectively, using scientific conventions and terminology. They evaluate evidence, making reasoned suggestions about how their working methods could be improved.</p>	<p>Pupils describe processes and phenomena related to organisms, their behaviour and the environment, using abstract ideas and appropriate terminology, for example simple cell structure and function. They take account of a number of factors or use abstract ideas or models in their explanations of processes and phenomena, such as environmental factors affecting the distribution of organisms in habitats. They apply and use knowledge and understanding in unfamiliar contexts, such as a food web in a habitat. They describe some evidence for some accepted scientific ideas, such as the causes of variation between living things. They explain the importance of some applications and implications of science, such as the use of selective breeding.</p>	<p>Pupils describe processes and phenomena related to materials, their properties and the Earth, using abstract ideas and appropriate terminology, for example the particle model applied to solids, liquids and gases. They take account of a number of factors or use abstract ideas or models in their explanations of processes and phenomena, such as word equations. They apply and use knowledge and understanding in unfamiliar contexts, such as relating changes of state to energy transfers in a range of contexts such as the formation of igneous rocks. They describe some evidence for some accepted scientific ideas, such as the patterns in the reactions of acids with metals and the reactions of a variety of substances with oxygen. They explain the importance of some applications and implications of science, such as the production of new materials with specific desirable properties.</p>	<p>Pupils describe processes and phenomena related to energy, forces and space, using abstract ideas and appropriate terminology, for example electric current as a way of transferring energy. They take account of a number of factors in their explanations of processes and phenomena, for example in the relative brightness of stars and planets. They also use abstract ideas or models, for example sustainable energy sources and the refraction of light. They apply and use knowledge and understanding in unfamiliar contexts. They describe some evidence for some accepted scientific ideas, such as the transfer of energy by light, sound or electricity, and the refraction and dispersion of light. They explain the importance of some applications and implications of science, such as the responsible use of unsustainable sources of energy.</p>
G	<p>Pupils plan appropriate approaches and procedures, by synthesising information from a range of sources and identifying key factors in complex contexts and in which variables cannot readily be controlled. They select and use methods to</p>	<p>Pupils describe a wide range of processes and phenomena related to organisms, their behaviour and the environment, using abstract ideas and appropriate terminology and sequencing a number of points, for example respiration and</p>	<p>Pupils describe a wide range of processes and phenomena related to materials, their properties and the Earth, using abstract ideas and appropriate terminology and sequencing a number of points, for example the rock cycle. They make links between different</p>	<p>Pupils describe a wide range of processes and phenomena related to energy, forces and space, using abstract ideas and appropriate terminology and sequencing a number of points, for example how energy is transferred by radiation or by conduction. They make links between</p>

<p>obtain reliable data, including making systematic observations and measurements with precision, using a range of apparatus. They recognise the need for a risk assessment and consult appropriate sources of information, which they follow. They record data in graphs, using lines of best fit.</p> <p>They analyse findings to draw conclusions that are consistent with the evidence and use scientific knowledge and understanding to explain these conclusions and identify possible limitations in primary and secondary data. They use quantitative relationships between variables. They communicate effectively, using a wide range of scientific and technical conventions and terminology, including symbols and flow diagrams. They begin to consider whether the data they have collected are sufficient for the conclusions they have drawn.</p>	<p>photosynthesis, or pyramids of biomass. They make links between different areas of science in their explanations. They apply and use more abstract knowledge and understanding, in a range of contexts, such as inherited and environmental variation. They explain how evidence supports some accepted scientific ideas, such as the structure and function of cells. They explain, using abstract ideas where appropriate, the importance and implications of science, such as the uses of cells in stem cell research.</p>	<p>areas of science in their explanations, such as between the nature and behaviour of materials and their particles. They apply and use more abstract knowledge and understanding, in a range of contexts, such as the particle model of matter, and symbols and formulae for elements and compounds. They explain how evidence supports some accepted scientific ideas, such as the reactivity series of metals. They explain, using abstract ideas where appropriate, the importance of some applications and implications of science, such as the need to consider the availability of resources, and environmental effects, in the production of energy and materials.</p>	<p>different areas of science in their explanations, such as between electricity and magnetism. They apply and use more abstract knowledge and understanding in a range of contexts, such as the appearance of objects in different colours of light. They explain how evidence supports some accepted scientific ideas, such as the role of gravitational attraction in determining the motion of bodies in the solar system. They explain, using abstract ideas where appropriate, the importance of some applications and implications of science, such as the uses of electromagnets.</p>
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