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.

Working scientifically

Key stage 1 programme of study (statutory requirements)	Notes and guidance (non-statutory)
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.	Pupils in years 1 and 2 should explore the world around them and raise their own questions. They should experience different types of scientific enquiries, including practical activities, and begin to recognise ways in which they might answer scientific questions. They should use simple features to compare objects, materials and living things and, with help, decide how to sort and group them, observe changes over time, and, with guidance, they should begin to notice patterns and relationships. They should ask people questions and use simple secondary sources to find answers. They should use simple measurements and equipment (e.g. hand lenses, egg timers) to gather data, carry out simple tests, record simple data, and talk about what they have found out and how they found it out. With help, they should record and communicate their findings in a range of ways and begin to use simple scientific language. These opportunities for working scientifically should be provided across years 1 and 2 so that

	the expectations in the programme of study can be met by the end of year 2. Pupils are not expected to cover each aspect for every area of study.

Year 1: Plants

<table>
<tr><th>Year 1 programme of study (statutory requirements)</th><th>Notes and guidance (non-statutory)</th><th>Working Scientifically ideas</th></tr>
<tr><td>Pupils should be taught to:
• identify and name a variety of common plants, including garden plants, wild plants and trees, and those classified as deciduous and evergreen
• identify and describe the basic structure of a variety of common flowering plants, including roots, stem/trunk, leaves and flowers.</td><td>Pupils should use the local environment throughout the year to explore and answer questions about plants growing in their habitat. Where possible, they should observe the growth of flowers and vegetables that they have planted.
They should become familiar with common names of flowers, examples of deciduous and evergreen trees, and plant structures (trees: trunk, roots, branches, leaves, flowers (blossom), fruit; garden and wild plants: flower, petals, stem, leaves, roots, fruit, bulb and seed).</td><td>• Where do the most plants grow in the school grounds?
• Do all plants have roots, stem/trunk, leaves and flowers.
• What type of plants/trees are there in the school/park?
• What grows first the root or the stem?

Pupils might work scientifically by: observing closely, perhaps using magnifying glasses, and comparing and contrasting familiar plants; describing how they were able to identify and group them, and drawing diagrams showing the parts of different plants and trees. Pupils might keep records of how plants have changed over time, for example the leaves falling off trees and buds opening; and compare and contrast how different plants change over time.</td></tr>
<tr><td colspan="3">Other teaching ideas
1. Discuss and describe a particular plant in detail. Take a photograph of it. Ask children what it will be like in a few weeks time. Make a list of what they say. Return to the plant in a few weeks.
2. Grow carrot tops, mustard and cress, pulses etc.
3. Sort and group large seeds.
4. Cut open fruits to look at seeds, break open seeds.
5. Grow bulbs in water so that you can see the roots system.
6. Make rubbings of different leaves.
7. Make a labels or map of the different trees/plants found in the school grounds</td></tr>
<tr><td colspan="3">Key information
• The shape of the leaves relates to the species.
• Leaves can be simple or compound.
• Single leaves, e.g. oak and sycamore, are called simple leaves.
• Leaves which are made up of leaflets, e.g. horse chestnut and ash are called 'compound' leaves.</td></tr>
</table>

- Trees can be identified by their leaves.

- All flowering plants have roots, stems, leaves and flowers.
- Roots, stems, leaves and flowers are similar on plants that are alike e.g. all dandelions. There are differences between roots, stems, leaves and flowers on different kinds of plants e.g. buttercup and dandelion.
- The flower grows first as a bud and then opens up into a flower.
- When the petals fall the seed pod is left. The pod will continue to grow and the seeds will ripen.
- Some plants grow flowers to attract insects.
- The insects take the pollen to another flower of the same type so the plant can make seeds.
- Seeds can be different shapes and sizes.
- Parts of the flower become a fruit.
- The fruits contain the seeds.
- Plants usually grow in soil - they also need light and water.

Year 1: Animals, including humans

Year 1 programme of study (statutory requirements)	Notes and guidance (non-statutory)	Working Scientifically ideas
Pupils should be taught to: • identify and name a variety of common animals that are birds, fish, amphibians, reptiles, mammals and invertebrates • 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 (birds, fish, amphibians, reptiles, mammals and invertebrates, and including pets) • identify, name, draw and label the basic parts of the human body and say which part of the body is	Pupils should use the local environment throughout the year to explore and answer questions about animals in their habitat. They should understand how to take care of animals taken from their local environment and the need to return them safely after study. Pupils should become familiar with the common names of birds, fish, amphibians, reptiles, mammals and invertebrates, including pets. Pupils should have plenty of opportunities to learn the names of the main body parts (including head, neck, arms, elbows, legs, knees, face, ears, eyes, hair, mouth, teeth) through games, actions, songs and rhymes.	• What diffences are there between the skeletons of different animals? • Can we taste when we can't smell? • Pupils might work scientifically by: using their observations to compare and contrast animals at first hand or through videos and photographs, describing how they identify and group them; grouping animals according to what they eat; and using their senses to compare different textures, sounds and smells.

associated with each sense.		

Other teaching ideas

1. Sort things in school grounds into plants and animals.
2. Sort animals further into birds, fish, amphibians, reptiles, mammals and invertebrates.
3. Songs naming parts of the body, eg. Head, shoulders, knees and toes.
4. Draw round a child and label body parts.
5. Match food to different animals
6. Go on a sound walk
7. Consider how to treat living things with care and sensitivity.
8. Explore websites for more information such as http://www.animalsworlds.com/
9. Find out more about canivores, omnivores and herbivores at websites such as http://animals.pppst.com/what-animals-eat.html

Key information

Humans

Living things need light, air and water to stay alive. Living things grow and change as they get older. Our favourite toys let us play games of make-believe, but they have never been alive. Living things can be divided into two main categories - plants and animals. (Bacteria and fungi can be referred to, if necessary, as 'other living things')

Fish

Fishes are cold blooded animals in the world that are covered with scales and equipped with a pair of fins to swim in the water. Unlike other animals in the world fishes do not have lungs as their breathing organ. Fishes are provided with a special organ called gills which are used for respiration. With the help of gills they draw oxygen from the water and into the blood stream. Fishes reproduce by laying eggs.

Depending upon the habitats and characteristics there are a variety of fish available on the world. Fresh water, tropical, marine, cold water and aquarium fish are the major types of fishes.

Amphibians

The amphibians belong to the class amphibian. Ectothermoc or cold blooded animals like **frogs**, **toads**, **salamanders**, **newts**, and **caecilians** metamorphose from a juvenile, water breathing form to an adult, air breathing form. Amphibians are four limbed animals. As by their ancestors "the fish" the amphibians lay eggs in the water. Amphibians are similar to the reptiles.

Reptiles

Animals that have scales and the ability to creep are called Reptiles. Since the animals have the ability to creep they got the name Reptiles (meaning to creep). Reptiles are cold blooded animals that live on the world since the Dinosaurs period. The Dinosaurs is the biggest and the extinct species of the reptiles. Reptiles include snake, turtles, alligator and lizards.

Birds

Birds are the only creatures in the world that have the capacity to walk, fly, sing, dance and swim. Birds are warm blooded animals with high body temperature that is necessary for their flights. The most highlighted characteristic of birds are its feathers. No other living organism in the world has wings (feathers). They are the light weight organisms and they have the capacity to grow feathers each year.

Mammals

Mammals are warm blooded animals. Of all the class in the animal world the mammals are considered to be the most advanced. Mammals belong to the class mammalia and are the only class that has hair and feed their young ones with the milk produced by the mammary glands.

Dogs and cats that we house are mammals; horse, sheep, baboons, giraffes and elephants are also mammals. We the human beings also belong to the class mammals.

Invertebrate

An **invertebrate** is an animal without a vertebral column. The group includes 95% of all animal species — all animals except those in the Chordate subphylum Vertebrata (fish, reptiles, amphibians, birds, and mammals).

Herbivores

A herbivore is an animal that gets its energy from eating plants, and only plants. Omnivores can also eat parts of plants, but generally only the fruits and vegetables produced by fruit-bearing plants. Many herbivores have special digestive systems that let them digest all kinds of plants, including grasses.

Herbivores need a lot of energy to stay alive. Many of them, like cows and sheep, eat all day long. There should be a lot of plants in your ecosystem to support your herbivores. If you put carnivores or some omnivores in your ecosystem, they'll eat your herbivores, so make sure you have enough herbivores to support them.

Carnivores

A carnivore is an animal that gets food from killing and eating other animals.

Carnivores generally eat herbivores, but can eat omnivores, and occasionally other carnivores. Animals that eat other animals, like carnivores and omnivores are important to any ecosystem, because they keep other species from getting overpopulated.

Since carnivores have to hunt down and kill other animals they require a large amount of calories. This means that they have to eat many other animals over the course of the year. The bigger the carnivore, the more it has to eat. You should make sure that you have many more herbivores and omnivores than carnivores.

You have several kinds of carnivores to choose from in this simulation, of different sizes:

Omnivores

An omnivore is a kind of animal that eats either other animals or plants. Some omnivores will hunt and eat their food, like carnivores, eating herbivores and other omnivores. Some others are scavengers and will eat dead matter. Many will eat eggs from other animals. Omnivores eat plants, but not all kinds of plants. Unlike herbivores, omnivores can't digest some of the substances in grains or other plants that do not produce fruit. They can eat fruits and vegetables, though. Some of the insect omnivores in this simulation are pollinators, which are very important to the life cycle of some kinds of plants. **Senses** We use all our senses to understand the world around us. Sight is one of our **five** senses. Our two eyes work together to help us see how far away things are. When we cannot use our eyes we use some of our other senses. We use all our senses to understand the world around us. Smell is one of our **five** senses. We use our nose to smell. It is difficult to smell things when you have a cold. We use all our senses to understand the world around us. Touch is one of our five senses. We usually use our hands to touch. Our fingers are very sensitive; we can feel differences in texture, shape and temperature. Our tongue is the most sensitive part of the body that is why babies put things in their mouths. Hearing is one of our five senses. We use all of our senses to understand the world around US. Sounds are heard when they enter the ear. Two ears help us detect the direction of the sound. There are lots of different animals.

Year 1: Everyday materials

Year 1 programme of study (statutory requirements)	Notes and guidance (non-statutory)	Working Scientifically ideas
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,	Pupils should explore, name, discuss and raise and answer questions about everyday materials so that they become familiar with the names of materials and properties such as: hard/soft; stretchy/stiff; shiny/dull; rough/smooth; bendy/not bendy; waterproof/not waterproof; absorbent/not absorbent; opaque/transparent. Pupils should explore and	• Which bag is most waterproof or strongest? • What material is the most hard/soft; stretchy/stiff; shiny/dull; rough/smooth or bendy? Pupils might work scientifically by: performing simple tests to

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	experiment with a wide variety of materials, not only those listed in the programme of study, but including for example: brick, paper, fabrics, elastic, foil.	explore questions such as: 'What is the best material for an umbrella? ... for lining a dog basket? ... for curtains? ... for a bookshelf? ... for a gymnast's leotard?'

Other teaching ideas

- Use senses to describe objects as shiny or dull, light or heavy, soft or hard, bendy or staff etc.
- Grade a range of materials from shiniest to dullest or lightest to heaviest etc.
- Compile a class list or dictionary of words that describe materials.
- Sort and group materials into groups like rough/smooth or colours or transparent, opaque, shiny, magnetic/non magnetic.
- Three of a kind. One person picks three things that have the same property, eg. they are all rough. The rest of the group/class have to figure out what the property is.
- Odd one out. As 'Three of a kind' but one thing has a different property eg. two transparent and one opaque.
- Test hardness by finding out which material will scratch which others.
- Explore ways in which we could send an Easter egg through the post safely?
- Make rubbings of surfaces.

Key information

There are lots of different materials. The 'material' is the substance from which something is made. Materials can be natural or made. They have different properties - this means they look and feel different and behave in different ways.
Materials are chosen for different purposes because of their properties e.g. a window is made of glass because glass is transparent.

Materials can be natural or made.
Things that are made by people may be manufactured from natural or made materials.
When we describe what the material feels like, looks like and what it can do we are describing the properties of the material.
Different materials are used to make different things because of their particular properties e.g. strength, hardness.

Some will decompose e.g. vegetable peelings can be used to make compost for the garden. Some will re-cycle and can be put into special containers for re-cycling e.g. aluminium cans, glass etc. These materials are collected and used a to make new cans, bottles etc. Some rubbish can be used again e.g. plastic carrier bags to line bins, coffee or cocoa tins for storage. Some rubbish can only be thrown away e.g. plastic_wrappings. Our rubbish is made up of many different materials Magnets attract metals that contain iron. Sometimes magnets seem to stick to paint or plastic - don't be fooled, there is iron underneath! Some magnets have a plastic covering. Magnets can attract through thin materials. *Only iron can be made into a magnet but magnets will attract three metals: iron, nickel and cobalt.* Magnets attract some metals. Strong magnets can: pick up heavy magnetic objects; pick up lots of paper clips; make a paper clip jump up; attract through thin materials. Rocks are made of different materials. Some rocks are harder than others. Hard rocks can scratch softer rocks. Your fingernail will only scratch very soft rocks. A copper coin will scratch harder rocks and a steel nail, even harder ones. Some rocks are too hard for the steel nail to scratch. Softer rocks will grate into fine particles or grains. Some materials float, others sink. Some materials or objects float because they have air trapped inside them. Think about buoyancy aids in the swimming pool, submarines and lifeboats. Materials will float if they are less dense than water.

Year 1: Seasonal changes

Year 1 programme of study (statutory requirements)	Notes and guidance (non-statutory	Working Scientifically ideas
Pupils should be taught to: • observe changes across the four seasons • observe and describe weather associated with the seasons and how day length varies.	Pupils should observe and talk about changes in the weather and the seasons. **Note:** Pupils should be warned that it is not safe to look directly at the Sun, even when wearing dark glasses.	• How does the temperature change during a week, month, term? Pupils might work scientifically by: making tables and charts about the weather; and making displays of what happens in the world around them, including day length, as the seasons change.
Other teaching ideas • Keep a diary of weather and temperature over a long period. • Take the temperature at different points during a day. • Paint a picture of a tree at different times of the year. • Match clothing to season in which it will be needed.		

• Film a weather report.
Key information Seasons are created by two very important events – the rotation of the Earth that gives us day and night, and the rotation of the Earth around the sun that gives us our year. Because the sun never changes, only the movement of the Earth creates changes in light and darkness, and in temperature. Because seasons are based on the rotation of the planet around the sun, the seasons change at the same time every year, even though the two halves of the planet experience opposite seasons! Some regions do not experience seasons the same way as others, but all parts of the Earth have seasonal changes. For the Polar Regions (the areas at the top and bottom of the Earth) and the temperate zones (the area around the middle), seasons change the amount of daylight and darkness they experience more than the temperature.

Optional Unit

Year 1 : Light

Year 1 programme of study (statutory requirements)	Notes and guidance (non-statutory)	Working Scientifically ideas
Pupils should be taught to: • observe and name a variety of sources of light, including electric lights, flames and the Sun • associate shadows with a light source being blocked by something.	Pupils should explore materials to raise questions that will help them to understand the differences between materials that are transparent, translucent and opaque (though these words do not need to be used at this stage). They should observe shadows being formed in everyday contexts, such as when they play outside or shine torches indoors. Note: Pupils should be warned that it is not safe to look directly at the Sun, even when wearing dark glasses.	• Which is the most reflective material? • Which materials let light through? • Which torch is the brightest? • How can we make our shadows bigger? • Which is the brightest light source in the class/school? Pupils might work scientifically by exploring shiny things and grouping them according to whether they shine in the dark or not. They can go on a shadow hunt and think about what is similar about the places where shadows are found (that is, that there is a light source and something is blocking it).
Other teaching ideas		

1. Going into a room which is pitch black and describing what it is like.
2. Brainstorming session of how many different sources of light the children can think of.
3. Go on a 'light' walk around local area to find different types of light eg. Traffic lights, stop lights, car lights, street lights, sunlight etc.
4. Make day and night pictures. How will they be different?
5. Make a display of objects/clothes used during the day/at night.
6. Go on a 'shadows' walk to observe light sources, direction of shadows.
7. Observing and describing something in subdued light then in bright light

Key information

- Light comes from a variety of sources.
- The greatest source of light is the Sun.
- Light can be bright or dim.
- Light can be different colours.
- Light will shine through some materials.
- Dark is the absence of light.
- We see things because light bounces off them.
- In a dark room we can usually see the outlines of shapes but colours are difficult to recognise.
- It is only really dark when there is no light at all.
- We can see reflections in mirrors and shiny objects.
- Mirrors reflect everything in front of them
- If we use two mirrors we can reflect the reflection several times
- We can see lots of reflections like this
- Kaleidoscope patterns are formed by mirrors making lots of reflections.

Transparent, translucent and opaque materials

Transparent

Transparent materials let light pass through them in straight lines, so that you can see clearly through them. Glass is an example of a transparent material.

Translucent

Translucent materials let some light through, but they scatter the light in all directions, so that you cannot see clearly through them. Tissue paper is an example of a translucent material.

Opaque

Opaque materials do not let any light pass through them. They block the light. Wood is an example of an opaque material

YEAR 2

Year 2: All living things and their habitats

Year 2 programme of study (statutory requirements)	Notes and guidance (non-statutory	Working Scientifically ideas
Pupils should be taught to: • explore and compare the differences	Pupils should be introduced to the idea that all living things have certain characteristics	Do a greater variety of minibeasts live on the ground or in the trees?

<table>
<tr>
<td>between things that are living, dead, and things that have never been alive
• identify that most living things live in habitats to which they are suited and describe how different habitats provide for the basic needs of different kinds of animals and plants, and how they depend on each other
• identify and name a variety of plants and animals in their habitats, including micro-habitats
• describe how animals obtain their food from plants and other animals, using the idea of a simple food chain, and identify and name different sources of food.</td>
<td>that are essential for keeping them alive and healthy. They should raise and answer questions that help them to become familiar with the life processes that are common to all living things. Pupils should be introduced to the terms 'habitat' (a natural environment or home of a variety of plants and animals) and 'micro- habitat' (a very small habitat, for example for woodlice under stones, logs or leaf litter). They should raise and answer questions about the local environment that help them to identify and study a variety of plants and animals within their habitat and observe how living things depend on each other, for example plants serving as a source of food and shelter for animals. Pupils should compare animals in familiar habitats with animals found in less familiar habitats, for example, on the seashore, in woodland, in the ocean, in the rainforest.</td>
<td>Do wood lice prefer the light or the dark, dry or damp conditions?
Which tree has most birds on it?
Which type of bird visits our playgrond most?

Pupils might work scientifically by: sorting and classifying things according to whether they are living, dead or were never alive, and recording their findings using charts. They should describe how they decided where to place things, exploring questions such as: 'Is a flame alive? Is a deciduous tree dead in winter?' and talk about ways of answering their questions. They could construct a simple food chain that includes humans (e.g. grass, cow, human); describing the conditions in different habitats and micro-habitats (under log, on stony path, under bushes); finding out how the conditions affect the number and type(s) of plants and animals that live there.</td>
</tr>
<tr>
<td colspan="3">Other teaching ideas
• Discuss what is living, what is dead and what never lived at all.
• Discuss animal and plant differences re: protection e.g. colour, poisons, pattern, spikes etc.
• Draw the food chain grass, cows, humans
• One child describes a plant/bird/minibeast and others have to guess it
• Odd one out. A child chooses 3 pictures of a minibeast/bird/plant. Others say which is odd one out and why</td>
</tr>
<tr>
<td colspan="3">Key information

Animals are especially suited to places where they live. To survive animals need the right food, water (or moisture) shelter, the right temperature and oxygen from air or dissolved in water. Habitats (except for ponds) do not have clear boundaries, animals can move away from the place where you found them, some e.g. birds may visit when you are not there.
Animals have young so it is likely that different sizes of the same species will be found.</td>
</tr>
</table>

Plants of the same species, growing in different places, often produce plants of a different size and shape to suit local conditions. This is called adaptation.

Different habitats provide differing conditions for the animals that live there.
Some animals are able to live in different habitats so you may find the same ones in different places.
Animals are especially suited to the place where they live. Some animals, e.g. frogs / tadpoles need different conditions at different stages of their life cycle.
Different plants grow in different habitats.
Plants are adapted to suit the conditions where they grow. Plants of the same kind can grow differently if the conditions are not the same, e.g. bluebells grow taller in the shade than in the sun.
All plants need different amounts of light and water to grow and produce flowers and seeds.
Some plants grow best in certain kinds of soil. All species of plants have specific requirements.

Year 2: Plants

<table>
<tr><th>Year 2 programme of study (statutory requirements)</th><th>Notes and guidance (non-statutory</th><th>Working Scientifically ideas</th></tr>
<tr><td>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.</td><td>Pupils should use the local environment throughout the year to observe how plants grow (including seeds, bulbs, fruit and vegetables, deciduous and evergreen bushes and trees). Pupils should be introduced to the requirements of plants for growth and survival, as well as the process of reproduction and growth in plants.
Note: Seeds and bulbs need water to grow but do not need light; seeds and bulbs have a store of food inside them.

Note: Seeds and bulbs need water to grow but most do not need light; seeds and bulbs have a store of food inside them.</td><td>Do shoots always grow up and roots always grow down?
Do plants need light in order to grow?
Will seeds grow in anything other than soil?
Pupils might work scientifically by: observing and recording, with some accuracy, the growth of a variety of plants as they change over time from a seed or bulb, or observing similar plants at different stages of growth; setting up a comparative test to show that plants need light and water to stay healthy.</td></tr>
<tr><td colspan="3">Other teaching ideas
Keep a growing diary
Grow water so that you can see the roots system
Grow a bean plant and create a how-to-guide on how to look after it.
Observational drawings of different plants</td></tr>
<tr><td colspan="3">Key information</td></tr>
</table>

Living things need light, air and water to stay alive. Living things grow and change as they get older. Plants in the scientific sense, include trees, bushes and grasses. Fruit, vegetables and leaves come from plants. • Seeds need water and light to grow well. • Most seeds will germinate without light. • Seeds will not germinate without water. • The shoot needs light to turn green and grow into a healthy plant. • Plants grown without light are often tall, thin and pale. • They are not strong plants. • Without water, plants droop or wilt. If they are not watered they will die. • On the windowsill plants' leaves turn towards the light. • All flowering plants have roots, stems, leaves and flowers. • Roots, stems, leaves and flowers are similar on plants that are alike e.g. all dandelions. There are differences between roots, stems, leaves and flowers on different kinds of plants e.g. buttercup and dandelion. • Seeds develop when petals fall. • Seeds can grow to form new plants. • The flower grows first as a bud and then opens up into a flower. • When the petals fall the seed pod is left. The pod will continue to grow and the seeds will ripen. • Some plants grow flowers to attract insects. • Insects when taking nectar from the flower brush against the stamen and pollen sticks to them. • The insects take the pollen to another flower of the same type so the plant can make seeds. • Seeds can be different shapes and sizes. • New plants grow from seeds. • The plants produce flowers. • Parts of the flower become a fruit. • The fruits contain the seeds.

Year 2: Animals, including humans

Year 2 programme of study (statutory requirements)	Notes and guidance (non-statutory	Working Scientifically ideas
Pupils should be taught to: • notice that animals, including humans, have	Pupils should be introduced to the basic needs of animals for survival, as well as the importance of exercise and nutrition for humans. They should also be introduced to the	• How clean are your hands? • Do people grow at the same rate?

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.	processes of reproduction and growth in animals. The focus at this stage should be on questions that help pupils to recognise growth; they should not be expected to understand how reproduction occurs. The following examples might be used: egg, chick, chicken; egg, caterpillar, pupa, butterfly; spawn, tadpole, frog; lamb, sheep. Growing into adults can include reference to baby, toddler, child, teenager, adult.	• How many times can you jump up and down in a fixed time? Pupils might work scientifically by: observing, through video or first- hand observation and measurement, how different animals, including humans, grow; asking questions about what things animals need for survival and what humans need to stay healthy; and suggesting ways to find answers to their questions.

Other teaching ideas

1. Put food into main groups ie. Meat, fruit and veg., cereal or dairy products.
2. Collage of healthy/non healthy food etc. using pictures from magazines.
3. How are babies looked after? What do they need?
4. Look at photographs of children when they were younger - make a display.
5. Discuss children's illness and how we get better.
6. Match offspring with adult animals

Key information

Living things need light, air and water to stay alive. Living things grow and change as they get older. Our favourite toys let us play games of make-believe, but they have never been alive. Living things can be divided into two main categories - plants and animals. (Bacteria and fungi can be referred to, if necessary, as 'other living things')

'Animals' in the scientific sense include birds, fish, mini beasts and humans.

Plants, in the scientific sense, include trees, bushes and grasses. Fruit, vegetables and leaves come from plants.

REMEMBER! Treat all living things with care and respect. Always put them back in their own habitat.
Animals in the scientific sense include birds, fish, mini beasts and humans.
All animals move, feed, grow, use their senses and reproduce.
Animals of the same kind, eg dogs can be different breeds - spaniels, sheepdog etc.
Consider how to treat living things with care and sensitivity.

Our body is the same on both sides.

We need food to give us energy.
We need food to grow.
We need food to keep us healthy.

Too much fatty or sugary food and sugary drinks make us fat. Sweet sticky foods and sugary drinks are bad for our teeth. We need food and drink to stay alive. It is best to eat breakfast before going to school. We should eat some: - meat, **fish,** cheese, eggs, nuts or beans every day. - fruit and vegetables every day. Too much sweet and fatty food is not good for us. It is important to eat the right amount of food. To be **fit** and healthy we need to: - - eat and drink, - keep clean, - exercise, - relax and sleep. We need to do these things every day. If we get ill we sometimes need to take medicines. Medicines should be taken according to the instructions., A baby needs looking after. It has to be fed and kept clean and warm. A baby needs to be loved. We learn to do things for ourselves as we grow up. Sometimes people who are older or ill cannot do things for themselves. We learn to look after others. All animals need food, water and a place to live. Pets' homes need regular cleaning. Some animals need exercise. We use all our senses to understand the world around us. Taste is one of our five senses. We use our tongue to taste. We can identify different tastes. Our sense of smell helps us to identify different flavours. Human beings are all different. We say they are unique. Some characteristics are often linked e.g. brown skin and brown eyes fair hair and pale skin red hair and freckles

Year 2: Uses of everyday materials

Year 2 programme of study (statutory requirements)	Notes and guidance (non-statutory	Working Scientifically ideas
Pupils should be taught to: • identify and compare the suitability of a variety of	Pupils should identify and discuss the uses of different everyday materials so that they become familiar with how some materials are used for more than one thing (metal can be used for coins, cans,	• Which sponge is the best for mopping up spills? • When squashed, which materials return to their original shape?

<table>
<tr>
<td>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.</td>
<td>cars and table legs; wood can be used for matches, floors, and telegraph poles) or different materials are used for the same thing (spoons can be made from plastic, wood, metal, but not normally from glass). They should think about the properties of materials that make them suitable or unsuitable for particular purposes and they should be encouraged to think about unusual and creative uses for everyday materials. Pupils might find out about people who have developed useful new materials, for example John Dunlop, Charles Macintosh or John McAdam.</td>
<td>What happens to materials when they are heated or cooled?
Which surface does a car roll down quickest?
Pupils might work scientifically by: comparing the uses of everyday materials in and around the school with materials found in other places (at home, the journey to school, on visits, and in stories, rhymes and songs); observing closely, identifying and classifying the uses of different materials, and recording their observations.</td>
</tr>
<tr>
<td colspan="3">Other teaching ideas
Find equipment in a park play area that bends or twists.
Make a model/collage out of different materials.
Find different materials around the school.
Play material bingo around the school.
Group objects based on materials which they are made off.</td>
</tr>
<tr>
<td colspan="3">Key information
These activities encourage children to make observations and predictions within their own everyday experiences.

Modelling materials can be changed in shape by squashing, bending, twisting and stretching. Some modelling materials e.g. dough and clay contain water which will evaporate if the material is left in a warm place. When the water evaporates the modelling material becomes hard and no longer pliable. Some modelling materials e.g. plasticine, become more pliable when they are warm. If left, they cool down and become harder but can be made pliable again by warming in our hands.

Flexible materials can be changed in shape by bending. Rigid materials do not bend as much. Rigid materials are not necessarily stronger materials; they may break instead of bending.

Flexible materials will roll into tubes. A more flexible material will roll into a smaller tube.

Fabrics can be sorted according to different properties e.g. smooth/rough; will tear/won't tear; loosely woven/close woven; shiny/matt; will stretch/won't stretch; soft/stiff; will crease/won't crease; natural/manufactured. We can change the shape of fabrics by twisting, stretching, squashing etc. Sometimes we need to use a material that will stretch for a</td>
</tr>
</table>

<table>
<tr><td>particular purpose e.g. elastic on a tie. Some fabrics are more absorbent than others; this is usually related to texture and weave.</td></tr>
</table>

Optional Unit

Year 2: Sound

<table>
<tr><th>Year 2 programme of study (statutory requirements)</th><th>Notes and guidance (non-statutory</th><th>Working Scientifically ideas</th></tr>
<tr><td>Pupils should be taught to:
observe and name a variety of sources of sound, noticing that we hear with our ears
recognise that sounds get fainter as the distance from the sound source increases.</td><td>Linked with work in music, pupils should explore various ways of making sounds, for example using a range of musical instruments to make louder and softer and higher and lower sounds.</td><td>What size/shape makes the best ears?
What makes the best string telephones?
Which ear protector is best?
Which sounds can be heard furthest away?
How can you make the sounds louder/softer?
How many ways can you play these instruments?
How far do you need to walk before you stop hearing eg. a clock tick?
Pupils might work scientifically by: comparing different sound sources and looking for patterns; carrying out tests to find the best places to locate fire bells in school.</td></tr>
<tr><td colspan="3">Other teaching ideas
Go on a sound walk either around school, in the school grounds or in the local community. If possible tape some of the sounds for use back in school.
Make a collection of objects that can be used to make sounds (not just instruments, also familiar objects).
Use the collection to make and describe as many different kinds of sound as they can eg. speaking, singing, striking, plucking, shaking, scraping, blowing, loud, soft, loudest, softest etc.
Listen to sounds through different objects eg. cardboard tubes, plastic funnels etc.
Use materials to muffle sounds like alarm clocks.
Use materials to keep sound from ears (NB nothing should be put into ears)
Listen to tape recordings of sounds made with instruments. Find the instrument and try to make the same sound.
Make up a story with sound effects.
Make junk musical instruments that can be shaken, plucked, blown etc.</td></tr>
<tr><td colspan="3">Key information</td></tr>
</table>

- Sounds are heard when they enter the ear.
- Something that makes a sound is called the source of the sound.
- Sound travels away from the source getting fainter as it does so.
- There are many different kinds of sound.
- We can make sounds in different ways.
- We can blow, shake, bang or scrape.
- We can make loud and quiet sounds.
- We can make long and short sounds.
- We can make high and low sounds.
- There are many kinds of sound. We can make sounds using our voice, our hands, our fingers and our feet.
- Sounds can be loud or quiet.
- Rhythm is a kind of pattern of long and short sounds

Lower key stage 2 – years 3-4

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

Working scientifically

Lower Key Stage 2 programme of study (statutory requirements)	Notes and guidance (non-statutory
• 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.	Pupils in years 3 and 4 should be given a range of scientific experiences to enable them to raise their own questions about the world around them. They should start to make their own decisions about the most appropriate type of scientific enquiry they might use to answer questions; recognise when a simple fair test is necessary and help to decide how to set it up; talk about criteria for grouping, sorting and classifying; and use simple keys. They should begin to look for naturally occurring patterns and relationships and decide what data to collect to identify them. They should help to make decisions about what observations to make, how long to make them for and the type of simple equipment that might be used. They should learn how to use new equipment, such as data loggers, appropriately. They should collect data from their own observations and measurements, using notes, simple tables and standard units, and help to make decisions about how to record and analyse this data. With help, pupils should look for changes, patterns, similarities and differences in their data in order to draw simple conclusions and answer questions. With support, they should identify new questions arising from the data, making predictions for new values within or beyond the data they have collected and finding ways of improving what they have already done. They should also recognise when and how secondary sources might help them to answer questions that cannot be answered through practical investigations. Pupils should use relevant scientific language to discuss their ideas and communicate their findings in ways that are appropriate for different audiences. These opportunities for working scientifically should be provided across years 3 and 4 so that the expectations in the programme of study can be met by the end of year 4. Pupils are not

	expected to cover each aspect for every area of study.

Year 3: Plants

<table>
<tr><th>Year 3 programme of study (statutory requirements)</th><th>Notes and guidance (non-statutory</th><th>Working Scientifically ideas</th></tr>
<tr><td>Pupils should be taught to:
identify and describe the functions of different parts of flowering plants: roots, stem, 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.</td><td>Pupils should be introduced to the relationship between structure and function: the idea that every part has a job to do. They should explore questions that focus on the role of the roots and stem in nutrition and support, leaves for nutrition and flowers for reproduction.
Note: Pupils can be introduced to the idea that plants can make their own food, but at this stage they do not need to understand how this happens.

Note: Pupils can be introduced to the idea that plants can make their own food, but at this stage they do not need to understand how this happens.</td><td>How does the amount of water/light/soil affect the height/number of leaves of a plant?
How is seed germination affected by seed size / temperature / moisture / soil?
How does the amount of space for roots affect the size of a plant?
What affects the speed that water rises up a plant stem?
Pupils might work scientifically by: comparing the effect of different factors on plant growth, for example the amount of light, the amount of fertiliser; discovering how seeds are formed by observing the different stages of plant life cycles over a period of time; looking for patterns in the structure of fruits that relate to how the seeds are dispersed. They might observe how water is transported in plants, for example by putting cut, white carnations into coloured water and observing how water travels up the stem to the flowers.</td></tr>
<tr><td colspan="3">Other teaching ideas
Growing cress seeds to illustrate phototropism (growing towards the light)
Observational drawing of plants root systems
Looking at root vegetables
Sorting and grouping plants or pictures of plants according to those whose leaves we eat and those we do not
Design a poster to show what plants need to grow
Split the stem of a carnation upwards and put each half in a different food colouring
Diagram of the transportation of water and nutrients through the plant</td></tr>
</table>

Key information

Plants need warmth, light and water for healthy growth.

Plants grown without light often germinate quickly or grow tall but they are not strong plants.

The plant is held in the soil by the root. The roots of different species of plant can be very different. Plants of the same species have roots which are similar.

Plants take up water from the soil through their roots.

When plants are pulled up, they cannot get water and the stems and leaves droop (wilt).

When the roots are put in water, the stems and leaves become upright again.
Seeds need space to grow away from the parent plant. Plants produce lots of seeds, only a few of them find suitable places and grow into new plants. They are adapted to be dispersed in several ways:

- seeds blown away by the wind have parachutes e.g. dandelion or wings (sycamore);
- seeds that stick to animal coats have tiny hooks on the outside which can be seen with a lens e.g. burdock;
- seeds used by animals for food, e.g. nuts are buried as a food store
- seeds eaten by birds are encased in brightly coloured fleshy fruit. The seeds inside have a hard outer covering so they can pass through the gut and still grow into new plants e.g. berries and rosehips.
- some seeds have an outer casing which dry and bursts open, flinging the seeds away. e.g. broom pods

Seeds need light, water and space (to get air and sunshine) in order to grow after they have germinated.

Some plants grow from pieces of root or underground stem left in the soil when it is dug.

Plants will eventually cover (colonise) an area.

The numbers and types of species in an area changes over the years

Most flowers have: sepals; petals; stamens (anthers and filaments) and carpels (stigma, style and ovary)

Flowers of the same species have common characteristics: the same number, shape and arrangement of sepals, petals, stamens and carpels, e.g. sweet pea, vetch and clover, daffodil, jonquil and narcissus .

A 'control' in a science experiment is one which is set up under 'normal' conditions - in this case, given all the requirements for growth - so that it can be compared to the others.

Plants can be grouped for identification according to the shape, pattern and arrangement of leaves and flowers.

Plants of the same species, growing in different places, often produce plants of a different size and shape to suit local conditions. This is called adaptation, e.g. bluebells grow taller in the shade than in the sun.

Different plants grow in different habitats.

All plants need different amounts of light and water to grow and produce flowers and seeds. Some plants grow best in certain kinds of soil. All species of plants have specific requirements.

Year 3: Animals, including humans

Year 3 programme of study (statutory requirements)	Notes and guidance (non-statutory	Working Scientifically ideas
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 animals have skeletons and muscles for support, protection and movement.	Pupils should continue to learn about the importance of nutrition (including a balanced diet) and should be introduced to the main body parts associated with the skeleton and muscles, finding out how different parts of the body have special functions.	• Do people with longer legs jump further/higher? • Do people with longer arms throw farther? • Which has stronger bones: chicken or fish, lamb or cow? • How many bones are there in a human body? • How many muscles are there in a human body? • Which is the longest bone in the body • Do people with large hands have big large feet? Pupils might work scientifically by: identifying and grouping animals with and without skeletons and observing and comparing their movement; exploring ideas about what would happen if humans did not have skeletons. They might compare and contrast the diets of different animals (including their pets) and decide ways of grouping them according to what they eat. They might research different food groups and how they keep us healthy and design meals based on what they find out.
Other teaching ideas 1. School cook to talk to children about planning school meals and a balanced diet 2. Cooking using healthy food and recipes 3. Collage of proteins, fats, carbohydrate, vitamin foods etc. 4. Collage of which part of plant a fruit or vegetable comes from 5. Sorting and grouping food packets 6. Ask children where their bones and muscles are 7. Make a paper model of a human skeleton 8. Make a jointed puppet using cardboard and split pins		

9. Discussion about location and function of joints e.g. hinge, ball and socket and how they function
10. Sing 'Dem bones'
11. Measuring length of some bones in the human body e.g. femur, tarsels, humerus etc.

Key information

Our bodies need a variety of foods for activity (energy), growth and health:

- Foods for growth include meat, fish and nuts.
- Foods for activity include bread, potatoes, pasta and fatty foods.
- Foods for health include fruit, vegetables and foods rich in fibre, e.g. wholemeal cereals.

Some of the food we eat comes from animals and some directly from plants. Cheese, butter, yoghurt, and cream all come from milk. Most of the milk we use comes from cows. When we use milk to make cheese or butter, parts of it are thrown away. Cows get their food from grass. A food chain shows where our food comes from. Nearly all food chains start with green plants that need the sun in order to grow.

Some food we eat comes directly from plants and some from animals that eat plants. Flour comes from wheat. Whole-meal flour is made from the whole grain and it is healthier because it has the bran in it. Many foods are made from wheat - cereals, spaghetti, bread etc. It is also an ingredient of cakes, biscuits etc. Grain from wheat and other cereals form the staple diet of people from many countries. Wheat, corn (maize) and rice are all grains from plants that need the sun in order to grow. A food chain shows where our food comes from.

- We need to eat:
  - a variety of food;
  - the right amount of food; to stay strong and healthy.

Moving and Growing

Our bodies need a variety of foods for activity, growth and health. Some foods for growth include meat, fish, nuts. Some foods for activity (energy) include bread, potatoes, pasta and fatty foods. Some foods for health include fruit and vegetables, and foods rich in fibre, e.g. wholemeal cereals. We need to eat: - a variety of food; and the right amount of food; to stay strong and healthy.

When we exercise we use up energy to move our muscles, so:

- we have to breathe faster
- our heart has to beat faster.

Energetic exercise makes us hot so our skin gets redder and we sweat (perspire). This helps to cool us down. When we stop exercising our body returns to normal after a while.

Bones make parts of our body, e.g. legs and spine, rigid so we can stand up. Joints between bones allow movement. Some parts of our body, e.g. back, have many small bones with sliding joints so we can bend in a curve. Some joints, e.g. elbow and knee, are hinge joints and move only backwards and forwards. Some joints, e.g. shoulder and hip, are ball and socket

joints and move all the way round. The longest bone in the body is the thigh bone. Every time we move our bodies we are using our muscles. Muscles can contract and relax. When muscles contract they pull bones together. Some parts of our bodies have big muscles e.g. calf muscles in our legs, biceps in our arms. Muscles are attached to bones. People start their life when they are born. People change in some ways as they grow up and as they grow old. They need to be looked after when they are young and sometimes when they are old or ill. At the end of their life, people die. A life cycle diagram is a way of showing this. When people are grown up they can have babies and the life cycle starts again. Some of the food we eat comes from animals and some directly from plants. Cheese, butter, yoghurt, and cream all come from milk. Most of the milk we use comes from cows. When we use milk to make cheese or butter, parts of it are thrown away. Cows get their food from grass. A food chain shows where our food comes from. Nearly all food chains start with green plants that need the sun in order to grow. Some food we eat comes directly from plants and some from animals that eat plants. Flour comes from wheat. Whole-meal flour is made from the whole grain and it is healthier because it has the bran in it. Many foods are made from wheat - cereals, spaghetti, bread etc. It is also an ingredient of cakes, biscuits etc. Grain from wheat and other cereals form the staple diet of people from many countries. Wheat, corn (maize) and rice are all grains from plants that need the sun in order to grow. A food chain shows where our food comes from.

Year 3 : Rocks

Year 3 programme of study (statutory requirements)	Notes and guidance (non-statutory	Working Scientifically ideas

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.	Linked with work in geography, pupils should explore different kinds of rocks and soils, including those in the local environment.	• How does the size of particles affect the flow rate of water through a funnel? • Which soil is best for seed germination? • Which is the hardest rock? Pupils might work scientifically by: observing rocks and exploring how and why they might have changed over time; using a hand lens or microscope to help them to identify and classify rocks according to whether they have grains or crystals, and whether they have fossils in them. Pupils might research and discuss the different kinds of living things whose fossils are found in sedimentary rock and explore how fossils are formed. Pupils could explore different soils and identify similarities and differences between them and investigate what happens when rocks are rubbed together. They can raise and answer questions about the way soils are formed.
Other teaching ideas 1. Examining rocks and soils with lenses and microscopes 2. Discussing, sorting and grouping rocks 3. Taking rubbings of different rocks 4. Putting different rocks into water to see how the water level changes 5. Shaking different soils in a transparent screw top plastic container and leaving them to stand will reveal the contents in layers		
Key information • Soil comes from the ground when rocks are worn away (eroded). • Soil is made up of different sized particles. • Clay particles feel silky when dry because they are very fine. When wet, they feel sticky and can be rolled into a ball. • Sand particles feel gritty because they are larger. When wet they cannot be rolled into a ball. • The chalk in soils comes from fossil shells deposited millions of years ago. The particles are very fine but do not become sticky when wet. • Water drains through some soils quicker than others.		

• Because clay particles are very fine there are few air spaces and the water cannot drain through easily. Clay soil gets water-logged in wet weather. When it dries out the clay sticks together forming a hard layer. • Sand particles are larger with bigger air spaces so the water drains through easily. • Stones in soil provide bigger air spaces and improve drainage.

Year 3: Light

Year 3 programme of study (statutory requirements)	Notes and guidance (non-statutory	Working Scientifically ideas
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 a solid object	Pupils should explore what happens when light reflects off a mirror or other reflective surfaces, including playing mirror games to help them to answer questions about how light behaves. They should think about why it is important to protect their eyes from bright lights. They should look for, and measure, shadows, and find out how they are formed and what might cause the shadows to change. **Note:** Pupils should be warned that it is not safe to look directly at the Sun, even when wearing dark glasses.	• How does distance of a shadow causing object from a screen affect the size of the shadow? • How does distance from the light source affect the size of the shadow? • How does the colour of a filter affect the colour of white/blue/red/green/yellow light? • How do overlapping shadows affect the darkness of the shadow? Pupils might work scientifically by: looking for patterns in what happens to shadows when the light source moves or the distance between the light source and the object changes.

• find patterns in the way that the size of shadows change.		

Other teaching ideas

1. Exploring how shadows of stationary objects change through the day (or the seasons)
2. Discussing where the sun first appears and where it goes during the day
3. Discussing where the sun disappears and where it goes during the night
4. How does the apparent movement of the sun compare with our model of the solar system?
5. Where do colours go at night - a speculative discussion
6. What kind of lights make sharp shadows?
7. Sorting and grouping materials into opaque, shiny and transparent
8. Make a shadow clock in the playground
9. Using shadows of children's heads to draw silhouettes
10. Using a torch, some objects and a screen to create silhouettes and then drawing around them
11. Make a collage of objects that are opaque or shiny or transparent
12. Observational drawings of the same object in different kinds of light

Key information

- Light travels in straight lines.
- Light passes through some materials and not others.
  Light passes through transparent materials.
- Light passes through translucent materials but you cannot see objects through it.
- No light passes through opaque materials.
- Shadows are made when the light cannot pass through an object.
- Transparent objects like glass bottles will not be able to make good shadows.
- The size of a shadow will change with the distance of the light and object from the screen.
- When you put an opaque object in the path of a beam of light, a shadow is made.
- Light cannot shine through an opaque object. Opaque objects cast clear, dark shadows.
  The Sun is a light source. The person is opaque.
- As the Sun appears to move through the sky the position of the shadow changes.
- Transparent materials let all light through; we can see clearly through these materials.
- Translucent materials let some light through; we can only see light through these materials but no shapes.
- Opaque materials let no light through; we cannot see through these materials at all.
- Light travels in straight lines.
- Light can pass round corners if it is reflected using mirrors.

Year 3: Forces and magnets

Year 3 programme of study (statutory requirements)	Notes and guidance (non-statutory	Working Scientifically ideas
Pupils should be taught to:	Pupils should observe that magnetic forces can act without direct contact,	• How well does magnetism pass through or attract different materials?

- 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.	unlike most forces, where direct contact is necessary (for example, opening a door, pushing a swing). They should explore the behaviour and everyday uses of different magnets (for example, bar, ring, button and horseshoe).	- Which magnet is strongest? - Are bigger magnets stronger? - Are all metal objects attracted to a magnet? Pupils might work scientifically by: comparing how different things move and grouping them; raising questions and carrying out tests to find out how far things move on different surfaces and gathering and recording data to find answers their questions; exploring the strengths of different magnets and finding a fair way to compare them; sorting materials into those that are magnetic and those that are not; looking for patterns in the way that magnets behave in relation to each other and what might affect this, for example, the strength of the magnet or which pole faces another; identifying how these properties make magnets useful in everyday items and suggesting creative uses for different magnets.
Other teaching ideas 1. Children have magnets and they search for magnetic materials 2. Discuss what magnetic materials do near magnets 3. Will magnets attract magnetic materials through paper, fabric etc? 4. Which part of a bar magnet attracts magnetic materials 5. Children have two bar magnets and explore how they interact 6. Discuss what bar magnets do near other bar magnets		

7. Make a fishing game with magnets 8. Make a maze game. The object has to follow the path/maze on a board with a magnet pulling the object from underneath
Key information • Pushes and pulls are examples of forces. • Forces act in particular directions. • When a force is applied it will make an object start moving, stop moving, change shape or change direction. • The greater the force, the greater the movement or change in shape. • The greater the mass the bigger the push or pull needed to move it. • The greater the mass, the greater the force needed to pull the mass. The steeper the incline, the greater the force required to pull the object up the ramp The greater the mass/incline the more the elastic band will stretch. This can be measured with a ruler. • Forces are measured in newtons. • Magnets attract certain metals. Like ends of magnets repel each other. Unlike ends attract.

Year 4

Year 4: All living things

Year 4 programme of study (statutory requirements)	Notes and guidance (non-statutory	Working Scientifically ideas

<table>
<tr>
<td>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.</td>
<td>Pupils should use the local environment throughout the year to raise and answer questions that help them to identify and study plants and animals in their habitat. They should identify how the habitat changes throughout the year. Pupils should explore possible ways of grouping a wide selection of living things that include animals and flowering plants and non-flowering plants. Pupils could begin to put vertebrate animals into groups such as fish, amphibians, reptiles, birds, and mammals; and invertebrates into snails and slugs, worms, spiders, and insects.

Note: Plants can be grouped into categories such as flowering plants (including grasses) and non-flowering plants, such as ferns and mosses.

Pupils should explore examples of human impact (both positive and negative) on environments, for example, the positive effects of nature reserves, ecologically planned parks, or garden ponds, and the negative effects of population and development, litter or deforestation.</td>
<td>Are mini beasts affected by bright light?
Compare two habitats: Which has most trees/plants/minibeasts?
In minibeasts which number of legs is most common?
What affects the numbers of different plants in different parts of the school grounds ?
Which tree has most birds on it?
Pupils might work scientifically by: exploring local small invertebrates and using guides or keys to identify them; making a guide to local living things; raising and answering questions based on their observations of animals and what they have found out about other animals that they have researched.</td>
</tr>
<tr>
<td colspan="3">Other teaching ideas</td>
</tr>
</table>

1. Using keys in reference books, identify minibeasts found in school grounds according to body parts/wings/legs/number of legs etc.
2. Using keys in reference books identify plants in classroom or school grounds according to leaf shape/flower/growth etc.
3. Odd one out. A child chooses 3 pictures of a minibeast/bird/plant. Others say which is odd one out and why
4. Make a database for minibeasts, plants or birds
5. Looking after stick insects/spiders/woodlice/caterpillars in the classroom
6. Discuss animal and plant differences re: protection e.g. colour, poisons, pattern, spikes etc.
7. Draw the food chain grass, cows, humans
8. Discuss what happens if there is not enough food or water
9. Asking children their favourite foods and sorting into plants/animals
10. Making a mobile based on a food chain or web
11. Drawing food chains which contain plants/animals with which we are familiar

Key information

- Plants need warmth, light and water for healthy growth.
- Plants grown without light often germinate quickly or grow tall but they are not strong plants.
- The plant is held in the soil by the root. The roots of different species of plant can be very different. Plants of the same species have roots which are similar.
- Plants take up water from the soil through their roots.
- When plants are pulled up, they cannot get water and the stems and leaves droop (wilt).
- When the roots are put in water, the stems and leaves become upright again.
- Seeds need space to grow away from the parent plant. Plants produce lots of seeds, only a few of them find suitable places and grow into new plants. They are adapted to be dispersed in several ways:
  - seeds blown away by the wind have parachutes e.g. dandelion or wings (sycamore);
  - seeds that stick to animal coats have tiny hooks on the outside which can be seen with a lens e.g. cleavers, burdock;
  - seeds used by animals for food, e.g. nuts are buried as a food store
  - seeds eaten by birds are encased in brightly coloured fleshy fruit. The seeds inside have a hard outer covering so they can pass through the gut and still grow into new plants e.g. berries and rosehips.
  - some seeds have an outer casing e.g. broom pods which dry and bursts open, flinging the seeds away.
- Seeds need light, water and space (to get air and sunshine) in order to grow after they have germinated.
- Plants grow from seeds that are in the soil even though we cannot see them.
- Some plants grow from pieces of root or underground stem left in the soil when it is dug.
- Plants will eventually cover (colonise) an area.
- The numbers and types of species in an area changes over the years
- Most flowers have: sepals; petals; stamens (anthers and filaments) and carpels (stigma, style and ovary)
- Flowers of the same species have common characteristics: the same number, shape and arrangement of sepals, petals, stamens and carpels, e.g. sweet pea, vetch and clover, daffodil, jonquil and narcissus .

• A 'control' in a science experiment is one which is set up under 'normal' conditions - in this case, given all the requirements for growth - so that it can be compared to the others. • Vertebrates are animals with a backbone. • Invertebrates are animals without a backbone. • Vertebrates can be subdivided into other groups: • Animals are especially suited to places where they live. To survive animals need the right food, water (or moisture) shelter, the right temperature and oxygen from *air or dissolved in water.* Habitats (except for ponds) do not have clear boundaries, animals can move away from the place where you found them, some e.g. birds may visit when you are not there. • Animals have young so it is likely that different sizes of the same species will be found. • Plants of the same species, growing in different places, often produce plants of a different size and shape to suit local conditions. This is called adaptation. • Different habitats provide differing conditions for the animals that live there. • Some animals are able to live in different habitats so you may find the same ones in different places. • Animals are especially suited to the place where they live. Some animals, e.g. frogs / tadpoles need different conditions at different stages of their life cycle. • Different plants grow in different habitats. Plants are adapted to suit the conditions where they grow. Plants of the same kind can grow differently if the conditions are not the same, e.g. bluebells grow taller in the shade than in the sun. • All plants need different amounts of light and water to grow and produce flowers and seeds. Some plants grow best in certain kinds of soil. All species of plants have specific requirements.

Year 4: Animals, including humans

Year 4 programme of study (statutory requirements)	Notes and guidance (non-statutory	Working Scientifically ideas
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	Pupils should be introduced to the main body parts associated with the digestive system, such as mouth, tongue, teeth, oesophagus, stomach and intestine and explore questions that help them to understand their special functions.	• Which is the best toothpaste to clean shoe polish from a tile? • How clean are our teeth at different times during the day (Use disclosing tablets) Pupils might work scientifically by: comparing the teeth of carnivores and herbivores, and suggesting reasons for differences; finding out what damages teeth and how to look after them. They might draw and

• construct and interpret a variety of food chains, identifying producers, predators and prey.		*discuss* their ideas about the digestive system and compare them with models or images.

Other teaching ideas

- Label a diagram of the different parts of the digestive system.
- Use websites to explore the digestive system such as http://kidshealth.org/kid/interactive/digestive_it.html
- Make a model of a digestive system
- Use model teeth and break up play dough
- Create food chains for animals in different countries.
- Sort animals into carnivores, omnivores and herbivores.

Key information

Teeth

A full set of teeth is: 4 incisors, 2 canines, 4 pre-molars and 6 molars, top and bottom, a total of 32 teeth.

- Teeth are adapted for different purposes:
    - sharp teeth for biting;
    - pointed teeth for holding and tearing;
    - flat topped teeth for grinding.
    - Carnivores, e.g. dogs, have large pointed canine teeth for tearing meat. They have no flat teeth for grinding food because their food is swallowed in lumps.
    - Herbivores, e.g. rabbits, have sharp teeth for biting; they have no pointed teeth because they do not tear their food. They have lots of flat teeth for grinding up plants.
    - Omnivores, have sharp teeth for biting, small pointed teeth for holding and tearing and flat teeth for grinding.

Your Digestive System

The story we're about to tell is of stormy seas, acid rains, and dry, desert-like conditions. It's an arduous journey that traverses long distances and can take several days. It's one in which nothing comes through unchanged. It's the story of your digestive system whose purpose is turn the food you eat into something useful -- for your body!

Down the Hatch

It all starts with that first bite of pizza. Your teeth tear off that big piece of crust. Your saliva glands start spewing out spit like fountains. Your molars grind your pizza crust, pepperoni, and cheese into a big wet ball. Chemicals in your saliva start chemical reactions. Seemingly like magic, starch in your pizza crust begins to turn to sugar! A couple of more chews and, then, your tongue pushes the ball of chewed food to the back of your throat. A trap door opens, and there it goes, down your gullet!

Next, your muscles squeeze the wet mass of food down, down, down a tube, or esophagus, the way you would squeeze a tube of toothpaste. It's not something you tell your muscles to do -- they just do it -- in a muscle action called peristalsis. Then, the valve to the stomach opens and pizza mush lands in your stomach!

Inside your stomach
Imagine being inside a big pink muscular bag -- sloshing back and forth in a sea of half-digested mush and being mixed with digestive chemicals. Acid rains down from the pink walls which drip with mucus to keep them from being eroded.

Sound a little like an amusement ride gone crazy? Every time you think you've got your equilibrium back, the walls of muscle contract and fold in on themselves again. Over and over again, you get crushed under another wave of slop. Every wave mixes and churns the food and chemicals together more--breaking the food into even smaller and smaller bits. Then another valve opens. Is the end in sight you ask, as the slop gets pushed into the small intestine.

Inside the small intestine, chemicals and liquids from places like your kidneys and pancreas break down and mix up the leftovers. The small intestine looks like a strange underwater world filled with things that resemble small finger-like cactus. But they're not cactus, they're villi. Like sponges, they're able to absorb tremendous amounts of nutrients from the food you eat. From the villi, the nutrients will flow into your bloodstream.

But hold on! The story's still not over yet -- the leftovers that your body can't use still have more traveling to do! Next, they're pushed into the large intestine. It's much wider and much drier. You find that the leftovers getting smaller, harder and drier as they're pushed through the tube. After all, this is the place where water is extracted and recycled back into your body. In fact, the leftovers that leave your body are about 1/3 the size of what first arrived in your intestines!

Where Food Turns Into Poop
Finally, the end of the large intestine is in sight! Now the drier leftovers are various handsome shades of brown. They sit, at the end of their journey, waiting for you to expel them -- out your anus. Of course, you know the rest! A glorious,if slightly stinky, journey, don't you think?

Year 4: States of matter

Year 4 programme of study (statutory requirements)	Notes and guidance (non-statutory	Working Scientifically ideas
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	Pupils should explore a variety of everyday materials and develop simple descriptions of the states of matter (solids hold their shape; liquids form a pool not a pile; gases escape from an unsealed container). Pupils should observe	• How does the temperature of water affect the time for salt/sugar to dissolve? • How does the amount of salt/sugar affect the time for water to evaporate?

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.	water as a solid, a liquid and a gas and should note the changes to water when it is heated or cooled. Note: Teachers should avoid using materials where heating is associated with chemical change, for example, through baking or burning.	• How does the type of filtering agent alter the cleanliness of water? • What affects the time for sand particles to flow in an egg-timer? • What happens when water is added to sand, salt and sugar, instant coffee, flour, and milk powder, custard powder, corn flour and icing sugar, plaster of paris, powder paint and dye. • Does the temperature of the water affect how much solid will dissolve in it? Pupils might work scientifically by: grouping and classifying a variety of different materials; exploring the effect of temperature on substances such as chocolate, butter, cream (for example, to make food such as chocolate crispy cakes and ice-cream for a party). They could research the temperature at which materials change state, such as when iron melts or when oxygen condenses, using and applying what they have learnt in mathematics. They might observe and record evaporation over a period of time, such as a puddle in the playground or washing on a line, and investigate the effect of temperature on washing drying or snowmen melting.

Other teaching ideas

1. Discussing, sorting and grouping familiar materials as solids or liquids
2. How many powders and how many liquids can you name?
3. Discussing the difference between powders and liquids
4. Handling Smarties and Treats to see how long they take to melt
5. Time how long it takes ice to melt in different parts of the room
6. Putting liquids in the freezer e.g. water, cooking oil, milk, sauce, salad cream
7. Separating by sieving: Big beans from small bans, lentils from rice, rice from salt, sand from stones, solid particles in oven dried soils

8. Discussing, explaining and learning the meaning of dissolve, soluble, insoluble and solution in relation to salt, sand and water
9. Filtering salt water and sand in water through paper
10. Dissolving Race. Each team has a plastic bottle half full of water, and salt. One spoonful is added the teams see who can make the salt dissolve fastest
11. Making a poster or collage showing solids and liquids and/or their properties
12. Draw a storyboard about the journey of water in the watercycle.
13. Draw pictures which show examples of condensation and evaporation.

Key information

Powders are made up of tiny solid particles. Some solids dissolve in water. This means the solids spread out to become part of the liquid. This means the solids become liquid when they are put into water or another liquid. Some substances are less soluble than others. If too much powder is added to the water only some will dissolve, the solution has become saturated.

Some solids do not dissolve in water. These are insoluble substances. Sometimes tiny solid particles spread out in the water so it looks as though they have dissolved but in fact they are suspended in the liquid and are really insoluble. Insoluble substances can be separated from liquids by filtering. Gravel, sand and pebbles all make good filtering material. Some solids will float on water, some will sink.

Plaster of Paris reacts with water causing a chemical change. The water and powder combine to form a solid substance. Heat is given off during this reaction. Substances that fizz when added to water are reacting chemically and giving off carbon dioxide gas. In simple terms this change is considered to be irreversible, however this particular reaction can be reversed under certain conditions (most reactions where there is a chemical change are irreversible).

Thermometers are used to read the temperature. We often record the air temperature when we learn about the weather so that we can compare the temperature on different days. The liquid in the thermometer rises as it gets warmer. *The liquid expands on heating.* The higher the temperature, the higher the liquid will rise. The number of degrees Celsius will be greater as it gets warmer. Thermometers can be used to take the temperature of gases, liquids or solids. Changes in temperature can be recorded on a graph or bar chart. IT can be used to store, retrieve and display data.

Melting is the process in which a solid material is heated causing the material to change its state and become liquid. When the heat is removed the liquid will cool down and become solid once more. Melting is a reversible process. Solid materials have a fixed shape. Liquid materials take the shape of their container. We can change the shape of solids by melting them but the material does not change.

Sieving can separate solid particles of different sizes. When two or more substances are mixed together but can be separated out again, this is called a mixture. Sieving is one way of separating a mixture of two or more dry substances, which have different sized particles

Water cycle
The Earth is covered by water, however, almost 97% is salt water found in the oceans. We can not drink salt water or use it for crops because of the salt content. We can remove salt from ocean water, but the process is very expensive.

How many processes make up the water cycle?
There are **six** important processes that make up the water cycle. 1. Condensation - the opposite of evaporation. Condensation occurs when a gas is changed into a liquid. 2. Infiltration - Infiltration is an important process where rain water soaks into the ground, through the soil and underlying rock layers. 3. Runoff - Much of the water that returns to Earth as precipitation runs off the surface of the land, and flows down hill into streams, rivers, ponds and lakes. 4. Evaporation - the process where a liquid, in this case water, changes from its liquid state to a gaseous state. 5. Precipitation - When the temperature and atmospheric pressure are right, the small droplets of water in clouds form larger droplets and precipitation occurs. The raindrops fall to Earth. 6. Transpiration - As plants absorb water from the soil, the water moves from the roots through the stems to the leaves. Once the water reaches the leaves, some of it evaporates from the leaves, adding to the amount of water vapor in the air. This process of evaporation through plant leaves is called transpiration.

Year 4: Sound

Year 4 programme of study (statutory requirements)	Notes and guidance (non-statutory	Working Scientifically ideas
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	Pupils should explore and identify the way sound is made through vibration in a range of different musical instruments from around the world; and find out how the pitch and volume of sounds can be changed in a variety of ways.	• How is the volume of a bell affected by the surface it is on? • What material conducts sound the best? • What material is the most effective sound insulator? • How can you amplfy sound ie make an alarm clock sound loud, shout a message across the playground? • Make the best drum from a container. • Does the length of material affect the pitch eg straw, string, wooden and metal ruler? • How can you make the best string telephone?

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.		Pupils might work scientifically by: finding patterns in the sounds that are made by different objects such as saucepan lids of different sizes or elastic bands of different thicknesses. They might make earmuffs from a variety of different materials to investigate which provides the best insulation against sound. They could make and play their own instruments by using what they have found out about pitch and volume.

Other teaching ideas

1. How are sound and vibrations connected? Hands on radios, tape players and anything else that makes sound and vibrates
2. How are vibrations affected by volume, tone and tuning buttons?
3. Hands on our own throats whilst humming - feel the vibrations?
4. Watching rice on an upturned speaker, how is it affected by volume and tone
5. Making and testing junk instruments
6. Putting a range of vibrating tuning forks into water
7. Write a mnemonic poem about vibrations
8. Cut the top of a straw into a triangle and blow through it. Cut the straw shorter and shorter to investigate how pitch changes.
9. Challenge children to make the best string telephone with resources provided.
10. Design and make an Ear Trumpet or a megaphone

Key information

Sound is caused when an object vibrates. The faster the vibrations the higher the sound. The slower the vibrations the lower the sound. The bigger the vibrations the louder the sound. The smaller the vibrations the quieter the sound. Shorter lengths of elastic or columns of air vibrate faster making a higher sound.

Sound can travel through all materials. Some materials transmit sound better than others. Sound passes through wood, metal and water more quickly than through air. Sound passes through hard materials better than soft materials.

Ears allow us to hear. Sound is muffled when ear muffs are worn because the sound waves are not able to reach the ear drum. External ears vary. Some animals can alter the position of their ears to detect the direction of the sound.

Echoes are sound waves being reflected from surfaces. Hard surfaces are more likely to produce echoes. Soft materials absorb the sound waves. Empty rooms without any furnishing

are more likely to produce echoes. Echoes can also be heard in caves, tunnels, mountainous areas, and near walls. Noise is measured in decibels. Sound is measured with a sound meter. Too much noise can damage your ears. Sound vibrations are absorbed better by some materials. Sound does not travel through a vacuum. Different vibrations alter the pitch and loudness of a sound. High notes vibrate more each second than low notes the frequency is higher. Sound travels in waves. Loud and quiet noises have the same number of vibrations per second. Loud noises have a greater amplitude - quiet noises have a small amplitude. Sound travels through hard materials more easily than soft materials. Light travels much faster than sound. For example, an aircraft can be seen before the noise of the engines is heard.

Year 4: Electricity

Year 4 programme of study (statutory requirements)	Notes and guidance (non-statutory	Working Scientifically ideas
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	Pupils should construct simple series circuits, trying different components, such as bulbs, buzzers and motors, and including switches, and use their circuits to create simple devices. Pupils should draw the circuit as a pictorial representation, not necessarily using conventional circuit symbols at this stage; these will be introduced in year 6. **Note**: Pupils might use the terms current and voltage, but these should not be introduced or defined formally at this stage. Pupils should be taught about precautions for working safely with electricity.	• How is brightness of the bulb affect by number of batteries/length of wire/thickness of wire/type of wire? • Which materials conduct electricity the best? How can we stop Burglar Bill from coming into the classroom? Find the best conductors and insulators. How does the number of batteries affect the brightness of a bulb? • How does the number of bulbs affect the brightness of a bulb? Pupils might work scientifically by: observing patterns, for example that bulbs get brighter if more cells are added, that metals tend to be conductors of electricity, and that some materials can and some cannot be used to connect across a gap in a circuit.

in a simple series circuit • recognise some common conductors and insulators, and associate metals with being good conductors.		

Other teaching ideas

1. Make a light-up Christmas card
2. Making a bulb light with the least possible equipment
3. Making a bulb light with a switch in the circuit
4. Draw simple circuits using agreed symbols
5. How can you make a bulb flash and what could it be used for?
6. Writing about the journey electricity makes as it goes around a circuit describing what it does in bulbs, wires and switches
7. Check pictures of circuits, indicating which will work, then using equipment to make and test each circuit

Key information

- A complete circuit is needed to make electrical devices work. The circuit must include a battery or power supply.
- Changing over the battery terminals reverses the flow of electricity. The direction of the flow of electricity does not affect a bulb but in LED's and buzzers the electricity can only flow one way. Reversing the flow of electricity through a motor reverses the direction in which the motor rotates
- Electricity can flow through some materials more easily than others. If the electricity cannot pass through the material the circuit is not complete. Materials that electricity can pass through easily are called conductors. Most metals are good conductors of electricity. Poor conductors are called insulators.
- A circuit with two or more bulbs wired in this way is called a series circuit. If you unscrew one bulb it breaks the circuit and none of the bulbs will light.
- As the electricity flows through the bulb it makes it light; the faster the flow of electricity, the brighter the bulb will be.
- A bulb in the circuit slows down (resists) the flow of electricity. More bulbs, wired in series, will slow down the flow even more so the bulbs become dimmer.

- A circuit with two or more components wired like this is called a parallel circuit.
- The two bulbs in a parallel circuit stay bright because there is only one bulb in each 'route' to resist the flow of electricity. The flow is faster so each bulb is brighter than in a series circuit.
- If you unscrew one bulb in a parallel circuit the other bulb will stay lit because the electricity can still pass through this 'route'.
- All materials and components in an electrical circuit resist (slow down) the flow of electricity to some degree.
- As we increase the length of resistance wire through which the electricity must flow, the current is reduced (i.e. the electricity flows more slowly) so the bulb becomes dimmer. When resistance is high, the bulb will be dim. When resistance is low, the bulb will be bright.
- Resistors are used to control the flow of electricity. A variable resistor contains a long piece of resistance wire coiled to take up less space. Variable resistors can be used to control light, volume and speed.
- A cell consists of 1.5 volts. A battery is a combination of two or more 1.5 volt cells. We often refer to 1.5 volt cells as batteries by mistake!
- The voltage of the battery is like a 'push' which makes the electricity flow.
- The bigger the voltage the harder the 'push' so the current is higher i.e. the electricity flows faster. The bulb is brighter when the flow of electricity is faster.
- We use symbols to represent components in a circuit
- The symbols are used to draw a circuit diagram
- The symbols are recognised internationally.

Upper key stage 2 – years 5-6

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

Working scientifically

Upper Key Stage 2 programme of study (statutory requirements)	Notes and guidance (non-statutory
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	Pupils in years 5 and 6 should use their science experiences to: explore ideas and raise different kinds of questions; select and plan the most appropriate type of scientific enquiry to use to answer scientific questions; recognise when and how to set up comparative and fair tests and explain which variables need to be controlled and

questions, including recognising and controlling variables where necessary • taking measurements, using a range of scientific equipment, with increasing accuracy and precision • recording data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, and bar and line graphs • using test results to make predictions to set up further comparative and fair tests • using simple models to describe scientific ideas • reporting and presenting findings from enquiries, including conclusions, causal relationships and explanations of results, in oral and written forms such as displays and other presentations • identifying scientific evidence that has been used to support	why. They should use and develop keys and other information records to identify, classify and describe living things and materials, and identify patterns that might be found in the natural environment. They should make their own decisions about what observations to make, what measurements to use and how long to make them for, and whether to repeat them; choose the most appropriate equipment to make measurements and explain how to use it accurately. They should decide how to record data from a choice of familiar approaches; look for different causal relationships in their data and identify evidence that refutes or supports their ideas. They should use their results to identify when further tests and observations might be needed; recognise which secondary sources will be most useful to research their ideas and begin to separate opinion from fact. They should use relevant scientific language and illustrations to discuss, communicate and justify their scientific ideas and should talk about how scientific ideas have developed over time. These opportunities for working scientifically should be provided across years 5 and 6 so that the expectations in the programme of study can be met by the end of year 6. Pupils are not expected to cover each aspect for every area of study.

Year 5: All living things

Year 5 programme of study (statutory requirements)	Notes and guidance (non-statutory)	Working Scientifically ideas
Pupils should be taught to: • explain the differences in the life cycles of a mammal, an amphibian, an insect and a bird • describe the life process of reproduction in	Pupils should study and raise questions about their local environment throughout the year. They should observe life-cycle changes in a variety of living things, for example plants in the vegetable garden or flower border, and animals in the local environment. They should find out about the work of naturalists and animal	• What do seeds require in order to germinate? • How does the ovary of a flower change as the flower wilts? • Which animals have the longest gestation period? Pupils might work scientifically by: observing and comparing the life

some plants and animals.	behaviourists such as David Attenborough and Jane Goodall. Pupils should find out about different types of reproduction, including sexual and asexual reproduction in plants, and sexual reproduction in animals.	cycles of plants and animals in their local environment with other plants and animals around the world (in the rainforest, in the oceans, in desert areas and in prehistoric times), asking pertinent questions and suggesting reasons for similarities and differences. They might try to grow new plants from different parts of the parent plant, for example seeds, stem and root cuttings, tubers, bulbs. They might observe changes in an animal over a period of time (for example, by hatching and rearing chicks), comparing how different animals reproduce and grow.

Other teaching ideas

1. Make a poster that explains pollination, fertilization, seed production, seed dispersal, germination and plant growth
2. Research which creatures carry pollen from flower to flower and why
3. List things that aid seed dispersal
4. Explore differences in life cycles between different types of animals.

Key information

Plant life cycles

All living things will die; and if the species is to continue, and is to have any future, then it needs to reproduce. Reproduction produces new offspring of their kind - plant or animal. As the old die off, the young take their place. A species that is good at reproduction will survive.

Green plants reproduce by flowering. The flowers contain the cells that will combine to produce the seeds and then the new plant. Ideally, cells from two different plants will combine; but if all else fails, a plant can fertilise itself to produce seeds.

The flower produces female egg cells in its ovary. The ovary has a sticky stigma on a long style to catch the male pollen cells. The pollen cells are produced in the stamens. These tiny specks are carried to the stigma of another plant by the wind, or on an insect. The insect gets sticky, sugary nectar from one plant and gives it to another plant - like a postal service.

When the egg cell is fertilised, it develops into a seed. The ovary may develop too, into a fruit. Because now the challenge is to move the seed - away from its parent plant to somewhere where it will grow. The wind may blow it, or water may carry it; it may stick to a passing animal, or be swallowed by one, only to emerge in the animal's droppings and grow. The new plant will flower in turn.

This is all a risky business - and so lots of pollen and seeds are produced to help ensure that new plants will grow. The whole process - from flower to flower - is called the flower's life cycle.

Animal Life Cycles

Animals that Grow Up (Simple Life Cycle):

Most animals including fish, mammals, reptiles and birds have very simple life cycles:

- they are born (either alive from their mother or hatched from eggs)
- they grow up

These animals have three stages -- before birth, young and adult. The young are typically similar to the parent, just smaller. The young slowly "grow" to become adults.

Amphibians:

Amphibians, like frogs and newts, have a slightly more complicated life cycle. They undergo a metamorphosis (a big change):

- they are born (either alive from their mother or hatched from eggs)
- they spend their childhood under water, breathing with gills
- they grow into adults and move to the land, breathing with lungs

Animals that Undergo a Complete Metamorphosis:

Insects

These insects have four stages in their life cycle:

- egg: unborn stage.
- larva: young stage -- this is when most of the feeding is done.
  (they usually look like worms)
- pupa: inactive (no feeding) stage between larva and adult stages.
  (usually well camouflaged)
- adult: final, breeding stage.
  (they usually grow wings)

Animals that go through a complete metamorphosis are what my daughter Kaitlyn calls "Wow!" animals -- they go to bed looking one way and wake up a completely different creature. Wow!

Animals that Undergo an Incomplete Metamorphosis:

About 10% of insects go through an incomplete metamorphosis. They do not have a pupal form -- these include dragonflies, grasshoppers and cockroaches. These insects have three stages in their life cycle: • egg: unborn stage. • nymph: young stage -- this is when most of the feeding is done. • adult: final, breeding stage - including wings.

Year 5: Animals, including humans

Year 5 programme of study (statutory requirements)	Notes and guidance (non-statutory	Working Scientifically ideas
Pupils should be taught to: • describe the changes as humans develop from birth to old age.	Pupils should draw a timeline to indicate stages in the growth and development of humans. They should learn about the changes experienced in puberty.	• How does head to body ratio change as a human grows? Pupils could work scientifically by comparing data about the gestation periods of humans and other animals or by finding out and recording the length and mass of a baby as it grows.
Other teaching ideas 1. Link to SRE puberty talks 2. Draw humans at different stages with correct head to body ratios. 3. Plot average height of males and females as they grow into a line graph. Compare differences and rate of growth at different stages.		
Key information **THE HUMAN LIFE CYCLE STAGES** The stages of life have been defined by cultures and religions in many ways. In ancient Greece, the human life cycle was mapped in seven-year periods. Today, most people recognize the human life cycle as having four or five distinct stages shared by all humans. Human life can be explained more concretely by looking at these life stages. **Birth** Birth takes place between fertilization and 40 weeks following fertilization, at which point the baby is fully formed and ready to exit the mother's uterus and enter the world. During the birth stage, the baby begins as a single cell, which proceeds to multiply into many cells that form the body parts and organs of new human life. **Infancy** Infancy is categorized as lasting from birth through the first year of life. At this point, the baby exits the mother's uterus. It can breath, its heart can beat and its organs can operate efficiently without the assistance of the mother. However, the infant is completely dependent upon its parents or caretakers for survival. **Childhood**		

Childhood takes place between ages 1 to 10. The first two years of childhood, the child is called a toddler. During this time, the child learns how to walk, talk and be more self-sufficient. These skills continue to expand during the remainder of childhood, and socialization takes place. Childhood is the building blocks upon which adolescence and, later, adulthood will be built, and the child is susceptible during this time to learned habits and behaviors. **Adolescence** Adolescence takes place between ages 12 and 18 and is a critical turning point because it is when puberty takes place. Boys' voices change and girls get their periods and both sexes become more sexually aware beings. As such, they begin to separate more from the parents and become more independent. **Adulthood** Adulthood is the longest stage and normally lasts from age 18 through old age. While there might be smaller psychological or culturally defined stages, adulthood is when human beings are fully grown and must provide entirely for themselves using the skills they learned throughout the first life stages. This is also a significant time because it is when the life cycle is initiated again by the conception and birth of the adult's own children. At the end of the adult life cycle, the body begins to deteriorate and the life cycle eventually ends in death.

Year 5: Properties and changes of materials

Year 5 programme of study (statutory requirements)	Notes and guidance (non-statutory	Working Scientifically ideas
Pupils should be taught to: • compare and group together everyday materials based on evidence from comparative and fair tests, including their hardness, solubility, transparency, conductivity (electrical and thermal), and response to magnets • understand 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	Pupils should build a more systematic understanding of materials by exploring and comparing the properties of a broad range of materials, including relating these to what they learnt about magnetism in year 3 and about electricity in year 4. They should explore reversible changes, including, evaporating, filtering, sieving, melting and dissolving, recognising that melting and dissolving are different processes. Pupils should explore changes that are difficult to reverse, such as burning, rusting and other reactions, for example vinegar with bicarbonate of soda. They should find	• How is evaporation of a liquid affected by size of container/ viscosity/ moving air/ additives/ temperature? • How is boiling time of water affected by adding salt? • Which liquid dissolves antacid tablets quickest? • Do all liquids evaporate at the same rate? - salt water, vinegar, cooking oil, milk, aftershave lotion • Do all frozen materials melt at the same temperature? Pupils might work scientifically by: carrying out tests to answer questions such as 'Which

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.	out about how chemists create new materials, for example Spencer Silver, who invented the glue for sticky notes or Ruth Benerito, who invented wrinkle-free cotton. **Note:** Pupils are not required to make quantitative measurements about conductivity and insulation at this stage. It is sufficient for them to observe that some conductors will produce a brighter bulb in a circuit than others and that some materials will feel hotter than others when a heat source is placed against them. Safety guidelines should be followed when burning materials.	materials would be the most effective for making a warm jacket, for wrapping ice cream to stop it melting, or for making blackout curtains?' They might compare materials in order to make a switch in a circuit. They could observe and compare the changes that take place, for example when burning different materials or baking bread or cakes. They might research and discuss how chemical changes have an impact on our lives, for example cooking, and discuss the creative use of new materials such as polymers, super-sticky and super-thin materials.

Other teaching ideas

1. Discussing the difference between powders and liquids
2. Discussing, sorting and grouping familiar materials as solids or liquids
3. Making a poster or collage illustrating the properties of solids or liquids or gases
4. List all you eat in a day as solids, liquids or gases
5. Explain with a drawing how smells travel around buildings
6. Research gases and their uses
7. Matching words to definitions evaporating, condensing etc.
8. Explore ways to remove salt from water.
9. Group changes into reversible and irreversible reactions.

Key information

Solids retain their fixed shape unless a force is applied to change the shape. The volume of material remains the same even if the shape is changed.

Liquids will pour and will take the shape of their container. The volume of liquid remains the same when it is poured into a different shaped container.

Very small solids, like sand, behave like a liquid; they can be poured and they take the shape of their container. However, each individual grain is a solid and behaves as such.

Gases spread out to fill all the space in a container. In a larger container the amount of gas will remain the same but it will spread out to fill the container and so have a greater volume.

Evaporation is the process by which water changes its state from a liquid to a gas (water vapour).

Heat energy is needed to change water into water vapour.

As water evaporates from the washing the air around becomes full of moisture. The wind moves the air around so that more water can evaporate. On a very damp day the air becomes saturated with water vapour so no more water can evaporate. (This means that the washing will not dry and the puddles won't dry up!).

The process of condensation occurs when the water vapour in the air cools down and changes state from a gas to a liquid.

The air around a cold surface cools down and some of the water vapour in the air condenses, forming tiny droplets of water on the cold surface.

Outside, condensation can be seen in the form of mist or fog; the air becomes saturated with water vapour, some of which starts to condense and hangs in the air as tiny droplets of water.

Thermometers can be used to take the temperature of gases, liquids or solids. The liquid in the thermometer rises as it gets warmer. The higher the temperature, the higher the liquid will rise. (The liquid expands on heating.) The number of degrees Celsius will be greater as the temperature rises.

Water boils at 100°C. The temperature of the water will not rise above 100°C, at which point the water will evaporate.

Changing state

- When two or more substances are mixed together and a chemical reaction takes place new substances are formed and the change is irreversible.
- Using different proportions of materials can affect the properties of the new substance that is formed e.g. the new substance can vary in hardness, flexibility, strength according to the proportions of original materials used.
- Bricks can be tested by dropping from successive heights until they break.
- Some substances are more soluble than others i.e. a greater mass will dissolve in a given amount of water.
- Some substances will not dissolve; they are insoluble.
- More solute will dissolve in a greater amount of water.
- In most cases more solute will dissolve in hot water than in cold water.
- A saturated solution will not dissolve any more solute.
- Some substances will not dissolve; they are insoluble. Insoluble substances can be separated from liquids by filtering or sieving.
- Soluble substances can be recovered by evaporating the liquid from the solution. Evaporation is the process by which water changes its state from a liquid to a gas (water vapour). When the liquid evaporates, the solid substance is left behind.
- Mass is the amount of matter in a substance.

- Matter cannot be lost during reactions. Matter is always conserved.
- During the evaporation process the water changes its state from a liquid to a gas leaving behind the solid substance in its original state. The matter has not changed during this process; the change that takes place when a substance dissolves in water is called a physical change because the substance can be recovered.
- Evaporation is the process by which water changes its state from a liquid to a gas (water vapour).
- Heat energy is needed to change water into water vapour.
- As water evaporates from the washing the air around becomes full of moisture. The wind moves the air around so that more water can evaporate. On a very damp day the air becomes saturated with water vapour so no more water can evaporate. (This means that the washing will not dry and the puddles won't dry up!)
- The process of condensation occurs when the water vapour in the air cools down and changes state from a gas to a liquid.
- The air around a cold surface cools down and some of the water vapour in the air condenses, forming tiny droplets of water on the cold surface.
- Outside, condensation can be seen in the form of mist or fog; the air becomes saturated with water vapour, some of which starts to condense and hangs in the air as tiny droplets of water.
- Thermometers can be used to take the temperature of gases, liquids or solids. The liquid in the thermometer rises as it gets warmer. The higher the temperature, the higher the liquid will rise. (The liquid expands on heating.) The number of degrees Celsius will be greater as the temperature rises.
- Water boils at 100°C. The temperature of the water will not rise above 100°C, instead the water will evaporate.
- Changes in temperature can be recorded on a graph or bar chart. IT can be used to store, retrieve and display data.
- The water cycle is a never-ending process in which water is exchanged between land and air.
- Heat energy from the Sun causes millions of tonnes of water to evaporate from the Earth's surface every day. Over a period of time the same amount of water will return to the Earth's surface in the form of rain or snow.
- As the water vapour in the atmosphere cools it condenses into water droplets and forms clouds. When the droplets in the clouds become larger and heavier they fall to the Earth as rain.
- The rain that falls on the mountains runs down in streams that join rivers and eventually reach the sea.
- Burning is a process that is not reversible.
- A fuel is a form of stored energy. The process of burning converts the chemical energy stored in the fuel to heat and light energy.
- Waste products are given off during the burning process. The matter that is burned is not destroyed but is converted into a different form or released into the atmosphere in the form of gases.
- Melting, freezing, evaporation, condensation and boiling are changes that can be reversed.
- Water freezes at 0°C. Other liquids may freeze at a lower temperature.
- Heat energy is required for melting to take place. Ice melts at 0°C. Other solids usually melt at higher temperatures.
- When two or more substances are mixed together and a chemical reaction takes place new substances are formed and the change is irreversible.
- Burning is a process that is irreversible.

Year 5: Earth and space

Year 5 programme of study (statutory requirements)	Notes and guidance (non-statutory	Working Scientifically ideas
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.	Pupils should be introduced to a model of the Sun and Earth that enables them to explain day and night. Pupils should learn that the Sun is a star at the centre of our solar system and that it has eight planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune (Pluto was reclassified as a 'dwarf planet' in 2006). They should understand that a moon is a celestial body that orbits a planet (Earth has one moon; Jupiter has four large moons and numerous smaller ones). **Note:** Pupils should be warned that it is not safe to look directly at the Sun, even when wearing dark glasses. Pupils should find out about the way that ideas about the solar system have developed, understanding how the geocentric model of the solar system gave way to the heliocentric model by considering the work of scientists such as Ptolemy, Alhazen and Copernicus.	• How is the size of shadow affected by the time of day/distance from light source/brightness of light source? • How does the position of the Sun change during the day? • How does the shape of the moon appear to change over a month? • How does day length change through a term/year? • How does air temperature change through a term/year? Pupils might work scientifically by: comparing the time of day at different places on the Earth through internet links and direct communication; creating simple models of the solar system; constructing simple shadow clocks and sundials, calibrated to show midday and the start and end of the school day; finding out why some people think that structures such as Stonehenge might have been used as astronomical clocks.
Other teaching ideas		

1. Discuss why different parts of the school are sunny/shady at different times of the day 2. Draw around the shadow of a child in the same place at different times of the day 3. Keep a record of how the position of sun changes through the day 4. Design and make a sundial 5. Make 3D models of Earth, Moon and Sun from plasticine, papier mache, fruit or balloons 6. Discuss a moving model of the Earth, Moon and Sun 7. Use a globe and a spotlight to discuss day and night 8. Use a globe and a spotlight to discuss the year 9. Explore the Perseid meteor and how this yearly meteor shower can be explained by moving of the Earth around the sun.
Key information • The Sun is a source of light. • Opaque objects cast shadows. • The sharpness of shadows will vary with different weather conditions. • The brighter the Sun the sharper the shadow. • The angle at which light falls on an object will affect the shape of the shadow. • The Sun appears to move across the sky during the day. • The shadows are shorter at mid-day. • The Sun is higher in the sky at mid-day in summer than it is at the same time in winter. • In summer the sun rises earlier in the day and sets later in the evening than it does in the winter. • We have more hours of daylight in the summer than in the winter. • The differences in the hours of sunlight is the reason for the seasons. • Countries on the equator have the same hours of sunlight throughout the year and therefore no seasons • The Moon appears to change shape. It follows a monthly cycle. • The Moon reflects light from the Sun. • Stars give out their own light • Darkness is the absence of light. • True darkness is only found in places like caves underground. • The Sun, Earth and Moon are approximately round or spherical. • The Sun is over a million times bigger than the Earth. • The Earth is six times bigger than the Moon. • The Sun is 150 million km from the Earth. • The Moon is quite close - only 400,000 km away! • We don't feel as if we are on a roundabout because the "park" or atmosphere is spinning at the same rate.

Year 5: Forces

Year 5 programme of study (statutory requirements)	Notes and guidance (non-statutory)	Working Scientifically ideas
Pupils should be taught to: • explain that unsupported	Pupils should explore falling objects and raise questions about the effects of air resistance.	• How does type of material/weight added/shape/ making holes

<table>
<tr>
<td>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
understand that force and motion can be transferred through mechanical devices such as gears, pulleys, levers and springs.</td>
<td>They should experience forces that make things begin to move, get faster or slow down. Pupils should explore the effects of friction on movement and find out how it slows or stops moving objects, for example by observing the effects of a brake on a bicycle wheel. They should explore the effects of air resistance by observing how different objects such as parachutes and sycamore seeds fall. Pupils should explore the effects of levers, pulleys and simple machines on movement. Pupils might find out how scientists such as Galileo Galilei and Isaac Newton helped to develop the theory of gravitation.</td>
<td>affect the falling time of a parachute?
How does moving the fulcrum on a lever affect the force needed to move an object?
What factors affect the sag of a simple beam bridge?
What affects the time of the swing of a pendulum?
What affects the height bounced by a ball?
What affects the time for different Plasticine shapes to fall in water?
How does air resistance affect our ability to run?
Pupils might work scientifically by: exploring falling paper cones or cup-cake cases, and designing and making a variety of parachutes and carrying out fair tests to determine which designs are the most effective. They might explore resistance in water by making and testing boats of different shapes. They might design and make artefacts that use simple levers, pulleys, gears and/or springs and explore their effects.</td>
</tr>
<tr>
<td colspan="3">Other teaching ideas

Rolling the same ball or car down different steps
Make and discuss parachutes - what slows them down
Explore why racing cars and motorbikes are strange shapes.
Discussion about floating and sinking - what pulls things down and what pushes them up?
Discuss autogyros - what pulls them down what holds them up
Discuss paper aeroplanes - what makes them go, what makes them stop
Make a plasticine boat that will support 50g</td>
</tr>
<tr>
<td colspan="3">Key information
Pushes and pulls are examples of forces.
Forces act in particular directions.
When a force is applied it will make an object start moving, stop moving, change shape or change direction.
The greater the force, the greater the movement or change in shape.
The speed with which an object falls to the ground does not depend on its mass.
The rate will vary if the object offers more resistance to the air because of its shape, e.g. a feather.
Weight is another name for the gravitational force from a large object like the Earth.</td>
</tr>
</table>

- If a feather and a lead ball were dropped together they would both hit the ground at the same time if there was no air on this planet.
- The greater the mass the bigger the push or pull needed to move it.
- The greater the mass, the greater the force needed to pull the mass. The steeper the incline, the greater the force required to pull the object up the ramp The greater the mass/incline the more the elastic band will stretch. This can be measured with a ruler. Forces are measured in newtons.
- A boat shape will float if it includes a large volume of air even though the material from which it is made is heavier than water.
- The mass of the boat is being pulled down due to gravity.
- The water is pushing the boat up. This is called upthrust.
- The boat floats when these two forces are balanced.
- When an object does not move the forces are balanced.
- There are many examples of this:
    - The tug of war game when the ribbon does not move.
    - A book on a table - the book presses down on the table with a force equal to its weight - the table pushes up with the same force.
    - A boat when it is floating.
- Objects will move when the force in one direction is greater than any other forces preventing it from moving.
- Objects move in the same direction unless a force is applied to change it.
- A force can make a moving object stop, speed up, slow down or change direction.
- When a moving truck hits a barrier, the force will make the barrier move or change shape or cause the truck to change shape or move backwards.
- Softer materials will be able to absorb the force by changing shape. Harder materials will be more likely to move or cause the truck to crumple or move back.
- Magnets attract certain metals. Like ends of magnets repel each other. Unlike ends attract.
- Objects fall to the ground at the same rate regardless of their mass providing they offer the same resistance to the air. Air resistance slows down the rate of fall e.g. autogyros, sycamore seeds. *Galileo first proved this in the 1600s when he dropped three balls of different masses from the Leaning Tower of Pisa. They all hit the ground at the same time.*

- The greater the air resistance the slower the autogyro or parachute will fall. Air resistance will be increased if there is a greater surface area of fabric or card. Force **is** measured **in** newtons **with** a newton meter. When a scale is put on a meter it is called calibration. When a newton meter is used to measure the force needed to lift an object it is the same as its weight.

    - *100g is equal to 1N*
    - *1g is equal to 0. 01N*
    - *1kg is equal to 10N*

- *Because the gravity of the Moon is only one sixth of the Earth, objects weigh 6 times less on the Moon. This means that if a 600g stone from Earth is lifted on the Moon it will <u>only</u>* weigh 100g.

- Friction is a force that reduces the sliding movements between two surfaces.
- It has many important applications in our lives - for instance - we slip on icy pavements, we could not walk without friction, braking depends on friction, a nail is held in a wall by friction, parachutes descend slowly due to friction.
- The moving parts of machines are lubricated to reduce friction. *When two surfaces rub together some of the energy is converted into heat.* Forces can be represented with arrows showing the direction of the force. If equal and opposite forces are applied, the object does not move. If unequal and opposite forces are applied, the object moves in the direction of the greater force. If forces are applied at right angles, the object moves diagonally. Objects are balanced when the forces acting upon them are equal. According to Newton's law of motion - "action and reaction are equal and opposite". An object will stay at rest until a force is applied which changes the balance of the forces. The object will then move in the same direction as the greater force. When springs and elastic bands are stretched they exert a force on whatever is compressing them. When springs are compressed they exert a force on whatever is compressing them. The see-saw will be balanced when the forces on both sides are balanced. When a boat floats, the up thrust from the water equals the pull of gravity. *Sea water is more dense than fresh water so it has a greater up thrust. Heavily laden boats that float in sea water could sink when they sail into fresh water.*

YEAR 6

Year 6: All living things

<table>
<tr><th>Year 6 programme of study (statutory requirements)</th><th>Notes and guidance (non-statutory)</th><th>Working Scientifically ideas</th></tr>
<tr><td>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 micro-organisms, plants and animals
give reasons for classifying plants and animals based on specific characteristics.</td><td>Pupils should build on their learning about grouping living things in year 4 by looking at the classification system in more detail. They should be introduced to the idea of broad groupings and how these subdivide. Through direct observations where possible, they should classify animals into vertebrates (reptiles, fish, amphibians, birds and mammals) and commonly found invertebrates (e.g. insects, spiders, snails, worms). They should discuss reasons why living things are placed in one group and not another. Pupils might find out about the significance of the work of scientists such as Carl Linnaeus, a pioneer of classification.</td><td>Which groups would you put organisms from the local environment?
Pupils might work scientifically by: devising classification systems and keys to identify some animals and plants in the immediate environment. They could research animals and plants in other habitats and decide where they belong in the classification system.</td></tr>
<tr><td colspan="3">Other teaching ideas
Discuss why the original method of classification in plants and animals would be a problem with all the organisms which we now know about.
Watch videos to explore classification like http://youtu.be/ZrrZAp9N46c
Sort a selection of animals into groups based on similar characteristics.
Discuss some of the problems with how scientisits before Linnaeus used to classify animals e.g. by if they were wild or domestic or terrestrial or aquatic or large or small.
Give examples that would be difficult to classify into each group.</td></tr>
</table>

- Find out about Linnaeus inclusion of animals such as Homo ferus (wild man) and Homo caudatus (man with tail) might have been included in the classification system
- Discuss why you think that some species have been names upto 20 times in the classification system.
- Create a new animal which would fit into a specific part of the classification system.

Key information

Scientific Classification
Biological Classification is the way scientists use to categorize and organize all of life. It can help to distinguish how similar or different living organisms are to each other.

An example of Classification

Biological classification works a bit like the library does. Inside the library books are divided up into certain areas. The kids books in one section, the adult books in another, and the teen books in another section. Within each of those sections, there will be more divisions like fiction, non-fiction. Within those sections there will be even more divisions such as mystery, science fiction, and romance novels in the fiction section. Finally you will get down to a single book.

Biological classification works the same way. At the top there are the kingdoms. This is sort of like the adult section vs. the kids' section. The kingdoms divide up life into big groups like plants and animals. Under the kingdoms are more divisions which would be like fiction, non-fiction, mystery, etc. Finally, you get to the species, which is sort of like getting to the book in the library.

7 Major Levels of Classification

There are seven major levels of classification: Kingdom, Phylum, Class, Order, Family, Genus, and Species. The two main kingdoms we think about are plants and animals. Scientists also list four other kingdoms including bacteria, archaebacteria, fungi, and protozoa. Sometimes an eighth level above the Kingdom called the Domain is used.

Classification for Humans

Here is an example of how humans are classified. You will see that our species is homo sapiens.

Kingdom: Animalia
Phylum: Chordata
Class: Mammalia
Order: Primates
Family: Hominidae
Genus: Homo
Species: Homo sapiens

Fun ways to Remember Biological Classification

A good way to remember lists is to make up a sentence using the first letters in a list. In this case we want to remember Kingdom, Phylum, Class, Order, Family, Genus, and Species: K, P, C, O, F, G, S

Here are some sentences:

- Kids Prefer Cheese Over Fried Green Spinach.
- Koalas Prefer Chocolate Or Fruit, Generally Speaking
- King Philip Came Over For Good Spaghetti
- Keeping Precious Creatures Organized For Grumpy Scientists

Interesting Facts about Biological Classification

- Although the system of classification continues to be modified, Carolus Linnaeus, a Swedish plant scientist, is generally credited with inventing the current system.
- Animals with exoskeletons like insects and crabs are part of the Phylum Arthropoda and are often called arthropods.
- Under the Phylum Chordata we get the classes of animals many are familiar with such as mammals, amphibians, reptiles, fish and birds.
- A species is usually defined as individuals that can reproduce (have kids).

Year 6: Animals including humans

Year 6 programme of study (statutory requirements)	Notes and guidance (non-statutory	Working Scientifically ideas
Pupils should be taught to: • identify and name the main parts of the human circulatory system, and explain 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.	Pupils should build on their learning from years 3 and 4 about the main body parts and internal organs (skeletal, muscular and digestive system) to explore and answer questions that help them to understand how the circulatory system enables the body to function. Pupils should learn how to keep their bodies healthy and how their bodies might be damaged – including how some drugs and other substances can be harmful to the human body.	• How does your heart rate change for different activities? • How would different types of stomach juices affect break down of food? • Is lung capacity linked to height, age, fitness? Pupils might work scientifically by: exploring the work of scientists and scientific research about the relationship between diet, exercise, drugs, lifestyle and health.
Other teaching ideas • Link to PSHE and drug awareness. • Explore the job of each part of the circulatory and digestive systems.		

- Dramatization depicting the different stages of each system.
- Make a movie on how to keep you bodies healthy.
- Create a quiz about the body.
- Explore different body systems using websites such as http://kidshealth.org/kid/htbw/
- Make links between the different systems see http://tinyurl.com/kzsoobb for an example of how this might look.
- Recreate parts of the different systems using experiments at http://tinyurl.com/me4blww
-

Key information

Your Cardiovascular System

What is it?

It's a big name for one of the most important systems in the body. Made up of the heart, blood and blood vessels, the circulatory system is your body's delivery system. Blood moving from the heart, delivers oxygen and nutrients to every part of the body. On the return trip, the blood picks up waste products so that your body can get rid of them.

Your Heart

About the size of your clenched fist, your heart is a muscle. It contracts and relaxes some 70 or so times a minute at rest -- more if you are exercising -- and squeezes and pumps blood through its chambers to all parts of the body. And it does this through an extraordinary collection of blood vessels.

Your Blood Stream

Your blood travels through a rubbery pipeline with many branches, both big and small. Strung together end to end, your blood vessels could circle the globe 2 1/2 times! The tubes that carry blood away from your heart are called arteries. They're hoses that carry blood pumped under high pressure to smaller and smaller branched tubes called capillaries. The tubes that more gently drain back to the heart are veins.

How does your blood get oxygen?

When you inhale, you breathe in air and send it down to your lungs. Blood is pumped from the heart to your lungs, where oxygen from the air you've breathed in gets mixed with it. That oxygen-rich blood then travels back to the heart where it is pumped through arteries and capillaries to the whole body, delivering oxygen to all the cells in the body -- including bones, skin and other organs. Veins then carry the oxygen-depleted blood back to the heart for another ride.

What's blood, anyway?

Most of your blood is a colorless liquid called plasma. Red blood cells make the blood look red and deliver oxygen to the cells in the body and carry back waste gases in exchange. White blood cells are part of your body's defense against disease. Some attack and kill germs by gobbling them up; others by manufacturing chemical warfare agents that attack. Platelets are other cells that help your body repair itself after injury.

Did You Know?

- The body of an adult contains over 60,000 miles of blood vessels!

- An adult's heart pumps nearly 4000 gallons of blood each day!
- Your heart beats some 30 million times a year!
- The average three-year-old has two pints of blood in their body; the average adult at least five times more!
- A "heartbeat" is really the sound of the valves in the heart closing as they push blood through its chambers.

Your Muscular System
So what do muscles do?
Muscles move cows, snakes, worms and humans. Muscles move you! Without muscles you couldn't open your mouth, speak, shake hands, walk, talk, or move your food through your digestive system. There would be no smiling, blinking, breathing. You couldn't move anything inside or outside you. The fact is, without muscles, you wouldn't be alive for very long!

Do I have lots of muscles?
Indeed. On average, probably 40% of your body weight is in muscles. You have over 630 muscles that move you. Muscles can't push. They pull. You may ask yourself, if muscles can't push how can you wiggle your fingers in both directions, back and forth, back and forth? The answer? Muscles often work in pairs so that they can pull in different or opposite directions.

How do muscles move?
The cells that make up muscles contract and then relax back to original size. Tiny microscopic fibers in these cells compress by sliding in past each other like a sliding glass door being opened and then shut again. The cells of your muscles use chemical energy from the food you eat to do this. Without food, and particular kinds of nutrients, your muscles wouldn't be able to make the energy to contract!

Some muscles are known as "voluntary" -- that is, they only work when you specifically tell them to. Do you want to say something? Or swing a bat? Or clap your hands? These are voluntary movements. Others, like the muscular contracting of your heart, the movement of your diaphragm so that you can breathe, or blinking your eyes are automatic. They're called involuntary movements. And how do any of these muscles move? Through signals from your nerves, and, in some cases, your brain, as well.

Can you hurt muscles?
Yup. If you hear someone say that they "pulled" a muscle, they have, in fact, torn a muscle in the same way that you can tear a ligament or break a bone. And, like these other living body parts, with a little help, they generally mend themselves.

Factoids:
- You have over 30 facial muscles which create looks like surprise, happiness, sadness, and frowning.
- Eye muscles are the busiest muscles in the body. Scientists estimate they may move more than 100,000 times a day!
- The largest muscle in the body is the gluteus maximus muscle in the buttocks.

Your Digestive System
The story we're about to tell is of stormy seas, acid rains, and dry, desert-like conditions. It's an arduous journey that traverses long distances and can take several days. It's one in

which nothing comes through unchanged. It's the story of your digestive system whose purpose is turn the food you eat into something useful -- for your body!

Down the Hatch
It all starts with that first bite of pizza. Your teeth tear off that big piece of crust. Your saliva glands start spewing out spit like fountains. Your molars grind your pizza crust, pepperoni, and cheese into a big wet ball. Chemicals in your saliva start chemical reactions. Seemingly like magic, starch in your pizza crust begins to turn to sugar! A couple of more chews and, then, your tongue pushes the ball of chewed food to the back of your throat. A trap door opens, and there it goes, down your gullet!

Next, your muscles squeeze the wet mass of food down, down, down a tube, or esophagus, the way you would squeeze a tube of toothpaste. It's not something you tell your muscles to do -- they just do it -- in a muscle action called peristalsis. Then, the valve to the stomach opens and pizza mush lands in your stomach!

Inside your stomach
Imagine being inside a big pink muscular bag -- sloshing back and forth in a sea of half-digested mush and being mixed with digestive chemicals. Acid rains down from the pink walls which drip with mucus to keep them from being eroded.

Sound a little like an amusement ride gone crazy? Every time you think you've got your equilibrium back, the walls of muscle contract and fold in on themselves again. Over and over again, you get crushed under another wave of slop. Every wave mixes and churns the food and chemicals together more--breaking the food into even smaller and smaller bits. Then another valve opens. Is the end in sight you ask, as the slop gets pushed into the small intestine.

Inside the small intestine, chemicals and liquids from places like your kidneys and pancreas break down and mix up the leftovers. The small intestine looks like a strange underwater world filled with things that resemble small finger-like cactus. But they're not cactus, they're villi. Like sponges, they're able to absorb tremendous amounts of nutrients from the food you eat. From the villi, the nutrients will flow into your bloodstream.

But hold on! The story's still not over yet -- the leftovers that your body can't use still have more traveling to do! Next, they're pushed into the large intestine. It's much wider and much drier. You find that the leftovers getting smaller, harder and drier as they're pushed through the tube. After all, this is the place where water is extracted and recycled back into your body. In fact, the leftovers that leave your body are about 1/3 the size of what first arrived in your intestines!

Where Food Turns Into Poop
Finally, the end of the large intestine is in sight! Now the drier leftovers are various handsome shades of brown. They sit, at the end of their journey, waiting for you to expel them -- out your anus. Of course, you know the rest! A glorious,if slightly stinky, journey, don't you think?

Factoids:
- An adult's intestines are at least 25 feet. Be glad you're not a full-grown horse ... their coiled-up intestines are 89 feet long!
- Chewing food takes from 5-30 seconds

• Swallowing takes about 10 seconds • Food sloshing in the stomach can last 3-4 hours • It takes 3 hours for food to move through the intestine • Food drying up and hanging out in the large intestine can last 18 hours to 2 days! • Americans eat about 700 million pounds of peanut butter. • Americans eat over 2 billion pounds of chocolate a year. • In your lifetime, your digestive system may handle about 50 tons!!

Year 6: Evolution and inheritance

Year 6 programme of study (statutory requirements)	Notes and guidance (non-statutory	Working Scientifically ideas
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.	Building on what they learned about fossils in the topic on rocks in year 3, pupils should find out more about how living things on earth have changed over time. They should be introduced to the idea that characteristics are passed from parents to their offspring, for instance by considering different breeds of dogs, and what happens when, for example, labradors are crossed with poodles. They should also appreciate that variation in offspring over time can make animals more or less able to survive in particular environments, for example, by exploring how giraffes' necks got longer, or the development of insulating fur on the arctic fox. Pupils might find out about the work of palaeontologists such as Mary Anning and about how Charles Darwin and Alfred Wallace developed their ideas on evolution.	• How are local aniamls/insects different from those in other locations/countries • Explore advantages and disadvantages of adaptations e.g. long fur Pupils might work scientifically by: observing and raising questions about local animals and how they are adapted to their environment; comparing how some living things are adapted to survive in extreme conditions, for example cactuses, penguins and camels. They might analyse the advantages and disadvantages of specific adaptations, such as being on two feet rather than four, having a long or a short beak, having gills or lungs, tendrils on climbing plants, brightly coloured and scented flowers.

	Note: At this stage, pupils are not expected to understand how genes and chromosomes work.	

Other teaching ideas

1. Odd one out. A child chooses 3 pictures of a minibeast/bird/plant. Others say which is odd one out and why
2. Classifying pictures of animals. Which live in hot or cold climates?
3. Pupils could use online resources to find out about a specific animal and a specific plant and then find out how it is suited to the environment in which it lives.
4. Create a tree of life to show the link between species.
5. Identify examples of how animals have adapted to their environment.
6. Explore Darwin's idea of evolution by using websites such as http://tinyurl.com/pxle7sh
7.

Key information

Effects of heredity

Offspring inherit characteristics from their parents. For sexual reproduction to occur a male and a female parent are needed. The offspring show some of the characteristics of each parent and so cannot be exactly like either of them. In addition, the way in which the various characteristics come together during reproduction involves a high degree of chance. Thus each individual offspring will have the characteristics of their parents combined in different ways, so they will also vary from each other. In some organisms reproduction can also take place asexually. In this process one individual produces an offspring by dividing in two or producing another structure which eventually becomes independent. Plants are produced asexually when a gardener takes cuttings. Offspring resulting from asexual reproduction are almost exactly like their parents. Similarities are retained but there is little or no opportunity for any variation. Thus variation within a species occurs as a result of sexual reproduction.

Sudden changes in characteristics

From time to time offspring will be produced with a characteristic that is very distinct and unexpected. These sudden changes, called mutations, occur with varying frequency in different species and are the result of changes that have taken place during the formation of the male sex cells (sperm or pollen) and/or the female sex cells (egg or ovum). When the egg and sperm come together at fertilization these new characteristics become part of the offspring. Often these changes are lethal so the offspring do not live, but occasionally the mutation results in a characteristic that is of benefit to the individual. The peppered moth used to be white, but in the nineteenth century a black form appeared which was better able to survive on tree-trunks blackened by smoke in Britain's cities.

What is evolution?

Evolution is the slow process that changes animals and plants and it's a great piece of science! It describes loads of things in nature like fossils, peacocks' tails, lions' teeth, birds' wings and human brains, just to name a few. It is also supported by lots and lots of evidence that has been collected by scientists for more than 150 years! Some people think it's not true. They prefer religious explanations of why nature is like it is, but the evidence says that evolution is the real explanation.

what is a species?

A species is a group of animals or plants that are very similar. Members of a species share the same characteristics. For example the species pet cats belong to all have sharp teeth, retractable claws, fur, a tail and the same number of toes and nipples. Members of our own species, *Homo sapiens*, to give it its proper name all walk upright, have some sharp teeth and some flat ones, our eyes point forwards, we have some hair but not all over and we have pretty big brains!

Scientists often decide whether two groups of animals or plants are different species by working out whether or not they can mate with each other. If you try and get a rose to make seeds with a cabbage it won't work: they are separate species. If you try and get a rose to make seeds with another rose that will work: they are the same species even if they look quite a lot different!

Of course you can't go around trying to force lots of animals and plants to mate with each other! Scientists can use other more subtle measures, for example if two groups of birds look really similar but sing different songs and don't seem to find each other attractive, it's a good bet they are different species.

How do species evolve?

All species are related to each other. If you trace your family tree back through your parents, grandparents etc. it will quite quickly join up with your cousin's family tree. If you keep going back far enough, eventually your tree will join up with that of a chimpanzee! Keep going and it will join up with your pet hamsters, further still with your pet cats. Keep going and eventually it will join up with your pet goldfish and if you really keep going for a long time you can trace it back so it joins up with an apple tree's family tree, and eventually bacteria will join up too!

So what makes all the species different? Charles Darwin had the answer! Animals and plants produce too many offspring. Think about how many tadpoles you see at the start of spring, and how few frogs you see at the end of spring. A lot of them die, because there is not enough food to go around. Of course they all try their best to get all the food they need, so they have to compete with each other.

Darwin realised all the members of a species are unique, they are all slightly different. Sometimes this can be the difference between life and death! Think about a bird which eats seeds which have a tough case like a nut. When nuts are in short supply only the really strong birds with big beaks will be able to crack them open and eat them. Since they get more food, they will be less likely to starve or get sick.

Now, since offspring inherit a lot of their characteristics from their parents birds with big beaks will have chicks that grow up to have big beaks too. So over many generations the average beak size in that group of birds which struggle to crack tough nuts will increase. Each generation changes by a really little bit, but all these changes can be added up over time to make a big difference: that's evolution! Darwin called this process natural selection.

What about us?

When Darwin told the world about his discovery in his book *On the Origin of Species* he didn't really say anything about humans other than to hint his ideas would reveal the secrets of human history. But the message was clear; natural selection is the process which has shaped all species, including us!

Other scientists wrote books about human evolution, often comparing our bones to those of apes and monkeys. Eventually Darwin decided to write a book about it too to set the record straight about what the thought about humans. He wrote a book called *The Descent of Man*. He presented lots of evidence to support the theory that humans evolved from apes. He also argued that all the different human races were one species, which was a keenly debated subject in Victorian times.

Year 6: Light

Year 6 programme of study (statutory requirements)	Notes and guidance (non-statutory	Working Scientifically ideas
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.	Pupils should build on the work on light in year 3, exploring the way that light behaves, including light sources, reflection and shadows. They should talk about what happens and make predictions.	• What happens to the size of a shadow when you move the object nearer the light? • How can we see round corners? – link to periscopes • Which materials are the best for reflecting light? • What colour of writing can be seen best in the dark? • How many reflections can you create using mirrors? • Which light makes the best shadows? Pupils might work scientifically by: deciding where to place rear-view mirrors on cars; designing and making a periscope and using the idea that light appears to travel in straight lines to explain how it works. They might investigate the relationship between light sources, objects and shadows by using shadow puppets. They could extend their experience of light by looking a range of phenomena including rainbows, colours on soap bubbles, objects looking bent in water and coloured filters (they do not need to explain why these phenomena occur).
Other teaching ideas 1. Read Periscope by Michael Rosen 2. Then create a periscope and explain how it works. 3. Find your blind spot 4. Create a pin hole camera		

5. Look at and through lenses and prisms and try to explain what happens to light shone through them.
Key information It was only a few hundred years ago that it was finally discovered how we see things. Before that, it was believed that we saw things because rays shot from our eyes, maybe bouncing back to our eyes or joining with rays of light landing on the object. We see things because our eyes are receivers of light. Light travels to our eyes. The light enters our eyes. We see the light reflected from an object. Light reflected from a shiny surface can reflect an image - a picture. This is how mirrors work. If light is blocked by an object, a shadow is formed. Opaque objects make strong shadows, because they let no light through them. Transparent objects let almost all the light through them. But even they cast a slight shadow.

Year 6: Electricity

Year 6 programme of study (statutory requirements)	Notes and guidance (non-statutory)	Working Scientifically ideas
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.	Building on their work in year 4, pupils should construct simple series circuits, to help them to answer questions about what happens when they try different components, for example, switches, bulbs, buzzers and motors. They should learn how to represent a simple circuit in a diagram using recognised symbols. **Note:** Pupils are expected to learn only about series circuits, not parallel circuits. Pupils should be taught to take the necessary precautions for working safely with electricity. .	• Does adding another battery make any difference? • Does the thickness of the wire affect the brightness of the bulb? • Does the length of wire affect the brightness of the bulb? Pupils might work scientifically by: systematically identifying the effect of changing one component at a time in a circuit; designing and making a set of traffic lights, a burglar alarm or some other useful circuit.
Other teaching ideas 1. Create a light to wear if caving. 2. Create a burglar alarm. 3. Spot the mistake in a circuit diagram and correct. 4. Draw on circuits using correct symbols.		

Key information

Electrical circuits

Electricity can flow through the components in a complete electric circuit. We can use symbols to draw circuits.

You can make bulbs brighter by adding more batteries to the circuit. But if you add more bulbs instead they will get dimmer.

Circuits

A circuit always needs a power source, such as a **battery**, with wires connected to both the **positive** (+) and **negative** (-) ends. A battery is also known as a **cell**.

A circuit can also contain other electrical **components**, such as bulbs, buzzers or motors, which allow electricity to pass through.

Electricity will only travel around a circuit that is **complete**. That means it has no gaps.

Symbols

We use these symbols to draw diagrams of circuits:

Switches

- When a switch is open (off), there is a gap in the circuit. Electricity **cannot** travel around the circuit.
- When a switch is closed (on), it makes the circuit complete. Electricity **can** travel around the circuit.

Changing circuits

Adding **more batteries** to a simple circuit will increase the electrical energy, which will make a bulb **brighter**.

More bulbs

Adding **more bulbs** to a simple circuit will reduce the electrical energy and make the bulbs **dimmer**.

Longer wires

Lengthening the wires in a simple circuit will reduce the electrical energy, as it has further to travel. The extra distance will make the bulb **dimmer**.

Adding a motor

If electrical energy is flowing around the circuit, the motor will rotate.