FOUR MARKS CE PRIMARY SCHOOL

SCIENCE CURRICULUM MAP

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Four Marks CE Primary School
Science Curriculum Map

Key Ideas Map: The table below gives an estimate of how long, in hours, each key idea takes to teach.

Key Idea Approximate number of hours	Key Stage 1	Lower Key Stage 2	Upper Key Stage 2
	Years 1 & 2	Years 3 & 4	Years 5 & 6
Plants	9	20	Not taught
Animals	15	16	9
Variation & evolution	30	30	31
Materials	16	21	18
Forces	Not taught	9	15
Electricity	Not taught	11	8
Light	Not taught	9	12
Sound	Not taught	Foundation taught (2)	11
Earth & Space	Not taught	Not taught	8

Whole School Long Term Map

Cycle A						
	Autumn	**Autumn 2**	**Spring 1**	**Spring 2**	**Summer 1**	**Summer 2**
Key Stage 1	Longitudinal Study: Seasonal Change & Weather Patterns: How does our weather change through the year? How do the seasons affect the plants and animals that live in our local environment?					
	Materials and their properties		Animals including humans Looking after ourselves and animals		Rainforest animals Comparisons with local habitats	
Lower Key Stage 2	Longitudinal Study: What plants can we grow that will help to provide food for bees and butterflies ?					
	States of Matter 8 sessions	Animals: Digestive system and teeth 7 sessions	Sound (foundation) 3 sessions	Light and shadows 8 sessions		Electrical circuits 6 sessions
Upper Key Stage 2	Evolution, natural selection & Life Cycles 10 sessions		Controlling Electrical circuits 8 sessions	Respiration in animals & human life cycle 8 sessions	Making new substances 8 sessions	

Cycle B						
	Autumn 1	**Autumn 2**	**Spring 1**	**Spring 2**	**Summer 1**	**Summer 2**
Key Stage 1	Longitudinal Study: Growing in the Garden: What will different plants need to grow and thrive in our school gardens?					
	Materials and their properties		Animals in the sea How animals survive		Lifecycles of humans, plants and other animals	
Lower Key Stage 2	Longitudinal Study: What are the creatures and plants that live in our pond? Where do they go in winter?					
	Rocks: Mixtures & separation 8 sessions	Animals; Skeletons, muscles & movement 6 sessions	Magnets & their effects 6 sessions		Plants: How plants reproduce 7 sessions	Feeding relationships & the environment 2 sessions
Upper Key Stage 2	Space & Gravity 10 sessions		How Light behaves and how we see. 6 sessions	Sound Travel 8 sessions	Forces that oppose motion 8 sessions	

Science Curriculum Key Vocabulary

This provides guidance of the key vocabulary which should be explicitly taught to enable the children to understand and explain Key Ideas.

Vocabulary is revised & built upon through their time at Primary School when Key Ideas are revisited.

Key Stage 2	Lower Key Stage 2		Upper Key Stage 2	
Year 1 & Year 2	**Year 3 & Year 4**		**Year 5 & Year 6**	
Animals including humans Fish, Reptiles, Mammals, Birds, Amphibians (and examples of each) Herbivore, Omnivore, Carnivore, Leg, Arm, Elbow, Head, Ear, Nose, Back, Wings, Beak Survival, Water, Air, Food, Adult, Baby, Offspring, Kitten, Calf, Puppy, Exercise, Hygiene.	**Animals including humans** Movement, Muscles, Bones, Skull, Nutrition, Skeletons Mouth, Tongue, Teeth, Oesophagus, Stomach, Small Intestine, Large Intestine, Herbivore, Carnivore, Canine, Incisor, Molar		**Animals including humans** Foetus, Embryo, Womb, Gestation, Baby, Toddler, Teenager, Elderly, Growth, Development, Puberty. Circulatory. Heart, Blood vessels, Veins, Arteries, Oxygenated, Deoxygenated, Valve, Exercise, Respiration	
Plants Deciduous, Evergreen, Trees, Leaves, Lowers, Blossom, Petals, Fruit, Roots, Bulb, Seed, Trunk, Branches, Stem Water, Light, Temperature, Growth	**Plants** Air, Light, Water, Nutrients, Soil, Reproduction, Transportation, Dispersal, Pollination, Flower		**Evolution & Change** Fossils, Adaptation, Evolution, Characteristics, Reproduction, Genetics	
Living Things & Habitats Living, Dead, Habitat, Energy, Food Chain, Predator, Prey, Woodland, Pond, Desert.	**Living Things & Habitats** Vertebrates, Fish, Amphibians, Reptiles, Birds, Mammals, Invertebrates, Snails, Slugs, Worms, Spiders, Insects, Environment, Habitat.		**Living Things & Habitats** Mammal, Reproduction, Insect, Amphibian, Bird, Offspring, Classification, Vertebrates, Invertebrates, Micro-organisms, Amphibians, Reptiles, Mammals, Insects	
Everyday Materials & their uses Wood, Plastic, Glass, Paper, Water, Metal, Rock, Hard, Soft, Bendy, Rough, Smooth, Stretchy, Stiff, Shiny, Dull, Waterproof, Absorbent, Opaque, Transparent, Brick, Paper, Fabric, Squashing, Bending, Twisting, Stretching, Elastic, Foil	**Rocks** Fossils, Soils, Sandstone, Granite, Marble, Pumice, Crystals, Absorbent,	**States of Matter** Solid, Liquid, Gas, Evaporation, Condensation, Particles, Temperature, Freezing, Heating	**Changes of Materials & Properties** Hardness, Solubility, Transparency, Conductivity, Magnetic, Filter, Evaporation, Dissolving, Mixing	
Seasonal Changes Summer, Spring, Autumn, Winter, Sun, Moon, Day, Night, Light, Dark, Warm, Cold	**Light** Light, Shadows, Mirror, Reflection, Dark, Reflective		**Earth & Space** Earth, Sun, Mood, Axis, Rotation, Day, Night, Phases of the Moon, Constellation, star	**Light** Refraction, Reflection, Light, Spectrum, Rainbow, Colour
	Sound Volume, Vibration, Wave, Pitch, Tone, Speaker		**Sound** Volume, Vibration, Wave, Pitch, Tone, Speaker	
	Forces & Magnets Magnetic, Force, Contact, Attract, Repel, Friction, Poles, Push, Pull	**Electricity** Cells, Wires, Bulbs, Switches, Buzzers, Battery, Circuit, Series, Conductors, Insulators	**Forces** Air Resistance, Water resistance, Fraction, Gravity, Newton, Gears, pulleys	**Electricity** Cells, Wires, Bulbs, Switches, Buzzers, Battery, Circuit, Series, Conductors, Insulators, Amps, Volts, Cell

Early Years Foundation Stage **Please note that the Foundation Stage Curriculum is separate to the National Curriculum which starts in Year 1.** **However, the Foundation Stage curriculum plays an important part in securing foundation skills in National Curriculum subjects.**			
Understanding the World NC links: Science	**Autumn**	**Spring**	**Summer**
	The Natural World Children will: • Explore collections of materials with similar and/or different properties. • Talk about what they see, using a wide vocabulary • Explore how things work. • Plant seeds and care for growing plants. • Understand the key features of the life cycle of a plant and an animal. • Explore and talk about different forces they can feel. • Talk about the differences between materials and changes they notice.	**The Natural World** Children will: • Explore the natural world around them. • Describe what they see, hear and feel whilst outside. • Understand the effect of changing seasons on the natural world around them.	**ELG: The Natural World** Children will: • Explore the natural world around them, making observations and drawing pictures of animals and plants; • Know some similarities and differences between the natural world around them and contrasting environments, drawing on their experiences and what has been read in class • Understand some important processes and changes in the natural world around them, including the seasons and changing states of matter.

Key Stage 1: Years 1&2

CYCLE A

Autumn	Spring	Summer
Up, Up and Away	**Doctor Doctor!:**	**There's no place like home**
Science Specific focus within Topics:		
Materials and their properties	**Animals including humans (looking after ourselves and animals)**	**Rainforest animals (Comparisons with local habitats)**

Longitudinal studies: Children should raise and explore questions that demand the identification of creatures and plants in their local environment and how their populations changes through the seasons. They should explore linking the properties of the seasons to the changing populations and beginning to question how populations of different organisms are related.

Seasonal Change & Weather Patterns: How does our weather change through the year? How do the seasons affect the plants and animals that live in our local environment?

Substantive Knowledge & Key concept: Know that:

- There are four seasons in a year.
- Spring is when the weather starts to get warmer and new life begins.
- Summer is the hottest time of year when the days are longest.
- Autumn is when leaves start to fall from trees and it starts to get colder.
- Winter is the coldest time of year and is when the days are shortest.

Disciplinary Knowledge- Working Scientifically:

Observe changes across the four seasons, plant growth linked to seasons, animal habits and habitats (e.g. hibernation in Winter and new life in Spring).

Observe and describe weather associated with the seasons and how day length (hours of sunlight) varies.

Know how to:

- Make simple predictions.
- Collect information about the weather and day length and analyse the data.
- Use scientific equipment to take measurements of rainfall and temperature.
- Observe and record changes over time.

National Curriculum for this topic

Materials and their properties
Substantive Knowledge & Key concepts:
Know that:

- Objects are made out of one or more materials.
- A material has properties.
- Different materials have different properties
- Materials can be classified by their properties.

Animals including humans: Looking after animals and ourselves
Substantive Knowledge & Key concepts:
Know that:

- All animals and humans need food, water and air to survive.
- Humans and animals also do better in certain conditions, such as having shelter, care and medicine
- Some animals eat meat, vegetables or both.
- There are different food groups that do different things.
- Humans must eat the right amounts from each food group.
- There are different types of animals- identify and name a variety of common animals.
- Animals can be sorted (categorised) in to groups carnivores, herbivores and omnivores
- Good hygiene is important to stay healthy.
- It is important for humans to exercise.
- Mental health is just as important as physical health
- A healthy lifestyle is made up of good mental and physical health

Animals of Africa (comparisons with local habitats)
Substantive Knowledge & Key concepts:
Know that:

- There are different types of animals.
- The different groups of animals are fish, amphibians, insects, mammals, birds and reptiles.
- Some humans and animals have the same body parts- identify, name and draw the basic parts of the human body/ animal bodies & those associated with our senses.
- Humans are a type of animal.
- Touch, smell, taste, sight, hearing help humans understand the world.
- All animals use their senses to help them survive.
- A living thing is something that moves, senses, breathes, gets rid of waste products (excrete), creates new living things and eats.
- A habitat provides everything a living thing needs to survive.
- Living things need each other to survive
- Identify and name a variety of plants and animals in their habitats including micro-habitats.

CYCLE B

Autumn	Spring	Summer
Fire, Fire!	**Journeys into the Unknown**	**All around us**
Science Specific focus within Topics:		
Materials and their properties	**Animals in the sea (how animals survive)**	**Life cycles of humans, plants and other animals**

Growing in the Garden: What will different plants need to grow and thrive in our school gardens?

Substantive Knowledge & Key concept: Know that:

- Plants need warmth, water, food and sunlight to grow
- Plants grow from seeds or bulbs into mature plants.
- When a seed starts to grow it is called germination.
- When a plant has begun to grow it needs water, warmth and light and food.
- Plants are made up of flowers, stems, leaves, and roots
- Trees are made up of leaf, branch, root and fruit
- Identify and name a variety of common wild and garden plants including wildflowers such as dandelions and daisies
- Deciduous trees lose leaves in winter and evergreen trees keep their leaves all year round

Disciplinary Knowledge- Working Scientifically:

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.

Know how to:

- Make simple predictions about how trees and plants will grow.
- Ask simple questions about how plants grow.
- Collect information about plant and tree growth over time and analyse the data.
- Use scientific equipment to perform simple tests.
- Observe and record changes in the growth of plants and trees over time.

National Curriculum for this topic

Materials and their properties
Substantive Knowledge & Key concepts:
Know that:

- Objects can be grouped by their properties
- Different materials have different properties
- Materials can be classified/ grouped by their properties.
- A material can be suitable for different uses.
- Materials are chosen because they are fit for purpose
- Some solid objects can be changed by squashing, bending, twisting and stretching
- Materials are flexible or rigid

Animals in the sea (how animals survive)
Substantive Knowledge & Key concepts:
Know that:

- All animals and humans need
- food, water and air to survive.
- There are different types of animals
- The different groups of animals are fish, amphibians, insects, mammals, birds and reptiles.
- Animals can be sorted (categorised) in to groups
- Some humans and animals have the same body parts
- A living thing is something that moves, senses, breathes, gets rid of waste products (excrete), creates new living things and eats.
- Some things were once living (dead), and some have never been alive.
- A habitat provides everything a living thing needs to survive.
- Living things need each other to survive (Describe how animals obtain their food from plants and other animals using the idea of a simple food chain).
- Some animals eat meat, vegetables or both.

Life cycles of humans, plants and other animals
Substantive Knowledge & Key concepts:
Know that:

- Humans are a type of animal.
- All humans have things in common but every human is unique.
- Some humans &animals have the same body parts
- Humans have 5 senses
- Touch, smell, taste, sight, hearing help humans understand the world.
- All animals use their senses to help them survive.
- Humans &animals have offspring which grow into adults.
- Some offspring are smaller versions of their parents &some look different.
- Some offspring start off life as eggs &then change as they grow.
- Plants grow from seeds or bulbs.
- When a seed starts to grow it is called germination.
- Plants need to spread their seeds to reproduce.
- There are 4 main ways for seed dispersal: gravity, wind, animals &water.
- When a plant has begun to grow it needs water, warmth &light &food.

Disciplinary Knowledge- Working Scientifically: Know how to: • Identify and classify different objects and materials based upon their properties. • Ask simple questions about the properties and suitability of different materials. • Perform simple tests to explore the properties of different materials and their suitability. • Use observations and ideas to suggest answers to questions • Gather and record data to help in answering questions	**Disciplinary Knowledge- Working Scientifically: Know how to:** • Identify and classify animals. • Ask simple questions about animals and ourselves and recognise that they can be answered in different ways • Perform simple tests, using equipment and observing changes. • Use observations and ideas to suggest answers to questions • Gather and record data in simple charts and tables.	**Disciplinary Knowledge- Working Scientifically: Know how to:** • Identify and classify animals. • Ask simple questions about animals and their needs and recognise that they can be answered in different ways • Use observations and ideas to suggest answers to questions • Gather and record data in simple charts and tables.	**Disciplinary Knowledge- Working Scientifically: Know how to:** • Identify and classify different objects and materials based upon their properties. • Ask simple questions about the properties and suitability of different materials. • Perform simple tests to explore the properties of different materials and their suitability. • Use observations and ideas to suggest answers to questions • Gather and record data to help in answering questions	**Disciplinary Knowledge- Working Scientifically: Know how to:** • Identify and classify animals. • Ask simple questions about animals and their needs and recognise that they can be answered in different ways • Use observations and ideas to suggest answers to questions • Gather and record data in simple charts and tables.	**Disciplinary Knowledge- Working Scientifically: Know how to:** • Identify and classify animals and plants. • Ask simple questions about humans and other animals and their needs and recognise that they can be answered in different ways • Observe changes in the life cycles of animals over time. • Use observations and ideas to suggest answers to questions • Gather and record data in simple charts and tables.
Forest School: Children should raise and explore questions that demand the identification of creatures and plants in their local environment and how their populations change through the seasons. They should recognise and articulate features of the changing seasons, and should begin to understand the intrinsic links between living organisms. *Orange objectives are Forest School Specific.					
Seasonal Change & Weather Patterns: How and why does our weather change through the year? How do the seasons affect the plants and animals that live in our woods?			**Growing in the Garden: What is the best (optimum) way to encourage plants and animals to live in our woodland? How can we ensure that our Forest School sessions have minimal negative impacts on the environment in our woods?**		
Autumn: Children will understand and respect the rules and ethos of Forest School. Children will begin to identify different species of flora and fauna. Children will learn to use the woodland environment effectively to create stable tarpaulin shelters, lean-to shelters and shelters for small animals. **Key questions:** What is a boundary? How do we carry large pieces of wood safely? What do you notice about the woodland? What is changing/what stays the same? What does a good shelter need?	**Spring:** Children will develop a deeper understanding of self-managed risk. *Children will learn to tie simple and useful knots e.g. reef knot, figure 8 knot, open and closed clove hitch* Children will recognise the way the woodland changes and adapts as autumn turns to winter. **Key questions:** Why are the leaves falling? Why are the leaves changing colour? What are knots useful for? Can you create a structure using your knot tying skills?	**Summer:** Children will use natural materials to create woodland art. Children can name and identify which trees are deciduous and which are evergreen. Children understand and can talk about how animals and plants survive the winter. Children can be safe around a fire circle and can strike a fire successfully and safely. **Key questions:** How will the mice survive the winter? Where did the flowers go? What do I need to think about before I can light a fire?	**Autumn:** Children will learn to light simple fires with support. They will have an opportunity to boil water over a fire to make hot drinks. Children will learn to safely use potato peelers for whittling and palm drills (identity discs) Children will learn to identify and describe some simple plant structures and their different features. **Key questions:** How do we safely extinguish a fire and ensure that we leave no trace? What is your blood bubble and how does it keep you safe when using tools?	**Spring:** Children will explore and discuss how the woodland is changing in early May. They will understand what animals (and themselves as human animals) need to survive. They will develop an understanding of food chains in the woodland. Children can identify some sounds they hear in the woodlands. **Key questions:** How is the world waking up in the springtime? What would we do to survive if we didn't have…? What eats what in the woods?	**Summer:** Children can identify and name a range of common animals, and are beginning to categorise them into mammals, amphibians etc. Children can describe the benefits of being outside. Children can cook safely over a fire and use the tools they have learned competently and independently observing some safety measures. **Key questions:** Why do frogs like to live in the water/ birds like to live in the trees? How do you feel when you are in the woods at Forest School?

SCIENCE KEY IDEAS					
Up, Up and Away	**Doctor Doctor!:**	**There's no place like home.**	**Fire, Fire!**	**Journeys into the Unknown**	**All around us**
Seasonal changes Predict what the weather will be throughout the year and collect data. Present information in tables and charts to compare the changing weather patterns across the seasons. Wildlife hunts throughout the seasons. Plant a tree and observe the changes over the seasons including taking measurements and making predictions.			**Plants** Sort and classify seeds and bulbs Plant different seeds and bulbs and make observations/ measurements as they grow. Explore the basic needs of plants and how water, light and temperature can affect growth.		
Materials and their properties	**Animals including humans (looking after ourselves and animals)**	**Animals of Africa (Comparisons with local habitats)**	**Materials and their properties**	**Animals in the sea (how animals survive)**	**Life cycles of humans, plants and other animals**
There are many different materials that have different describable and measureable properties. Materials that have similar properties are grouped into metals, rocks, fabrics, wood, plastic and ceramics (including glass). The properties of a material determine whether they are suitable for a purpose.	Animals need food to survive; it gives them energy to move and material to grow. Animals are all different and so eat different foods, some eat other animals (carnivores) and others only eat vegetables (herbivores). Animals that eat other animals have to hunt them (predators) animals that are hunted are prey. Name basic parts of the human body and understand how exercise, eating the right amounts of food, hygiene and sleep keeps bodies in a good condition.	Identify and name a variety of common animals in different regions of Africa and those in our local area. Understand that animals are adapted to eat and survive in different habitats. Explore how environmental change can affect the plant and animals that live there. Explore micro-habitats and the animals that live within them.	There are many different materials that have different describable and measureable properties. Materials that have similar properties are grouped into metals, rocks, fabrics, wood, plastic and ceramics (including glass). The properties of a material determine whether they are suitable for a purpose	Identify and name a variety of common animals in the sea and in coastal habitats. Compare animals from the same group and different groups. Sort and classify animals from different groups. Understand the basic needs of humans and how these needs may differ for other animals. Create food chains for different animals.	Children will consider how this model is the same for all, but varies between different animals in the following ways: Different animals live for different ages Different animals reach different sizes before they are able to reproduce Different animals reproduce at different ages All flowering plants make seeds that can grow into new plants Sometimes the plant dies after it has produced its seed Sometimes the plant lives for many generations producing seeds each year

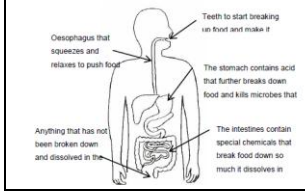
Key Stage 2: Years 3&4

CYCLE A			CYCLE B		
AUTUMN	**SPRING**	**SUMMER**	**AUTUMN**	**SPRING**	**SUMMER**
Full Steam Ahead	**Angry Earth**	**It's Chocolate!**	**Where do we come from?**	**The Source of Life- Egypt**	**River Deep & Mountain High**
Science Specific focus within Topics:					
States of Matter **Animals: Digestive system and teeth**	**Sound Travel** **(foundation learning)**	**Light & Shadows** **Electrical Circuits**	**Rocks: Mixtures & Separation** **Animals: Skeletons, muscles & movement**	**Magnets & their effects**	**Plants: How plants reproduce** **Feeding relationships & the environment**
Longitudinal studies: Children should raise and explore questions that demand the identification and classification of creatures and plants in their local environment (insects, spiders, birds, mammals, reptiles and amphibians).					
What plants can we grow that will help to provide food for bees and butterflies ?			What are the creatures and plants that live in our pond? Where do they go in winter?		

States of Matter
Chapter 1
Materials can be divided into solids liquids and gases.
Solids hold their shape unless forced to change.
Liquids flow easily but stay in their container because of gravity.
Gases move everywhere and are not held in containers by gravity.
Chapter 2
Heating causes solids to melt into liquids and liquids to evaporate to gases
Cooling causes gases to condense to liquids and liquids to freeze to solids
Chapter 3
Different substance change state at different temperatures but the temperatures at which given substances change state are always the same.
Chapter 4
The temperature at which a substance melts from a solid to a liquid is the same at which it freezes from a liquid to a solid.
The temperature at which a substance boils from a liquid to a gas is the same at which it condenses from a gas to a liquid.

Animals: Digestive system and teeth
Chapter 1
Animals need a variety of foods to help them survive. The main food groups are:
Meat, dairy and pulses to provide protein for muscles.
Grains and root vegetables to provide carbohydrates for energy.
Fat for insulation and energy.
Fruit and vegetables for minerals, vitamins and fibre.

Chapter 2
Different animals require different foods to survive. Humans require a balanced diet to remain healthy but healthy diets vary depending upon the type of activity that humans do.
Chapter 3
The nutrients in food have to get to every part of the body. The blood transports them. The role of digestion is to get the nutrients in food to dissolve in the blood, if it doesn't dissolve it can enter the blood and be transported. Humans achieve this as below:



Sound Travel:
Chapter 1
Sounds can be made in many different ways and individual sounds have the properties of pitch and volume.
When a sound is made it immediately spreads out in all directions. As it travels its volume decreases but its pitch remains the same.
Chapter 2
Sound is made when an object is made to vibrate (move backwards and forwards or up and down).
As the material vibrates it makes whatever it is in contact with vibrate, including air. As the air vibrates it makes whatever it is in contact with vibrate also, which might be a wall or even your eardrum. Sound moves through materials vibrating making other materials they are in contact with vibrate.

Light and shadows
Chapter 1
We can only see things when there is light and the light had to come from somewhere. All light originally comes from a light source
Chapter 2
When light hits an object it can do a number of things
If the object is transparent it will go through it and we will be able to see through it.
If the object is opaque, it will block the light and no light will get through.
If the object is perfectly reflective light will bounce back off it and we will see reflections of objects.
If the material is translucent it will allow light through but we won't be able to see through it.

Electrical circuits
Chapter 1
Lots of devices are powered by electricity; these need a source of electricity, which could be mains or battery.
Chapter 2
The battery's job is to push electricity to the device, but it needs something to carry the electricity all the way from the supply to the device, this is what we call a circuit.
Chapter 3
If there are more batteries, they push harder and so the device will work harder e.g. brighter or faster.
Chapter 4
However not everything can carry the electricity from the source to the device, some materials allow the electricity through (conductors) and others don't (insulators)

Rocks & Soil: Mixtures & separation
Chapter 1
When more than one substance is present in the same container it is called a mixture
Chapter 2
When a substance is added to a liquid it has dissolved if no bits of the substance can be seen and the liquid is transparent. This mixture is called a solution. Not all substances dissolve in water.
Chapter 3
All mixtures can be separated if they have a difference in property. This is because both (or all) of the materials are still present.

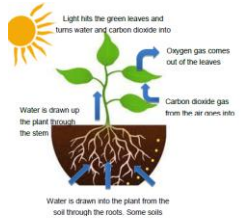
Separation Technique	Difference in property needed
Filtration and sieving	A solid that does not dissolve in a liquid. Different sized solid bits
Magnets	Some materials magnetic others not
Evaporation	A solid dissolved in water and the solid has a high boiling temperature
Floating	Some materials float and other sink

Animals: Skeletons muscles and movement
Chapter 1
All vertebrates have internal skeletons that protect vital organs.
Invertebrates have exoskeletons that protect vital organs
Chapter 2
Skeletons support the weigh of land animals.
Stronger bones can support more weight
Chapter 3
Bones are connected (but can move relative to each other) at joints. Muscles connect to bones and move them when they contract. Stronger bones can anchor stronger muscles

Magnets and their effects
Chapter 1
Magnets exert attractive forces on some metals
Chapter 2
Each end of a magnet is called a pole, opposite poles are called north and south. Magnets exert attractive forces on each other when the poles facing each other are north and south (opposites).
Magnets exert repulsive forces on each other when the poles facing each other are the same.
Chapter 3
Magnetic forces work through other materials including air, so magnets don't need to be touching to exert their force. It is called a non-contact force
Chapter 4
The strength of magnetic forces are affected by:
The strength of the magnet.
The distance between the magnet and the object.
The material the object is made from.

Plants: How plants reproduce
Chapter 1
Flowering plants have evolved specific parts to carry out pollination, fertilisation and seed growth.
Coloured and scented petals and attract insects
Stamen hold pollen
Stigma collect pollen
Ovaries contain eggs that grow into seeds when pollen from the male moves down the stigma.
Chapter 2
All flowering plants reproduce by pollen from the male reaching the stigma of the female. However, all plants look slightly different because they pollinate in different ways.
Chapter 3
Plants have evolved many different ways to disperse their seeds. Seed dispersal increase the chances of the seeds germinating and growing into mature plants
Chapter 4
Seeds and bulbs need the right conditions to germinate. They contain a food store for the first stages of growth (i.e. until the plant is able to produce its own food through its leaves)

How plants make their food
Chapter 1
Plants don't eat and so have to make their own food to provide them with energy and material to grow.
Chapter 2:
The model of how plants grow
Plants turn water from the ground and carbon dioxide from the air into sugar, which is used for energy and making new material to grow.



Feeding relationships and the environment
Chapter 1
In any habitat there are food chains and webs where nutrients are passed from one organism to another when it is eaten. If the population of one organism in the chain or web is affected it has a knock on effect to all others
Chapter 2
Environmental change (the seasons, human activity, climate change) affects different organisms differently and therefore different habitats differently because all organisms in a habitat are interdependent.

Forest School: Children should raise and explore questions that demand the identification and classification of creatures and plants in their local environment (insects, spiders, birds, mammals, reptiles and amphibians).					
What plants can we grow that will help to provide food for bees and butterflies? How can we ensure we are having a positive impact on our woodland?			**What are the creatures and plants that live in our pond? Where do they go in winter?**		
Autumn: Children will understand and respect the rules and ethos of Forest School. Children will be able to identify different natural resources found in the woodland e.g. stone, clay, water, soil etc. Children will learn to work successfully as a group to build tarpaulin and tripod shelters. They will adapt and develop their thinking to ensure their shelters are fit for purpose (stable, waterproof, camouflaged etc.) **Key questions:** What is a boundary? What can I find in the woodland? How do I know I am in a woodland environment? How does the woodland adapt through the autumn? What does a good shelter need?	**Spring:** Children will develop a deeper understanding of self-managed risk when climbing trees, and exploring the flora and fauna. They will begin to identify different plants, and recognise some species of poisonous plants on site e.g. stinging nettles, lords and ladies. Children will learn to tie more sophisticated knots and use them for attaching structures to trees. Children will use lashing techniques to secure pieces of wood together. Children will begin to understand that there are different soil types and what characterises these. **Key questions:** How can I explore the woodland safely? How can I identify a stinging nettle? What are knots useful for? Can you create a structure using your knot tying skills?	**Summer:** Children can name and identify which trees are deciduous and which are evergreen. They can talk about how the woodland adapts throughout the year and why. Children can be safe around a fire circle and can strike a fire successfully and safely. Children are beginning to understand simple woodland management techniques such as pollarding and coppicing. Children will notice and discuss weather patterns and seasonal change. **Key questions:** What is the difference between our woodland and a rainforest? What are the effects of deforestation on a small scale- e.g. when we remove a tree from our woodland? What do I need to think about before I can light a fire? How can I extinguish a fire safely? How does lighting a fire effect the woodland environment?	**Autumn:** Children will learn to light simple fires with growing independence. They will understand how to safely extinguish these. They will begin to discuss the impact of lighting fires on the woodland environment. They will have an opportunity to cook snacks over a fire e.g. chocolate bananas. Children will learn to safely use a bow saw and a saw horse. They will construct a saw horse using a square lash knot with adult support. **Key questions:** How do we safely extinguish a fire and ensure that we leave no trace? What is your blood bubble and how does it keep you safe when using tools? How can we ensure we are maintaining good standards of hygiene when prepping food in the woodland?	**Spring:** Children will explore and discuss the impact of water on the environment and the animals. They will understand what animals (and themselves as human animals) need to survive. They will develop an understanding of food chains in the woodland. They can talk about how to encourage wildlife to a specific area. Children can identify an increasing amount of sounds in the woodland, e.g. specific bird calls. **Key questions:** What impact does water have on the environment? How do animals and plants use water to survive? How do their adaptations allow them to survive in/near water? What would we do to survive if we didn't have…? What eats what in the woods? What is natural and what is man-made? How can you tell the difference?	**Summer:** Children can identify and name a range of common animals, and are beginning to categorise them into mammals, amphibians etc. Children can describe the benefits of being outside. Children can cook safely over a fire and use the tools they have learned competently and independently observing some safety measures. Children will understand how to orientate a map correctly. **Key questions:** How can we categorise animals? How does being in the woodland make you feel? How can we light a fire safely? How can we maintain and take care of tools and other Forest School equipment? How can you ensure others can easily read your map?

Key Stage 2: Years 3 &4					
CYCLE A			**CYCLE B**		
AUTUMN	**SPRING**	**SUMMER**	**AUTUMN**	**SPRING**	**SUMMER**
Full Steam Ahead	**Angry Earth**	**It's Chocolate!**	**Where do we come from?**	**The Source of Life- Egypt**	**River Deep & Mountain High**
Science Specific focus within Topics:					
States of Matter **Animals: Digestive system &teeth**	**Sound Travel (foundation only)**	**Light & Shadows** **Electrical Circuits**	**Rocks: Mixtures & separation** **Animals: Skeletons, muscles & movement**	**Magnets & their effects**	**Plants: How plants reproduce** **Feeding relationships & the environment**
CYCLE A			**CYCLE B**		
National Curriculum for this topic					
States of Matter Materials can be divided into solids, liquids and gases. Solids, liquids and gases are described by observable properties Heating causes solids to melt into liquids and liquids to evaporate to gases Cooling causes gases to condense to liquids and liquids to freeze to solids The temperatures at which given substances change state are always the same. **Animals: Digestion:** Different animals are adapted to eat different foods. Animals have teeth to help them eat. Different types of teeth do different jobs. Food is broken down by the teeth and further in the stomach and intestines where nutrients go into the blood. The blood takes nutrients around the body. Nutrients produced by plants move to primary consumers then to secondary consumers through food chains.	**Sound Travel** Sound travel can be blocked. Sound spreads out as it travels. Changing the shape, size and material of an object will change the sound it produces. Sound is produced when an object vibrates. Changing the way an object vibrates changes its sound. Sound moves through all materials by making them vibrate. Bigger vibrations produce louder sounds and smaller vibrations produce quieter sounds. Faster vibrations (higher frequencies) produce higher pitched sounds.	**Light:** There must be light for us to see. Without light it is dark. Light comes from a source. We need light to see things even shiny things. Transparent materials let light through them and opaque materials don't let light through. Beams of light bounce off some materials (reflection). Shiny materials reflect light beams better than non-shiny materials **Electrical circuits** A source of electricity (mains or battery) is needed for electrical devices to work. A complete circuit is needed for electricity to flow and devices to work. Electricity sources push electricity round a circuit. More batteries will push the electricity round the circuit faster. Some materials allow electricity to flow easily and these are called conductors. Materials that don't allow electricity to flow easily are called insulators. Devices work harder when more electricity goes through them	**Animals: Skeletons muscles and movement** • Many animals have skeletons to support their bodies and protect vital organs. • Muscles are connected to bones and move them when they contract. • Movable joints connect bones **Rocks** Compare and group together different kinds of rocks on the basis of their Appearance and simple physical properties Describe in simple terms how fossils are formed when things that have lived are trapped within rock Recognise that soils are made from rocks and organic matter	**Magnets & their effects:** Magnets exert attractive forces on some materials. Magnets exert attractive and repulsive forces on each other. Magnets exert non-contact forces, which work through some materials. Magnetic forces are affected by the magnets strength. Magnetic forces are affected by the mass of the object being attracted. Magnetic forces are affected by the distance between magnet and object	**How plants reproduce:** Flowering plants have evolved specific parts to carry out pollination, fertilisation and seed growth. Seed dispersal improves chances of enough seeds germinating and growing to mature plants and reproducing. Seeds and bulbs need the right conditions to germinate. They contain a food store for the first stages of growth (i.e. until the plant is able to produce its own food) How plants make food: Plants make their own food in their leaves to provide them with energy, grow, repair, and reproduce. Leaves absorb sunlight and carbon dioxide through leaves. Plants have roots to provide support and to draw moisture from the soil, through stems to take water to the rest of the plant. The plant makes its food from water and carbon dioxide, using sunlight as energy, in the green parts of plants (mainly leaves) **Feeding relationships and the environment** Living things can be divided into groups based upon their characteristics. Different food chains occur in different habitats. Environmental change affects growth (i.e. until the plant is able to produce its own food) Human activity significantly affects the environment. Different organisms are affected differently by environmental change.

Key Stage 2: Years 5&6					
CYCLE A			**CYCLE B**		
AUTUMN	**SPRING**	**SUMMER**	**AUTUMN**	**SPRING**	**SUMMER**
Survival	**Cluedo**	**Who goes there?**	**The Final Frontier**	**It's all Greek to me!**	**The Battle of Britain: Bombs, Battles and Bravery**
Science Specific focus within Topics:					
Evolution, Natural Selection & Life Cycles	**Controlling electrical Circuits. Respiration in animals**	**Making new substances**	**Space & Gravity**	**How light behaves & how we see Sound Travel**	**Forces that oppose motion**

Evolution & natural selection

Chapter 1

Over the last many millions of years there are many examples of organisms becoming extinct and others evolving into new organisms over many generations.

The fossil record provides evidence for this.

Chapter 2

The way fossils form and are found mean the fossil record is an incomplete record of all evolution. Scientists have had to piece together evidence to work out how organisms evolve.

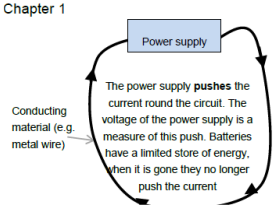
Chapter 3

Darwin's theory of Natural Selection explains how evolution occurs. It can be simplified in the flow chart.

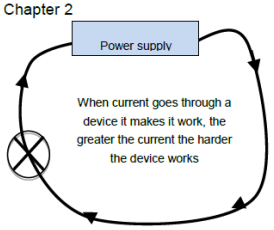
Some organisms reproduce sexually where offspring inherit information from both parents, others reproduce asexually by making a copy of a single parent. Asexual reproduction results in little variation in a population that makes evolution less likely.

Controlling electrical circuits

Chapter 1



Chapter 2



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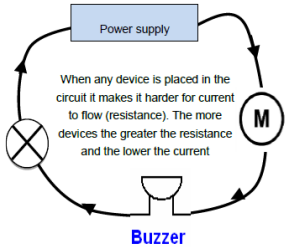

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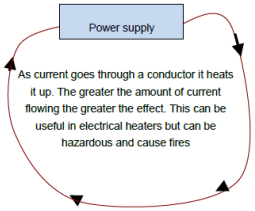


Making new substances

The Big idea

It is possible to change materials into completely different ones. This is very important because new substances might have different properties to materials we currently have. For example plastics can be moulded into intricate shapes, are waterproof, strong and electrical insulators. When materials are heated or mixed with other materials they sometimes can be made to turn into new materials. The question is how would we know if it was a new material or the same material mixed differently?

Indicators that something new has been made are:

The properties of the material are different (colour, state, texture, hardness, smell, temperature)

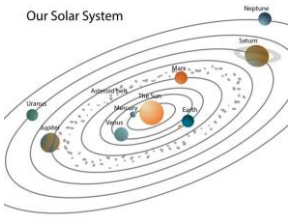
If it is not possible to get the material back easily it is likely that it is not there anymore and something new has been made (irreversible change)

Space and gravity

Chapter 1

The universe is vast and contains billions of stars.

The solar system is a collection of planets and moons orbiting our nearest star, the sun. It can be represented using a model.



Chapter 2

Stars produce vast amounts of heat and light. All other objects are lumps of rock, metal or ice and can be seen because they reflect the light of stars

Chapter 3

Gravity is a force of attraction between any two things that have mass and bigger masses exert bigger forces.

Gravity works over a distance but gets weaker as the distance increases. Stars, planets and moons have so much mass they exert a large gravitational attraction on other things, including each other.

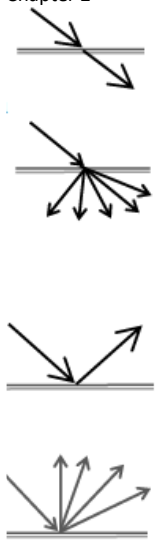
Differences in gravity result in smaller mass objects like planets (or moons) orbiting larger mass objects like stars (or planets).

Light & how we see

Chapter 1

When light is emitted from a light source it travels in straight lines until it hits an object. This can be represented by an arrow.

Chapter 2



When light hits an object it may go through it in a straight line (transparent, light goes through and the arrows don't scatter so you can see an image through it) or the material may allow the light to go through but scatter it in many directions (translucent, light goes through but you can't see an image through the material). It may bounce off the material in a straight line (reflect, so we can see a reflection image in the object), or it may scatter off in many directions (so we can't see an reflection image in the object). Shiny surfaces are better reflectors and rough surfaces scatter light more. Opaque objects don't allow any light to pass through them.

Chapter 3

Animals see when light enters their eyes; they see an object when light from the object enters their eyes.

Forces that oppose motion

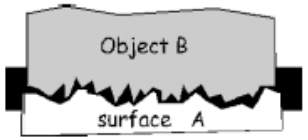
Chapter 1

When objects move through air and water they have to push it out of the way. The water and air push back with forces called water resistance and air resistance. The harder it is to push the material out of the way the greater the resistance.

Gases weigh less than liquids and so water resistance is greater than air resistance

Chapter 2

Friction is a force against motion caused by two surfaces rubbing against each other. It occurs because no surfaces are perfectly smooth; they have bumps and undulations that can interlock when placed on top of each other.



To move one interlocking surface over another one of three things must happen:

The surfaces must rise slightly,

The bumps on the surface must bend.

The bumps on the surface must break.

All of these actions requires a force, this is what causes friction.

Chapter 3

Some objects require large forces to make them move; gears, pulley and levers can reduce the force needed to make things move.

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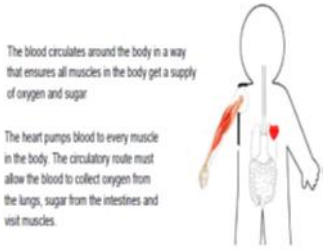
Respiration in animals

Chapter 1

All animals need oxygen to survive. Every part of animals bodies need oxygen, especially muscles

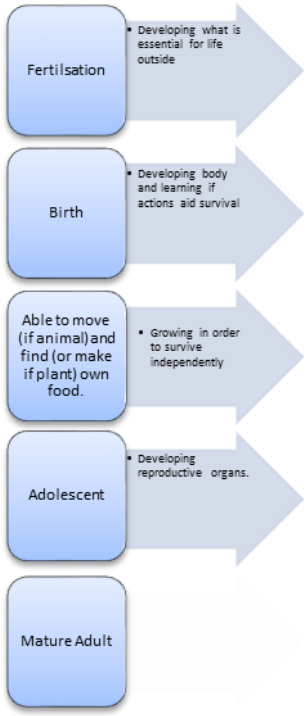
Muscles need a supply of oxygen and sugar to make them work, they are supplied this by the blood.

The big model



Chapter 3

All living things have similar stages of life.



Sound Travel:

Chapter 1

(revision from Year 3/4)

Sounds can be made in many different ways and individual sounds have the properties of pitch and volume.

When a sound is made it immediately spreads out in all directions. As it travels its volume decreases but its pitch remains the same.

Chapter 2 *(revision from Year 3/4)*

Sound is made when an object is made to vibrate (move backwards and forwards or up and down).

As the material vibrates it makes whatever it is in contact with vibrate, including air. As the air vibrates it makes whatever it is in contact with vibrate also, which might be a wall or even your eardrum. Sound moves through materials vibrating making other materials they are in contact with vibrate.

Chapter 3

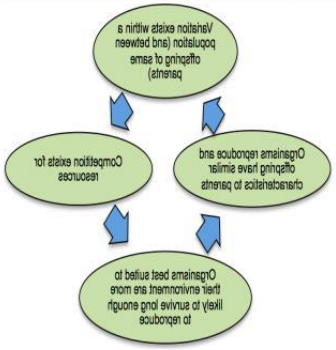
Pitch and volume are determined by how the material vibrates:

Pitch is determined by how fast an object vibrates, i.e. the frequency of vibration. The higher the frequency the higher the pitch.

Volume is determined by how big the movement of each vibration is (the amplitude of vibration). The bigger the amplitude the higher the volume.

Smaller objects and tighter strings and surfaces tend to vibrate with a higher frequency.

	Different animals have adapted these stages differently which has enabled them to survive				

Key Stage 2: Years 5&6					
CYCLE A			**CYCLE B**		
Autumn	**Spring**	**Summer**	**Autumn**	**Spring**	**Summer**
Survival	**Cluedo**	**Who Goes There?**	**The Final Frontier**	**It's all Greek to me!**	**The Battle of Britain: Bombs, Battles & Bravery.**
Evolution & Natural Selection & Life Cycles	**Controlling Electrical Circuits. Respiration in animals**	**Making new substances**	**Space & Gravity**	**How light behaves & how we see Sound Travel**	**Forces that oppose motion**
National Curriculum for this topic					
Evolution & natural selection Some organisms reproduce sexually where offspring inherit information from both parents. Some organisms reproduce asexually by making a copy of a single parent Fossils provide evidence that Living things have changed over time. Environmental change can affect how well an organism is suited to its environment. Over time the characteristics that are most suited to the environment become increasingly common Different types of organism have different life cycles. Life cycles have evolved to help organisms survive to adulthood. 	**Controlling electrical circuits** Batteries are a store of energy. This energy pushes electricity round the circuit. When the battery's energy is gone it stops pushing. Voltage measures the 'push'. Current is how much electricity is flowing round a circuit. The greater the current flowing through a device the harder it works. When current flows through wires heat is released. The greater the current the more heat is released. **Respiration in animals** Oxygen is breathed into the lungs where it is absorbed by the blood. The heart pumps blood around the body. Muscles need oxygen to release the energy from food to do work: Oxygen is taken into the blood in the lungs, the heart pumps blood through blood vessels to the muscles, the muscles take the oxygen and nutrients from the blood	**Making new substances** Heating can sometimes cause materials to change permanently. When this happens, a new substance is made. These changes are not reversible. Sometimes mixed substances react to make a new substance. These changes are usually irreversible.	**Space and gravity** Stars, planets and moons have so much mass they attract other things, including each other due to a force called gravity. Gravity works over a distance. Stars produce vast amounts of heat and light. All other objects are lumps of rock, metal or ice and can be seen because they reflect the light of stars. Objects with larger masses exert bigger gravitational forces Objects like planets, moons and stars spin Smaller mass objects like planets orbit large mass objects like stars	**Light and how we see** Light travels in straight lines. Light reflects of all objects (unless they are black). Non-shiny surfaces scatter the light so we don't see a single beam. Animals see light sources when light travels from the source into their eyes. Animals see objects when light is reflected off that object and enters their eyes **Sound Travel** Sound travel can be blocked. Sound spreads out as it travels. Changing the shape, size and material of an object will change the sound it produces. Sound is produced when an object vibrates. Changing the way an object vibrates changes its sound. Sound moves through all materials by making them vibrate. Bigger vibrations produce louder sounds and smaller vibrations produce quieter sounds. Faster vibrations (higher frequencies) produce higher pitched sounds.	**Forces that oppose motion** Air resistance and water resistance are forces against motion caused by objects having to move air and water out of the way. Children should apply their learning about gravity (Earth in Space) to explain why objects fall towards the earth and explore falling objects, related to the effects of air resistance. All matter (including gases) has mass. Friction is a force against motion caused by two surfaces rubbing against each other Some objects require large forces to make them move; gears, pulley and levers can reduce the force needed to make things move. Some objects require large force to make them move: gears, pulleys and levers can reduce the force that is needed to make things move.

An assessment and progression framework for working scientifically

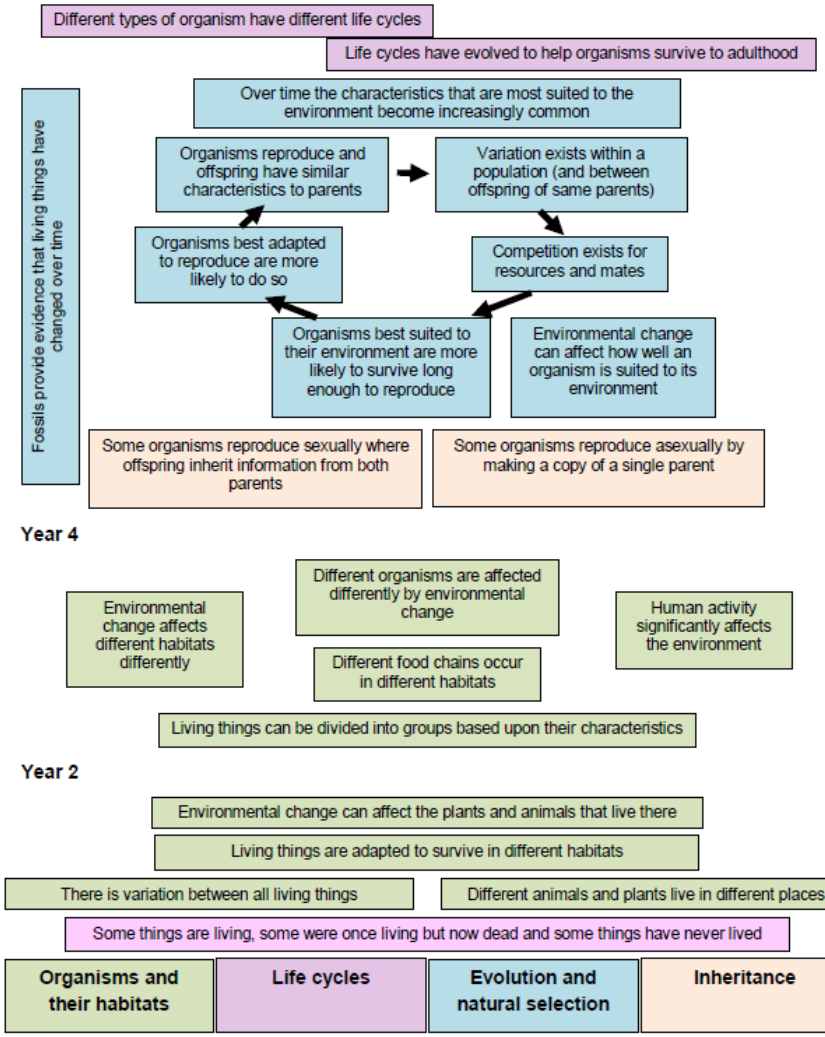
This guidance is based on a clear vision of what it means to make progress in scientific enquiry and expresses age-specific national expectations for pupils aged 7, 9, 11 years. The guidance informs planning and supports good assessment practice.

Types of enquiry in each phase:

		Type of Enquiry	All children should learn to:	Recording & teaching that supports key learning
Key Stage 1	**Years 1 & 2**	• Comparing difference & changes • Describing in order to classify • Surveys to identify patterns & support classification • Describing the effect of changing things • Using secondary sources, including the internet & experts • Pupils begin to look for relationships between variables (patterns)	• Gather evidence to describe the differences and similarities between different organisms, habitats and objects. • Gather evidence to describe how things change over time or as a result of something happening (e.g. how some things spring back when bent and others do not, or plants wilt when they are not watered. • Begin to gather evidence to describe the relationship between variables and patterns (cause and effect) by identifying and seeming to quantify what must be changes and what measured (what change & what measure).	• Venn diagrams, bar charts. • Timelines and tables showing how one and more than one thing changing over time, bar charts, tally charts. • Results tables with the independent variable increasing in one column and the dependent variable in the other.
Lower Key Stage 2	**Years 3 & 4**	• As above • Pupils become more confident in identifying relationships between variables (patterns)	• Recognise that factors other than that we are changing may have an effect and seek to control these factors (what change and what measure and what we keep same). • Gather evidence to describe and classify patterns of behaviour, characteristics and properties of materials and make generalisations from data samples.	• Results tables with independent variable increasing in one column and dependent variable in the other. • Increasing use of equipment that allows for standard measure (thermometers, data loggers, measuring cylinders, force meters, digital balances).
Upper Key Stage 2	**Years 5 & 6**	• Pupils explore more complex relationships or questions requiring greater precision; this will often require the identification of important values (e.g. biggest, smallest, optimum)	• Recognise that conclusions may be uncertain due to difficulties controlling and measuring variable accurately and that measurement always introduces some error. Understand that repeating experiments helps to identify what the true value is and that data points far from the mean are likely to be inaccurate and should be discounted when averaging. • Adapting experiments to produce more precise conclusions when the question requires it, especially when seeking to find maximum, minimum or specific values.	• Results tables with the independent variable increasing in one column and the dependent variable in the other, results tables that show pupils choosing to repeat experiments as appropriate, and the averaging of repeated measurements, scatter graphs to identify precise relationships and important values.

Progression of Key Ideas in Science

Key idea: variation and evolution



Possible applications and activities related to new NC

- Pupils should tackle questions requiring them to compare the life 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). They should be encouraged to think about how each stage helps the organism to survive into adulthood.
- They might observe changes in an animal over a period of time (for example, by hatching and rearing chicks). They explore asexual reproduction by trying to grow new plants from different parts of the parent plant, eg stem and root cuttings They should find out about the work of naturalists and animal behaviourists, such as David Attenborough and Jane Goodall.

Evolution (throughout this section the powerful idea that helps children is: *"Organisms that are best suited to their environment will be more likely to survive long enough to attract a mate and reproduce"*)

- Pupils could be shown artistic impressions of how horses, giraffes, elephants, humans or other animals have thought to have changed over time, and be encouraged to describe changes and think about how these changes occurred and over what time scales.
- Pupils could be shown fossils of extinct animals and asked to consider if there is an animal alive today that is similar. The point being that pupils deduce that not everything that once lived is still living and that what is alive today was not always here.
- 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 could investigate how some living things are adapted to survive in extreme conditions, for example cactuses, penguins and camels, or 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. They could hypothesise what might happen to organisms in the future if global warming continues.
- **Note:** at this stage, pupils are not expected to understand how genes and chromosomes work.
- Pupils might find out about the work of paleontologists, such as Mary Anning, and about how Alfred Wallace and Charles Darwin developed their ideas on evolution.

- Pupils should use the **local environment throughout the year** to raise and answer questions that require them to identify and study plants and animals in their habitat. The important progression from KS1 is that pupils should begin to see how changes in the habitat as a result of seasonal changes (or other environmental changes) affect the organisms that live within the habitat. They need to investigate questions about how habitats change over a year (and longer periods). They need to investigate how the organisms within a habitat change with the seasons, human induced environmental change and the effects of short-term changes like drought or long periods of cold. Pupils could investigate the affects of growing under glass or poly tunnels.
- Pupils should 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.

- Children should raise and seek to answer questions about the **local environment**; through seeking answers to these questions they will *need* to identify and study a variety of plants and animals within their habitat and observe how living things depend on each other. Identification should serve the question; identification serves little purpose on its own. Pupils will need support to identify the local wildlife, so identification charts that contain the local wildlife will need to be constructed.
- Pupils need to explore how the seasons affect local organisms, eg what happens to flowers, trees and grass, or what happens to squirrels, rabbits and woodlice or the fish in the pond. They could begin to relate the temperature changes through the year to how well plants grow or why some animals hibernate in winter.

Variation and evolution (teachers notes)

What is life?

Children should build an increasingly sophisticated picture of what constitutes life. Ask them if things are alive or not and challenge them to justify their choices. If children initially define life as movement, it makes sense to spend some time looking at how different animals move and why that might be important for their survival, which may move on to investigating nutrition and then plant nutrition. If children start by thinking about growth as a definition of life, it makes sense to investigate how different animals grow before moving on to other characteristics of life. The *characteristics of life* are not a simple checklist; some living things do not show all of these characteristics, eg immature organisms do not reproduce. Some things show one or more characteristics of life but are not living. Determining if something is living is challenging!

Environmental enquiry

- Children need to develop a rich understanding of variation through studying their environment and then asking questions about environments and organisms that they may have never seen before. It is essential that pupils are encouraged to notice and explore variation in depth (organisms of the same and different species, between offspring from the same parents (plants and animals), between offspring and their parents and between different habitats). Establishing a strong understanding of variation through KS1 and Years 3 and 4 is essential if pupils are to understand evolution in Years 5 and 6. Pupils will need to explore variation through comparative studies (eg how habitats change along a line, how organisms behave differently in different habitats or conditions, how different habitats support different organisms) and longitudinal studies (those over a long period of time spanning seasonal changes and possibly several years by comparing the results they have found with those of previous cohorts, for example, how AstroTurf, concrete or tarmac, changes if left untouched over several years, how a natural pond evolves from being dug over several years, or even how a big tub of soil changes over a long period of time if simply left where do all those plants come from?).
- Pupils need to learn how the environment changes through the seasons (this is the best way to teach about the seasons, through longitudinal studies lasting a year). They need to consider how changes to habitats affect the organisms within them. For example, how the amount and variation of organisms change in a pond through the year and how different parts of the pond might be affected differently. Pupils need to consider how humans can affect the local environment through pollution, building, new planting (planting a bush next to a pond), introducing or removing certain organisms (eg fencing rabbits out from the school field).

Evolution

- That organisms have changed over time is as close to a fact as we have in science. The evidence for it is overwhelming (fossil record and DNA). Creationist ideas must not be taught within the context of science as it only serves to confuse children, creationism is not an alternative scientific theory to evolution because it is based on faith. Scientific theories are those that are backed up by overwhelming evidence and allow us to make predictions that can be tested; creation stories do not allow for this and are therefore not science. When we teach science we teach children to base their ideas upon evidence and so it is not appropriate to suggest that non-evidence based ideas are alternatives to evolution. This approach is one that is supported by all major religious groups and is what is expected by law. Of course schools may teach creation stories as part of religious education (RE) or when exploring our rich cultural heritage.
- Evolution and natural selection are not synonymous. Evolution is the observation that organisms have changed over many years; natural selection is Darwin's theory of how this happens. The process of natural selection works as follows: in any population there is variation, in nature there is competition for resources and mates, organisms best suited to win that competition are more likely to survive and reproduce (and those less suited are less likely). When they reproduce their offspring will have similar characteristics to their parents (but there will be variation), the same process happens generation after generation and gradually characteristics can change significantly if the change results in the organism being more likely to survive and reproduce.
- A very common misconception is that animals evolve in order to be better suited to their environment, eg if the weather became hotter furry animals would become less furry in order to stay cool. This contains two misconceptions: (1) that organisms will to change and (2) adaptations that occur during a lifetime are passed on to offspring. Natural selection does not require that individuals change during a lifetime, just that there is variation in a population so the better suited characteristics are already there.

Life cycles

Organisms go through varying stages in life to prepare them for maturity when they are able to reproduce. Organisms have evolved differently and therefore overcome the challenge of growth and preparing for maturity in different ways. For example, mammals gestate in the womb as their vital organs develop; as they are developing the mother provides food, water and oxygen. In birds, reptiles and most insects these vital organs develop in an egg, where all the nutrients required for the development are already stored in the egg. It is important that children do more than describe the stages of various life cycles, but think carefully about how the stage supports the survival of the organism to reach maturity. It is also helpful to compare different life cycles to identify how similar developments are achieved in different ways and why some stages are much longer with different organisms. For example, humans take much longer to reach maturity than most other mammals because of the need to learn social behaviours like speech.

Classification and keys

The classification of living things is complex and based upon genetic similarities. It is therefore a useful tool to work out evolutionary patterns. This is beyond primary level science and so we need not worry too much about detailed classification. Important classifications are plants and animals (and vertebrates, invertebrates and mammals, birds, reptiles, amphibians and insects) When asking children to group and identify animals and plants we need to think carefully about the purpose of this activity. For example, if we know an animal has a skeleton we can predict that it will move when its muscles pull on bones, if a fossil animal is found to have well-developed incisors and canines it was likely to have been a carnivore. If we give children activities that require this kind of reasoning then grouping by characteristics is useful because it allows us to make predictions.

Key idea: animals

SENSE	NUTRITION	MOVEMENT	GROWTH	RESPIRATION

Muscles need oxygen to release the energy from food to do work.

- Oxygen is taken into the blood in the lungs.
- The heart pumps blood through blood vessels to the muscles.
- The muscles take the oxygen and nutrients from the blood.

The heart pumps blood around the body

Oxygen is breathed into the lungs where it is absorbed by the blood

Different animals mature at different rates and live to different ages

Year 4

Food is broken down by the teeth and further in the stomach and intestines where nutrients go into the blood. The blood takes nutrients around the body

Nutrients produced by plants move to primary consumers then to secondary consumers through food chains

Movable joints connect bones

Muscles are connected to bones and move them when they contract

Different animals are adapted to eat different foods

Animals have teeth to help them eat. Different types of teeth do different jobs

Many animals have skeletons to support their bodies and protect vital organs

Year 2

Exercise keeps animals' bodies in good condition and increases survival chances

Animals have senses to help individuals survive. When animals sense things they are able to respond

Animals need a variety of food to help them grow, repair their bodies, be active and stay healthy

Different animals move in different ways to help them survive

Animals grow until they reach maturity and then do not grow any larger

Animals need food to survive

Animals move in order to survive

Animals reproduce new animals when they reach maturity

There are many different animals with different characteristics

All animals eventually die

Possible applications and activities related to new NC

- Children should learn about the growth and development of humans, including the changes experienced in puberty. They could compare data about the gestation periods of humans and other animals, time to reach adulthood and try and explain how animals are adapted for these differences.
- Children should explore how the circulatory system allows food and oxygen to be moved around the body, and consider what might happen if these processes were damaged through illness or injury.
- Children should be encouraged to explain the links between diet, hygiene and exercise and their impact on health – this should include the role of micro-organisms in some diseases. They should look for evidence to support commonly held ideas such as: salt is bad for you; you should drink eight glasses of water per day; blueberries are a *superfruit*.
- Pupils should draw a timeline to indicate stages in the growth and development of humans. They should learn about the changes experienced in puberty.
- Pupils could work scientifically by researching the gestation periods of other animals and comparing them with humans; by finding out and recording the length and mass of a baby as it grows.
- Children should consider how some drugs are helpful (in treating illness), and also how some drugs and other substances can be harmful to the human body.

- Children should continue to learn about the importance of nutrition (including a balanced diet). Children should be encouraged to think about why a balanced diet for a child might be different to a balanced diet for an adult. They should consider how plants and animals (including humans) are connected in simple food chains.
- Children should be introduced to the main body parts associated with the skeleton and muscles, focussing on their role in support, protection and movement. Children should try to explain the consequences of breaking a bone and research how it might be treated.
- Children need to be taught that the blood carries everything the body needs to where it is needed, so food needs to be broken into small enough pieces to get into the blood from the intestines. Children should be introduced to the digestive system – mouth, tongue, teeth, oesophagus, stomach and intestine – and explore questions that help them to understand their special functions. They should be given opportunities to use their knowledge of teeth and skeletons to speculate on the lifestyles of extinct animals and consider how carnivores and herbivores are adapted to what they eat.

- Children should be encouraged to use names for the main parts of their body, including sense organs. They need to explore questions related to how senses aid survival? Children must explore how we hear with our ears and how we can make different sounds, and that these sounds can be described using terms high and low, loud and quiet.
- Children should **use the local environment throughout the year** to raise 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. Children should become familiar with the names of common birds, fish, amphibians, reptiles, mammals and invertebrates, including pets. (Common means local and ones they are interested in or have come across, ie relevant.)
- 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 processes of reproduction and growth in animals. The focus at this stage should be on questions that help pupils to recognise growth; they are not expected to understand how reproduction occurs. The following examples might be used: egg, caterpillar, pupa, butterfly; spawn, tadpole, frog. Growing into adults can include reference to baby, toddler, child, teenager and adult. Maturity is reached when an organism is able to reproduce.

Animals (teachers notes)

Humans are animals!

It is a common misconception that humans are somehow different from animals. Comparing how humans behave and how our bodies work with those of other animals is a useful way to address this misconception and is likely to raise lots of interesting questions from children, for example, why do humans live so long compared with other animals, why do we have different types of teeth to dogs.

Senses

Pupils need to explore the five senses and consider how these senses might be different in different animals. It is important that they are encouraged to think about how these senses help the animal survive. For example, cheetahs have long, strong legs that help them run fast which allows them to catch their prey; rabbits have eyes on the side of their heads allowing them to see all around them which helps them see predators approaching; sharks have an excellent sense of smell allowing them to detect blood and food from a long way off. Our fingers have a heightened sense of touch allowing us to do fine work, which has allowed us to make and use tools. It is important that children learn that sensing usually leads to a response. We touch something hot and our body responds, this has helped us survive; a cat sees a bird and it can approach it to eat it, etc.

Digestion

The blood carries oxygen and nutrients to where they are needed (usually muscles), it also carries waste products away from them. All of these materials need to dissolve in the blood. Nutrients are absorbed from the small intestine, they travel through the intestinal wall, through the walls of blood vessels into the blood; for this to be possible food needs to be broken down into tiny bits, this is called digestion. Digestion begins in the mouth by the action of teeth and chemicals in the saliva; it goes down the gullet to the stomach (the purpose of stomach acid is to kill bacteria but it does break down the food a little more), from the stomach to the small intestine, which breaks the food down further through the use of chemicals. Water is absorbed through the walls of the large intestine and blood vessel walls into the blood.

Different animals have evolved to survive exploiting different diets: some animals are able to make the building blocks of muscles and DNA from the raw materials they eat, whilst others have to eat these building blocks. Pupils do not need to understand this detail but it partially explains why animals have different diets and how carnivores and herbivores are able to survive.

Respiration

Respiration is the process that happens in cells where sugar and oxygen are converted into carbon dioxide and water releasing energy. This is how organisms get energy from food, even plants. The difference between plants and animals is how they get their sugar; animals eat it and plants make it themselves. Pupils do not need to know about cells but they do need to know that a major purpose of digestion, breathing and the blood transport system is to get sugar and oxygen to muscles. Breathing is not respiration, breathing is the process by which animals get oxygen into their bodies, and respiration is what happens in muscles to release energy for the body to use. Breathing draws air into the lungs and oxygen can move through the walls of the lungs and surrounding blood vessels into the blood. There is no need to *digest* oxygen because it is already in small enough particles to pass through the walls of the lungs and the blood vessels.

Muscles and skeletons

Pupils can predict a lot about skeletons using a few simple ideas. If they know that muscles pull bones by contracting and that joints connect bones and that bigger muscles pull harder, they can predict why some bones are bigger than others and where muscles must be connected. They can also compare and offer hypotheses for the similarities and differences between different vertebrates' skeletons. Pupils could work out for themselves that muscles work in opposing pairs.

Lesson ideas

Animals: Years 5 and 6

Key ideas	Ideas for lessons
• Muscles need oxygen to release the energy from food to do work. • Oxygen is taken into the blood in the lungs. • The heart pumps blood through blood vessels to the muscles. • The muscles take the oxygen and nutrients from the blood.	• Given a big torso, children discuss and sketch how muscles get the oxygen and sugar they need to work. • What would happen to pulse rate as we do exercise and what happens as we continue doing exercise? Model this using sketched line graphs. • Does prolonged, gentle exercise raise the heart rate as much as short interval training? • Why do we get *out of puff* when we do exercise? What would happen if we exercised at the top of a mountain where there is less air? • Does having a sugary drink affect our pulse rate? • Does caffeine affect pulse rate? (Most soft drinks contain caffeine.) • Consider the body-wide effects of smoking. • Apply understanding of these ideas to diagnose symptoms. • Given the position of the lungs, heart, stomach and intestines, design an efficient delivery system to get glucose and oxygen to the muscles. You could get groups of pupils to design a role-play activity to model this. • Research the diets of different athletes and consider the differences. • Research heart rates of different animals and consider why they are so different.
The heart pumps blood around the body	• Does everyone's heart beat at the same rate? • Do bigger peoples' hearts need to beat faster? • Can you make someone's heart beat faster without them having to do any exercise?
Oxygen is breathed into the lungs where it is absorbed into the blood	• Measure how long a candle burns under a jar of normal air and exhaled air. • Compare lung capacity by blowing through a tube into an upturned water container. Do bigger people have bigger lungs? Does exercise increase your lung capacity? Does your lung capacity increase over the year as you grow? • Produce a case study on lung disease caused by city smog, smoking and coal dust.

Animals: Years 3 and 4

Key ideas	Ideas for lessons
• Movable joints connect bones. • Muscles are connected to bones and move when they contract. • Many animals have skeletons to support their bodies and protect vital organs.	• Give children a large empty torso where they sketch in pencil what they think the skeleton is like. Get them to move in a variety of ways and feel how they move and adapt their skeleton. • Make a skeleton for a string puppet having been given a description of how it must move. What is in place of muscles? • Pupils describe what happens to muscles and bones when a person rides a bike. Use iPads to explore movement in slow motion. • Investigate the effect of making bones bigger in diameter on their strength. • Predict the skeleton of an animal and really apply the ideas opposite to do so. Show the real skeleton and explain the differences. • Give them a bone or two *found somewhere*. What do they think they can say about the animal from the bone? • If an animal has a skeleton what else can we say about it? Predict and test through research. • Make a model arm from pieces of wood, string, Sellotape. (Provide other materials, including elastic, which does the opposite of a muscle because it contracts when relaxed.) If feeling confident, you could look at chicken legs with all the flesh cleaned off and then remove the skin to see how muscles are attached. • Look at X-rays to identify how bones can be broken but also heal. Is it true that mended bones are stronger than original ones? • Compare X-rays of animals, looking for similarities and differences and predicting where vital organs are.
Nutrients produced by plants move to primary consumers then to secondary consumers through food chains.	• Construct a whole-class food web of an ecosystem. Children identify the organisms and research what they eat and what eats them. • Construct a food chain for a local habitat. Consider what would happen if the grass was cut/the tree was removed/the snails were killed by slug pellets/an alien plant or animal was introduced.
Food is broken down by the teeth and further in the stomach and intestines where nutrients go into the blood. The blood takes nutrients round the body.	• Use drama to model the role of teeth, stomach and intestines. • Provide a large empty torso and ask them to draw what they think happened to the meal they ate last night.

Key ideas	Ideas for lessons
• Different animals are adapted to eat different foods. • Animals have teeth to help them eat. Different teeth do different jobs.	• Tell a story of an obviously adapted animal getting lost in a completely different habitat. Get pupils to continue the story of what happens to it. • Construct a food chain based upon the teeth found in a local area What ate what? • Show a real food chain and get children to predict what the different animals' teeth must be like, check on internet. • After washing hands, get pupils to feel their teeth and describe what they are like, then look in a mirror and draw them. They then eat a variety of foods and describe which teeth they are using and hypothesise what each type of tooth is for. • Show pictures of, or real, teeth and jaw fossils and children think about what the animal ate. • Someone has lost a tooth. Will it affect what they can eat? Model teeth with knives, nails and crushing implements and investigate their effects on different foods. • Investigate what makes teeth rot by looking at the effect of different liquids on small marble chips (which work better than egg shells and fizz slightly in lemon juice; even better if you use powdered calcium carbonate). • Use disclosing tablets and compare the effectiveness of manual versus electric toothbrushes, brushing techniques and even different toothpastes. • *The tiger who came to tea*; what if it was not a tiger but an animal you have never seen before? What would it eat? Provide children with snippets of information for them to predict what they should feed the animal. • Dissect owl pellets (cheap to buy) to identify what their diets are. What do they not use and why? • If you were stranded on a desert island with very little obvious food and all you had was an apple, a diet Cola or a tomato and you were only allowed to have one, what would you choose and why?

Animals: Years 1 and 2

Key ideas	Ideas for lessons
Exercise keeps animals' bodies in good condition and increases survival chances.	• What happens to our bodies when we exercise? Can we measure these changes? (Breathing, temperature, sweatiness, pulse rate, tiredness.) • Which exercises make us most tired? How could we check if it is true? • Why do wild animals not go to the animal gym? • Vet role-play: *"My dog is so fat he can't walk to the park, what should I do?"* • Why do wild animals not get fat or do they?
Animals have senses to help individuals survive. When animals sense things they are able to respond.	• Children imagine being a particular predator or prey and predict the sense they would need to have to help them survive. • Why do woodlice curl up? Do they all behave in the same way? • Look for camouflaged animals and hypothesise what different animals' habitat might be like based on their colour. Make camouflage jackets for teddies for the local environment and then see if they survive the great teddy monster (it eats teddies!). • Go on a blindfolded sensory walk. What could you do to sense danger? Show nocturnal animals and predict how they sense danger. How would you survive if you lost your sight? You could get a blind person to visit children with their guide dog to share their experiences. • How far away can we smell things? Can animals smell further or less (same with how smelly). • Can we fool our senses. (Which is the orange jelly from coloured jellies with no flavour just sugar? Can you tell the yellow Skittle from its flavour only? Put mystery foods and smelly things in tins with holes in the lid. Do we all have equally good senses of smell and taste?) • Taste test of exotic fruits. Do we all agree on sweetness? (About constantly hitting the idea that we are different, ie there is variation amongst us.) Are any fruits so sweet they are unhealthy?
All animals eventually die. Animals reproduce new animals when they reach maturity. Animals grow until they reach maturity and then do not grow any larger.	• Construct a timeline based on family pets. Could start to add in other animals and how old they are when they reproduce. Extrapolate the timeline for animals like tortoises and parrots. • Find another animal that lives for as long as a human. What other similarities and differences are there? • Construct a simple lifeline for chickens, frogs and butterflies, and look for similarities and differences. • Measure the height or weight of animals as they grow over a period of a year or two to establish that they do not grow forever. • Ask children to bring in records (weight and height) and photographs of themselves from when they were young to now, put on a timeline and then add similar ones for a pet. What are the similarities and differences? You could put up teachers information on the same timeline and see if children can spot how growing stops when adult.

Key ideas	Ideas for lessons
	• Observe chickens hatching. Why must they be kept warm and what would happen in the wild to keep them warm? What is happening when it is an egg and where does it get its food from to grow? Why do we not develop in an egg? • Frog spawn investigations (looking at and monitoring one or two closely, and noting significant changes and thinking about how the changes help it survive, monitoring the amount of frog spawn over time to see that it gets less as it is eaten. Do they all develop at the same rate? Do they all look the same?) • After exploring different eggs, tell a story about a two-metre egg being found. What might hatch from the egg? • Watch a caterpillar grow to form a cocoon and then a butterfly. What do the children think happens to the butterfly next? • Why do humans have babies? Do all animals have babies and are they all as cute? Why are babies so cute?
Animals move in order to survive. Different animals move in different ways to help them survive.	• Dinosaur dig! Look at individual bones and predict what part of the body they came from and how the animal moved. • Explore through videos the many ways in which animals move. Develop the descriptive language, act out the movement types, show unusual animals and get to predict how they move. Lead into discussions about how slow animals survive; maybe they have *super senses* like smell. How do you know if snails can smell? Investigate. • Investigate local animals, describe how they move and where they live, and try to spot any patterns, eg are slow-moving animals nocturnal?, do scurrying animals live undercover? • On what surface do snails move best? Do they produce less slime on smooth surfaces? • Collect/observe as many animals in the local environment as possible and develop a language for movement. Get children to act the movements. Show some wild animals and ask why some need to move so fast (get food, escape predators). Show an unfamiliar predator and ask the children to consider how it might move to get its prey.
Animals need food to survive. Animals need a variety of food to help them grow, repair their bodies, be active and stay healthy.	• Can carnivores eat vegetables? • What foods would be suitable to feed snails, woodlice, etc. • Bird box study: what food do mothers feed their young? Do all animals eat the same food and how could we find out? • Construct simple food chains from what they investigate and compare different ones and compare with what we eat. • Make food diaries and compare them with a food diary for an animal. How healthily do we eat? Do animals eat more healthily than us? • Design the perfect lunch box. Produce a help sheet for parents.

Key ideas	Ideas for lessons
	• Look at a wide variety of animals on video and in the local environment, and farm and zoo trips. What do they eat and do they all eat in the same way? • You have found an empty dinosaur egg. Where in the school grounds would the dinosaur go to find food and survive?
There are many different animals with different characteristics.	• Look for similarities and differences between birds and ask questions about the differences. • Survey how many limbs different animals have and try to categorise them. Reach the point where if you know an animal has four limbs what else can you say about it? • Do all animals use their tails? How do they use them? Who chopped mine off?

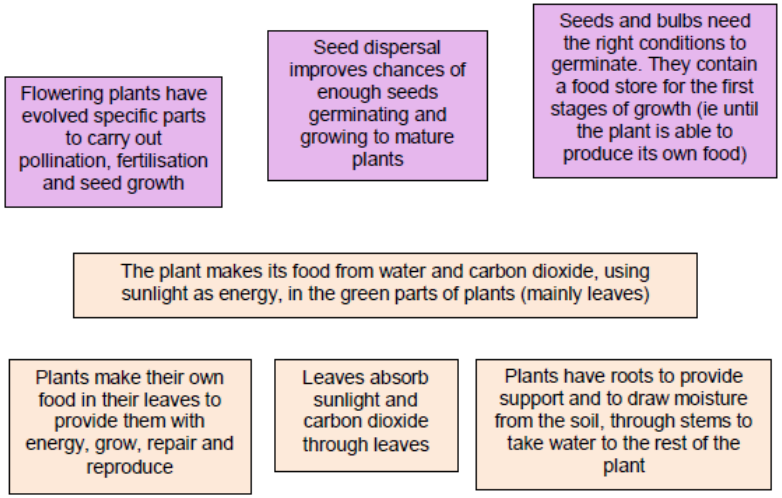
Key idea: plants

Possible applications and activities related to new NC

Year 6

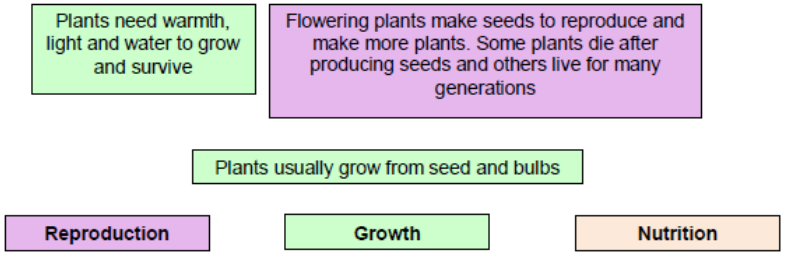
- Although there are no new plant key ideas introduced in Years 5 and 6, the plants will be studied in relation to evolution and life cycles.

Year 4



- Children should have opportunities to explore the link between structure and function of the roots, stem and leaves of a plant – for example, examining the movement of coloured water through plant stems, seeing how removing leaves from seedlings affects growth. Children should be taught that the green material in plants, especially in the leaves, enables plants to make their own food.
- Children should have opportunities to explore the conditions required to maximise plant growth.
- Children should explore how different plants use a range of strategies for (a) pollination and (b) seed dispersal.
- Children should have opportunities to examine the flowers of a variety of plants closely, perhaps using a digital microscope, to see how they are adapted to maximise the chance of pollination – this can be for both insect pollinated and wind pollinated plants.

Year 2



- Children should have opportunities to grow a variety of flowers and vegetables, observing their growth, and identifying the conditions required for growth. This will lead children to start describing plants in terms of their flowers, petals, stem, leaves, roots, fruit, bulb and seed.
- Through their use of the local environment throughout the year, children should be encouraged to ask questions which will require them to identify and name a variety of common plants and trees (deciduous and evergreen).

Lesson ideas

Plants: Years 3 and 4

Key ideas	Ideas for lessons
Seeds and bulbs need the right conditions to germinate. Seeds contain a food store for the first stages of growth (ie until they have developed to be able to produce their own food).	• What are the best conditions for germinating grass seed? • What happens to a seed as it germinates and starts to grow? (Look at a wide variety of seeds, including those used in food production.) • Identify the best conditions for specific seeds to germinate and then write instructions for the seed packet. • Research into seeds with unusual conditions for germination, eg forest fire. • Look at the effect of some conditions on germination, eg gravel, sand, soil, clumped together, spread out. What fraction of seed germinates in each condition? • You are on an alien world with no soil: what will be the best material to plant seeds for your food in?
Seed dispersal improves the chances of enough seeds germinating and growing to mature plants.	• Do seeds with *helicopter blades* move further from a parent tree than those that drop and roll? • How do dandelions and poppies disperse their seeds? (Maybe compare with the results from above.) • Design a seed that would be effectively dispersed by wind, water, mammals, birds. (Application of knowledge.) • Collect seeds in the school grounds and identify means of dispersal. • Leave a tub of *new* compost outside the classroom. If plants start growing, where did they come from? Can we identify them and check the means of seed dispersal?
Flowering plants have adapted specific parts to carry out pollination, fertilisation and seed growth.	• Dissect a flower – identify the parts – observe with a microscope. • Look at the difference between insect pollinated plants and wind pollinated plants. • What is the best colour for a flower if it is to attract insects?
The plant makes its food from water and carbon dioxide, using sunlight as energy, in the green parts of plants (mainly leaves).	• Germinate cress and grass seeds. After a few days, cut the grass and cress. Why does only the grass regrow? • How do the number of leaves on trees/plants change over the seasons? (Make the link to available sunlight.) • Do plants in the school greenhouse always grow faster than those outside?
	• Some people say that talking to plants makes them grow quicker? Is that really true?
Plants have roots to provide support and to draw moisture from the soil and sometimes stems to take water to the rest of the plant.	• Are roots essential for a plant to grow? • Place celery in black ink and daffodils (or other flowers) in coloured water. What happens over a period of a few days? • How many different types of roots can you find in the school grounds? • Look at roots under the microscope. • Grow plants in clear containers with no soil to observe the development of the root system. • Are there any plants that grow out of soil? Where do they get their nutrients?
Leaves absorb sunlight and carbon dioxide.	• Design a shoe box maze for plants to go through. (Plants will grow towards the light.) • Will plants grow differently in red, green or blue light?
Plants make their own food in their leaves to provide them with energy, grow, repair, and reproduce.	• Compare the growth of a plant with the leaves removed or covered with an unaltered plant. • Look at what has happened to the grass after we left the paddling pool out all over half term.

Plants: Years 1 and 2

Key idea	Ideas for lessons
Plants eventually die, they make seeds to reproduce and make more plants. Some plants die after producing seeds, others live for many generations.	• Does it matter which part of an apple or a sunflower you plant if you want to make a new plant? • Look at an area of the school grounds over a school year. What happens? Do new plants come back? • Meadow planting (seeds – plant – die – seeds). • Life cycle of a sunflower. What *connects* the cycle between seedling and mature plant? • The upside-down seed. • Mystery seed/bulb: how do we make it grow? • Once they have flowered, how long do different flowers last? • Do bigger seeds grow bigger plants?
Plants need warmth, light and water to grow and survive.	• Find out what the best conditions are to grow cress and then turn these into instructions for the seed packet. • An alien visitor wants to grow plants for food but does not believe that plants need light, warmth and water. How can we prove to him that this is true? • Do plants always need soil to grow? • The plants in the headteacher's *secret garden* are looking unhealthy. Can you help her? • Buy dying plants from a garden center: give the children the opportunity to be *plant doctors*. • We are growing vegetables! What are the best conditions for growing the best vegetables? • Can a plant have too much water? • Observe a tree in the school grounds over the school year. How do the seasons affect its growth?
Plants usually grow from seeds and bulbs.	• Do bigger seeds produce larger plants? • Provide a wide variety of seeds and beans and things that look like seeds and beans: pupils predict which are real and then test to see which grow. • Ask children to find seeds from the garden and local area (best done with parental supervision). They photograph the plant, identify it and then plant the seed to see if it grows.

Key idea: materials

Year 6

All matter (including gases) has mass

Sometimes mixed substances react to make a new substance. These changes are usually irreversible

Heating can sometimes cause materials to change permanently. When this happens, a *new* substance is made. These changes are not reversible

Year 4

Solids, liquids and gases are described by observable properties

Materials can be divided into solids, liquids and gases

Heating causes solids to melt into liquids and liquids to evaporate to gases

Cooling causes gases to condense to liquids and liquids to freeze to solids

The temperatures at which given substances change state are always the same

When two or more substances are mixed and remain present the mixture can be separated

Some changes can be reversed and some cannot

Materials change state by heating and cooling

Year 2

Materials have describable properties

There are different materials

Different materials have different properties

Materials can be changed by physical force (twisting, bending, squashing and stretching)

Describing materials

Changing materials

Possible applications and activities related to new NC

Provide lots of opportunities to explore changes that require children to describe the properties of materials before and after, and gather evidence to decide if new substances have been made (this would involve trying to get back the original materials to prove no new substances had formed). Examples are: making jelly; cooking biscuits; glues (wallpaper paste versus Araldite, for example), drying clay and firing clay; concrete; plaster of Paris; dissolving simple solutes; dissolving fizzy soluble tablets; reacting real chalk dust with vinegar or lemon juice.

Separating mixtures applies the ***key idea*** that materials have properties. To separate mixtures, first identify the differences in the properties of the mixture's components, and then decide what would affect one material and not the other to separate them. It is important that children have explored the relevant property before they are expected to apply an understanding of it to separate materials.

Reversible changes that should be investigated are melting, freezing, evaporation and condensation (Years 3 and 4) and dissolving (Years 5 and 6). **Not just for water.** Temperatures of state changes should be investigated and compared.

- Where does the puddle go? (Testing to see if it soaks away in order to explore evaporation.)
- Using the model of the water cycle to explain why there is little rain in deserts or more rain near the coast.
- Investigating questions that relate to the properties of rocks and grouping them according to their properties. Explore how fossils form when once living things become trapped within sand and clay that hardens into rock over millions of years.
- Investigate composition of different soils to answer questions, eg about how they formed.

Investigate the properties (see above notes) of a wide range of materials, including metals, plastics, wood, rocks and liquids. Investigations should always be purposeful. Examples of questions that encourage this:

- which toys would be safe to put in a baby's playpen?
- what is the best material to make a mop?
- which chocolate melts the quickest?
- which elastic band would make the best catapult?

Materials (teachers notes)

Ensuring progression

A key question that drives many lessons is: *"What material is the best for doing job X?"* For example: *"What is the best material to make a coat from?"*, *"What rock would make the strongest statue?"* As children learn more key ideas about materials their enquiries into these questions must become more sophisticated. To be able to tackle increasingly sophisticated versions of this question, children need to understand increasingly complex properties. A simple way to view a progression in properties is shown in the box below.

Early Key Stage 1: Easily observable properties, eg colour, hardness, runniness, *opaqueness*, shininess, flexibility. → **Later Key Stage 1:** Properties that can be measured, eg temperature, distance, volume. (It is important we move on to these properties quickly if children are to do fair tests). → **Key Stage 2:** Properties that require children to devise their own measurement scale, eg magnetic strength, electrical conductivity, absorbency, waterproofness, strength, light intensity, solubility, and viscosity.

A word about particles

The particle model for solids, liquids and gases is not part of the primary National Curriculum and there is no real need to teach it. It is important that pupils have many rich opportunities to explore the observable properties of solids, liquids and gases and then use knowledge of these properties to offer hypotheses and make predictions. The important properties pupils should know and understand are:

Solids

- solids keep their shape, some can be bent, twisted and moulded but once the force is removed the shape is fixed. Some solids are brittle
- all pure solids melt when heated, although some need to be heated to very high temperatures. The temperature at which they turn to a liquid is called the melting temperature

Liquids

- liquids flow and so fill the bottom of any container they are in and take its shape. Some liquids flow more easily than others, the *thicker* the liquid the greater its viscosity
- when liquids are heated they evaporate more rapidly (from the surface) and when all of the liquid has enough energy to evaporate at the same time bubbles of gas form within the liquid (it boils). The temperature at which a liquid boils is called the boiling temperature

Gases

- gases are materials that are free to move anywhere, they are not held within a container. Any pure substance can become a gas if it is given enough energy. When gases are cooled they lose the energy needed to allow them to move freely and they start to come together and form a liquid, this is called condensation. The temperature at which a gas forms a liquid is called the condensation temperature; it is of course the same as the boiling temperature
- gases are a substance and so they have mass. This can be measured by comparing the masses of filled and empty balloons.

Lesson ideas

Materials: Years 5 and 6

Key ideas	Ideas for lessons
Sometimes mixed substances react to make a new substance. These changes are irreversible.	• Gas produced by bicarbonate/water mix. What needs to be done to produce more gas? • Have we made something new? How can you prove it? (Key question: can I get the original materials back?) • vitamin tablet in water • Steradent and water • baking powder and vinegar • plaster of Paris and water • Andrews Salts and water. • Put a small amount of vinegar and bicarbonate into a pop bottle and place a balloon over the top. A Wonderwall from this will generate many questions related to what has happened, as well as what would happen if the proportions are changed. • Instant snow (super absorbing polymer) is a good resource to test if the change is permanent or not.
Heating can sometimes cause materials to change permanently. When this happens, a new substance is made. These changes are not reversible.	• When something is *cooked* have new materials been made? How could you find out? (Key question: can I get the original materials back?) • Sometimes when we make food it is horrible. Can we get back the ingredients if we do not like what we have made? Making jelly, cooking eggs, baking a cake, baking bread, Angel Delight. • Invisible ink experiments: can the ink be made invisible again? • Bake sale. Children create cakes, biscuits, lollies, etc to sell. If they make a mistake, which ones can they start again with and why? • Take some wet clay and dry it; take the dried clay and fire it. Has a new substance been made at each stage and how could you find out?
All matter (including gases) has mass.	• Does air weigh anything? Test this using a coat hanger, a deflated balloon and an inflated one. Can children see which balloon is heavier? • Half fill a one litre Coke bottle with polystyrene beads (used for packaging) then, whilst pumping some air into the bottle, ask the children what might happen inside the bottle. Let them explain what happens next. 
	• Weigh some bubble wrap before and after popping. What happens and why? You will need some very accurate scales. • Using space bags (vacuum bags) weigh some sponges + bag. Then vacuum them (remove air) and weigh again. Explain. • Does lemonade weigh more when it is fizzy or flat? Why? • Explore that air is made of stuff by running with large pieces of card in front and to the sides. So if air is made of stuff would it weigh anything? • What is heavier: a balloon full of air or one that is empty? Test this using rough metre-rule scales. The rough and ready way gives less definitive answers and gives pupils more reason to argue.

Materials: Years 3 and 4

Key ideas	Ideas for lessons
When two or more substances are mixed and remain present the mixture can be separated.	• A white powder has been found at the scene of a crime and detectives have asked you to find out what it is. Pupils could conduct simple tests (solubility, heating, burning) on powdered salt, sugar, flour and chalk dust. • Magic Sand (a fine sand coated so that water runs off easily, producing some interesting effects). • Why cannot you turn normal Coke into Diet Coke by filtering it? • When water is heated it evaporates to steam. What happens with Cola or orange squash? • How can you sort out this mess? – Cooking disaster (flour and currants). – Building disaster (sand and gravel). – Council disaster (sand and salt). – Office disaster (paper clips and elastic bands). – Garden disaster (compost and water). – Clear water competition: sieving muddy water (this can be made more challenging by adding salt to the water) to obtain drinkable water. • Dissolve salt in water. Where has it gone? Is it still there? How would we know? This could lead on to trying to dissolve other solids in water to come up with a definition of dissolving (a substance has dissolved when it has mixed in with the water so completely that none of the original solid can be seen, leaving a clear solution). • There are lots of follow-on experiments that explore dissolving. Do the following things affect how much solid dissolves: volume of water, temperature of water, type of solid, how much you stir? They will confuse rate of dissolving with how much: help them to be aware of the difference.
Heating causes solids to melt into liquids and liquids to evaporate to gases. Cooling causes gases to condense to liquids and liquids to freeze to solids. The temperatures at which given substances change state are always the same.	• Who can make their *pet* ice cube last the longest? • What is the best place to evaporate water? • How can we make butter softer? • Hold a chocolate button in one hand. – What will happen? – What does happen? • What happens to ice if it is left all day? • How can you rescue a jelly baby from an ice cube?
	• Food technology: recipes that include melting/cooling, eg chocolate rice crispy cakes. • Some alien babies (jelly babies), encased in ice, have been found with a note saying: *"Please look after my precious babies. They must be kept frozen or they will die. I shall be back around 3.00 pm today."* • The snowman's coat problem. Which will melt first? Wrapped up or no clothes?
Solids, liquids and gases are described by observable properties. *(This idea is full of* best material for *type investigations. In all of these, make sure that the materials provided do not produce such an obvious answer that no meaningful testing is provided. If possible, establish a hypothesis to investigate, eg do materials become more waterproof when they get thicker?)*	• Make an escaping hamster a new cage. What material will you use and why? Consider what material you will use to line the cage with (absorbency). • Slime Olympics: which liquid flows the quickest? Design a race. • Make some ice eggs (frozen water in balloons) and pose the problem: what should we wrap the egg in to stop it melting? (Include water as a material perhaps.) • Which material is best to keep out the light in the castle? Quick 10 minutes to identify from a selection of materials (chosen so that the dark one is best). Allow pupils to come up with a hypothesis as to why that material is best (because it is dark). Pose the more challenging question: which of the following dark materials is best at keeping out light? (Choose materials where difference is not obvious and they have to do a fair test to find out.) • The teacher makes a big thing of putting a vase of flowers on the table but *accidentally* spills them. Quick! Help me. (Best material for mopping up.) Consider which material could be used and why, the children then explore whether it is true that materials with this property are actually the best for mopping up. • Paper towel testing. Are the most expensive paper towels the best? Test a range of materials: J-cloths, newspapers, paper towels (a range). • Gas spray. How long before you can smell it? Explain what has just happened.
Materials can be divided into solids, liquids and gases.	• Sand trick. Pour water into a jug filled with sand. Where has the water gone? • On a snowy day the question, *"Why do we put salt on the path?"*, can lead to the question, *"Do all things melt the snow as well as salt?"*. • Spray perfume in a corner and ask pupils to say when they can smell it. Can they offer a hypothesis for why they all smelt it eventually, but those closest smelt it first? • When does a liquid get so thick it is no longer a liquid? Pupils design experiments to test the viscosity of different liquids. Maybe they could be given flour and water to see if they can make a paste that is so viscous it is a solid.

Key ideas	Ideas for lessons
	• What makes a windmill and a kite work? Would they work on the moon? • Dancing raisins: fizzy drink and raisins. Why do you think that happens and how could you find out? • Make carbon dioxide (CO_2) extinguish a candle. • Display some unusual materials for the children to decide if they are solids or liquids: toothpaste, hair gel, powders, sand, shaving foam, potting gel, fake snow, etc. Encourage them to think about what makes them like more than one state of matter. • *"Only liquids flow."* Is that true? How can we find out? • *"You can't change the shape of a solid."* Is that true? How can we find out? • Ask children to explore their surroundings for materials that back up and contradict these statements, and use this to generate definitions of solids and liquids.

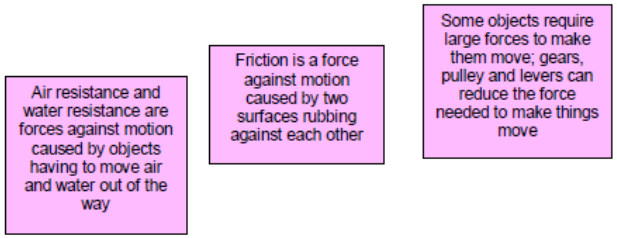
Materials Years 1 and 2

Key ideas	Ideas for lessons
Materials can be changed by physical force (twisting, bending, squashing and stretching).	• Rapunzel is back in the tower. The prince would like to rescue her but she cannot climb out of the tower. Make her a rope, but all the prince can find is a box of tights. • Give children a wooden block that is quite heavy (or box of stuff) and lots of thin paper strips. Their challenge is to lift the box with the paper strips. They are allowed to do anything with the paper strips, but they have to say what they have done and what effect it had (could try twisting, plaiting, layering, etc). • Real-life object property classification through play. Explore bend/ twist/stretch and use a Venn diagram to sort. • Which elastic band is the most stretchy? What do you think and how could you find out? • What is similar and different about elastic and Silly Putty? Could you make a bungee cord from Silly Putty?
Different materials have different properties. Materials have describable properties.	• I will be redecorating and replacing my kitchen. I would like to replace the worktops with a material which will be durable and smooth, as well as decorative. Suggest the best/worst rock type, explaining your reasons. • Which material is the best for wrapping a Christmas present? • What is the best material to make a cloche for your plant and why? • What is the best material for a nursery blind (curtain) so a baby can sleep during the day? • What material would be suitable for a floor covering in a house? What do you need to consider (requirements)? • What is the best material to make a drawbridge? • B&Q is developing a new type of roof tile and has sent some sample (bricks) to be tested. You must test each material and reply to them with your recommendation and why. • Which materials could be used to make a super mop for Cinderella? • How can we protect the toys (cuddly) so we can keep them outside? • How can we make a hat for Father Christmas to keep him warm and dry? • Object material match: Why was material x used to make object y? • Investigate a range of materials to find which one will be suitable to patch an umbrella. • Which is the best material to make Katie Morag's coat? It needs to be able to keep her warm on the Isle of Struay, off the west coast of Scotland (very cold).

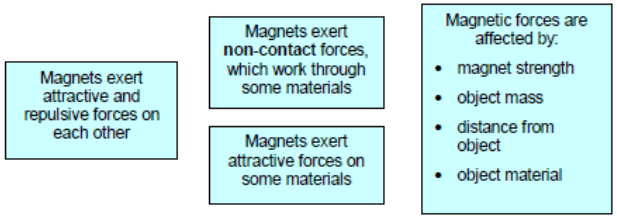
Key ideas	Ideas for lessons
	• Plan which material would be best for a pair of curtains for Mrs Owl. • The best material for a shadow puppet. • The best material to make a roof from. • Sort/explore materials by various properties/criteria. • Make an outfit for a super hero. Wash, then freeze it. Consider how materials change. Defrost the outfit and discuss the changes. Investigate the best place to dry the outfit. Where does the water go? • As part of a topic on homes, a problem was posed: the tiles for the roof had not been delivered (letter from a builder). He needed to find the best material to cover the building to protect it until the roof tiles were delivered. • What would be the best materials to build the three little pigs' houses? • Make play dough and encourage children to describe and compare accurately how the materials change at the various stages. • What materials are best for making a boat for Gingerbread Man to cross the stream? • Design, make and test a bag that will carry four tins of beans across the playground.
There are different materials.	What materials can you find around the school? Slow reveal: what label can we give this group? What else could we put in? Give children an object and ask them where should it go? Material hunt: give the children a material property and send them off around the school to photograph it once found.

Key idea: forces

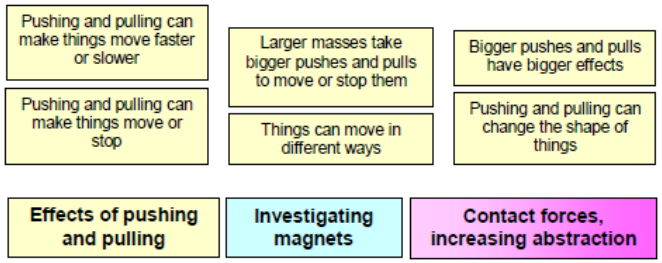
Year 6



Year 4



Year 2



Possible applications and activities related to new NC

- Children should use the idea of gravity (teach gravity – see *Earth and space* – before this topic) to explain why objects fall towards the earth and explore falling objects, raising questions about the effects of air resistance. Children might explore how the ideas of Galileo and Newton helped to develop our ideas about gravity and air resistance.
- Children should explore the effects of friction on movement and find out how it slows or stops moving objects. Children should be encouraged to picture what is happening at the point of contact between two surfaces moving past each other.
- Children should explore how the use of levers, pulleys and simple machines can appear to make movement easier.
- Children should explore the behaviour and uses of springs and elastic materials, for example in catapults.

Children should be given opportunities to explore the way magnets interact with a range of different materials and each other. At this stage, children should begin to appreciate that magnetism can *pull* objects without touching them. Similarly, magnets can *push or pull* each other without being in contact.

(The effects of pushes and pulls can also be explored through work on the skeleton and movement in animals. Muscles contract pulling bones; bigger muscles exert bigger forces requiring stronger bones to support them).

Provide children with a variety of experiences with moving objects, such as toys – inside and outside – balls and hoops in PE. They might investigate questions like:

- how can I make my paper boat move?
- how can we get the hoop to roll further?
- how can we get a ball to bounce higher?
- is it always true that a steeper slope makes the toy car go further/faster?
- making different mass objects move, eg blowing different balls in a race, which fruit can you throw the furthest?

Forces (teachers notes)

When should we begin teaching forces?

- The National Curriculum makes no mention of forces in Key Stage 1. It is only statutory to teach it in KS2, but when pupils are taught about magnets. As written, there are no opportunities for pupils to explore simple contact forces arising from physical acts like pushing, pulling and twisting, neither are pupils taught how changing the size of these forces makes things behave differently. We believe this is an omission that will make it difficult for children to place their experiences of magnetism within a more concrete understanding of forces. We have therefore identified some important key ideas that define what a child needs to understand before they explore magnets. It is not necessary that these ideas are taught in a discrete topic on forces, but could be taught through exploring the behaviour of materials and how animals move.

Gravity

- Gravity is another non-contact force; the key ideas associated with gravity are described and explained in *Earth and space*.

Force arrows

- The use of arrows to depict forces should be slowly introduced. At KS1, model movement in the way and direction we push and pull without drawing arrows. At KS2 begin to use arrows to depict forces (size and direction). Later in KS2 draw arrows to represent different forces acting at the same time

What is and what is not friction?

- Friction is a force opposing motion created when two surfaces rub against each other. It is caused by the surfaces being rough (even if only on a microscopic scale) and interlocking slightly with each other. Sometimes the two surfaces are sticky (this stickiness can be as a result of the surface being sticky or it could be that the molecules on the surface attract each other). Friction is the force required to overcome this stickiness or force interlocking surfaces over each other. Pupils do not need to be taught about molecular attractions, but they should be taught to draw pictures of how they visualise what is happening at surfaces experiencing friction; this will allow them to make predictions about what could be done to increase or decrease friction.
- Air resistance and water resistance are not caused by friction but by objects having to physically move air and water out of the way, this requires a force.

Force multipliers

- Gears, levers and pulleys are called force multipliers because they allow a small input force to be converted into a large output force; think about the small force you exert on a foot brake producing an enormous force capable of stopping a car weighing nearly a ton. They work because the force you put in *x* the distance you operated that force over is the same as the output force *x* the distance that is moved over. For example, you may only exert a force of 100N on the brake pedal pushing it down by 10cm, if this pushes the callipers on your brake in by only 0.1cm then they move in with a force of 10,000N, ie the force has been multiplied. The same thing happens on a seesaw. A light person sitting right at the end can force a heavier person up if they are sitting near the middle; this happens because the low weight person moves down a greater distance than the high weight person moves up. Children do not need to understand this quantitative relationship, but they should be encouraged to articulate why they think levers, gears and pulleys work using the two parameters of force and amount moved. It is easier to start with levers because it is easier to visualise movement. Children can often use balance beams intuitively, encourage them to discuss and articulate how they managed to balance them.

Lesson ideas

Forces: Years 5 and 6

Key ideas	Ideas for lessons
Some objects require large forces to make them move: gears, pulleys and levers can reduce the force needed to make things move.	• Challenge children to balance a heavy mass with a light one on a seesaw/ balanced ruler. • Make a trebuchet that uses a mass on a lever to launch a projectile. What is the effect of changing the length of the lever on how far the projectile goes? • Provide pupils with lots of ropes and planks (pulleys perhaps). Challenge them to lift a heavy bag using just their little finger. • How did ancient people manage to get enormous stones to stand on their ends? What is the minimum number of children needed to lift the headteacher's soft top car off the ground?
Friction is a force against motion caused by two surfaces rubbing against each other.	*Establish that two surfaces are bumpy and the bumps interlock making it hard to slide and then get children to use this idea regularly.* • Racing balloons along lubricated and non-lubricated strings. Pupils draw pictures to show how the two strings are different and how lubrication works. • Does increasing the amount of tread increase the grip and why or why not? (Best not to use different shoes as there are so many things that are different between them). Does more tread help more on rougher or smooth surfaces? • Which tyre produces the most grip? (Get lots of old tyres and cut them up; children can stick them to the bottom of blocks of wood.) • Ancient Greeks were lazier than ancient Britains because they made palaces from marble rather than sandstone because it is easier to drag. Is this true? • Which material would give the fastest ride down a helter skelter. • Do surfaces that have a lot of friction also affect how quickly balls roll down them? (Remember that rolling is not the same as sliding or skidding!) • Are bananas really the slippiest fruit?
Air resistance and water resistance are forces against motion caused by objects having to move air and water out of the way.	• Do ships sink quicker in fresh water or salty water? • What shape submarines travel the quickest? • Why are fish the shape they are? • Paper helicopters: what is the optimum wing length/width? • Do heavier objects fall more quickly?

Key ideas	Ideas for lessons
	• How exactly does the surface area of a parachute affect how long it takes to fall? (What do we mean by surface area in this context?) • Why are bullets less likely to kill you if you are underwater?

Forces: Years 3 and 4

Key ideas	Ideas for lessons
Magnets exert **non-contact** forces, which work through some materials.	• Can you use magnets to quickly and accurately measure the thickness of a book? • Simply ask the question:, *"Do magnets work through all materials, and which materials are the most effective at blocking the magnetic force?"*.
Magnetic forces are affected by: • magnet strength • object mass • distance from object • object material.	• Are bigger magnets always stronger? • How many different ways can you devise to compare the strength of different magnets? Which is the best method and why? • How many times stronger is a super magnet (often called neo magnets and available cheaply from Amazon, etc.) than a normal magnet? • If you put more than one magnet together does it become stronger? • Do magnets lose their strength over time? • Does covering a magnetic material in paint, plastic or paper make the attraction weaker? • Do the magnets that attract materials the strongest also repel each other the hardest? • Show a cartoon of a magnet attracting something over a long distance and then ask how far do magnets work?
Magnets exert attractive and repulsive forces on each other.	• Make a magnetic toy that utilises both the attractive and repulsive forces of magnets. • Show a Maglev train and challenge them to make two objects that levitate above each other • Ring magnets can be stacked to create a variety of patterns depending on how their poles are arranged. • Challenge children to recreate these patterns and explain how they did it. • What could I put in my paper boat that would allow me to use a magnet to drive my boat by both pushing and pulling it?
Magnets exert attractive forces on some materials	• Spend 15 minutes testing as many materials as possible to see which are attracted to a magnet and which not. Can the children see any patterns? Are all metals magnetic? • I want to make a cardboard car move on a thin board by using a magnet under the board. What is the best material to stick under the car? • Can magnets be used to separate a variety of mixtures? Explain how it works or does not work. • What could I put in my paper boat that would allow me to use a magnet to drive my boat?

Forces: Years 1 and 2

Key ideas	Ideas for lessons
Larger masses take bigger pushes and pulls to move or stop them.	• Push one, two and three people on a bike to experience the increasing difficulty. • Run cars down a slope and add more weight each time to see how far they go. Heavier masses take bigger forces to stop them and so should travel further. • How far can children blow balls of the same size but different masses? • Protection from forces. Tomato farmers/egg producers high up a mountain get their produce to market in the valley by rolling it down the hill. What is the best way to protect the tomatoes and eggs and how does it work?
• Bigger pushes and pulls have bigger effects. • Pushing and pulling can make things move faster or slower.	• Drop balls from different heights and measure how high they bounce. • Run cars, balls and sledges down ramps from different heights and measure how far the object travels. • Make a castle drawbridge and investigate the forces needed to pull it up if it is reinforced to make it stronger (and heavier). • Balloon powered cars and rockets: how does the vehicle travel differently if the balloon is blown up different amounts? • Catapult plastic tubs across the room using elastic bands. What is the effect of pulling the band back different amounts or using thicker elastic bands? • Film canister rockets (place a fizzy tablet and water in a plastic film canister and let the lid fly off). How does changing the amount of tablet effect how far the rocket flies. • Does the length of your leg or arm affect how far you can kick a ball or hit a tennis ball? • Tug of war: does weight make a difference? Are three small people better than two big ones? You could do a Wonderwall to establish questions for investigation. • Take a trip to a local park to identify which rides use pushes and pulls, which are easier to operate and why, which ones can be made to go faster and how, and which ones cannot go faster and why (eg the slide because you cannot change gravity).
Pushing and pulling can change the shape of things.	• Which Plasticine is the easiest to use? • Which Magic Putty needs the least effort to stretch it? • Make playdough from different recipes to find the one that is the most squishy. • Did you know that red playdough is the easiest to mould? Is this true? Test it! • Which elastic band is the scratchiest?

Key ideas	Ideas for lessons
	• Which elastic band would be good to make a bungee cord for teddy? • Go on a hunt for objects that change back when twisted or bent and those that do not. Develop vocabulary of stretchy (elastic) and brittle. The word for something that changes shape when bent but does not break or spring back is plastic.
Pushing and pulling can make things move or stop.	• Crash experiments! Get some car track lifted at both ends and investigate what happens when different types of cars are collided with each other. • Pupils identify if movement is caused by a push or pull – quick fire stuff. • The first team to identify five things that move with pushes.
Things can move in different ways.	• Scavenger hunts for things that move in different ways (including toys). • When studying animals, develop vocabulary of how different animals move in different ways. Get children to act these different ways. • Choose the best toys that roll, slide, and bounce. • How can we make a ball bounce higher? • A concept cartoon-type approach to questions like: do bigger balls bounce higher? • When investigating materials ensure appropriate movement vocabulary is developed, eg what is best to put on a slide to make a penguin slide better?

Key idea: electricity

Year 6

Batteries are a store of energy. This energy pushes electricity round the circuit. When the battery's energy is gone it stops pushing. Voltage measures the *push*

The greater the current flowing through a device the harder it works

Current is how much electricity is flowing round a circuit

When current flows through wires heat is released. The greater the current the more heat is released

Year 4

More batteries will push the electricity round the circuit faster

Electricity sources *push* electricity round a circuit

A source of electricity (mains or battery) is needed for electrical devices to work

Devices work harder when more electricity goes through them

Some materials allow electricity to flow easily and these are called conductors. Materials that do not allow electricity to flow easily are called insulators

A complete circuit is needed for electricity to flow and devices to work

Electricity powers many common appliances

Ideas associated with *push*

Ideas associated with resistance *and push*

Ideas associated with resistance

Year 2

Possible applications and activities related to new NC

- Children should apply their understanding of current and resistance when exploring heating effects, short circuits, fuses and how to control devices, including bulbs.
- Children should be challenged to apply their knowledge of circuits to solve more complex electrical problems (only series circuits). For example, designing and making burglar alarms, model houses and traffic lights.
- Children should start to use circuit diagrams in communicating their ideas and experiments.

- Children should explore the effects of changing the number of devices and batteries to a circuit.
- The conductivity of different materials could be explored, for example, through making switches, electrical games and emergency circuits from scrap materials.

- Children should construct and compare simple series circuits containing different components, such as bulbs, buzzers, motors, switches and different combinations of switches.
- At this stage it is better to represent circuits pictorially rather than using conventional circuit symbols.

Electricity (teachers notes)

What is electricity?

An electric current (which is what people casually refer to as *electricity*) is simply the movement of charged particles. If a material contains charged particles that can move it will conduct electricity. In a metal some of the electrons (which have negative charges) around each atom are free to move freely through the material and so metals are conductors. Something needs to *make* the electrons move or there will be no electric current. This is what a battery (called a cell) does; it pushes the electrons round the circuit. The bigger the cell voltage the more it pushes the electrons (giving them more energy), the more the electrons are pushed the greater the current. So increasing the voltage of a cell means the current also increases.

A cell's voltage measures the energy it gives to the electrons, the greater the cell voltage the more energy given to the electrons and the greater the rate and amount of electron flow and therefore the greater the current.

Devices like lamps and motors are also given voltage ratings. Whereas cells give energy to the electrons (strictly speaking they transfer electrons from the chemicals in the cell to the electrons) devices take energy from the electrons to do work. The more energy the device needs to work the greater its voltage. This is why a 3V lamp will not work unless there is a 3V cell.

The cell voltage (the push) alone does not determine the current. Things in the circuit slow the flow of electrons; all devices and even the wires themselves impede the movement of electrons. This is called *resistance*; different devices and wires cause different amounts of resistance. The greater the resistance in the circuit, the lower the current. The current in a circuit depends upon the cell voltage and the resistance in the circuit.

The heating effect of current

As electrons flow through a wire (the electric current) they lose some of their energy as heat; the greater the current the greater the amount of energy lost and the hotter the wire becomes. This effect is used in electric heaters and conventional light bulbs where the wire gets so hot it glows. The heating effect can also be a problem because it can cause electrical devices to overheat and valuable energy is wasted as heat.

Circuit diagrams and symbols

Circuit components can be represented by circuit symbols. When children first explore electrical circuits it is important they draw realistic pictures of how the circuit is arranged, because they need to see how their drawings are related to the actual circuit. Begin to use circuit symbols in upper KS2 as a form of shorthand. It is not the using of the symbols that is important but that children are able to communicate their ideas about circuits; if symbols help them do this then they should be taught them. Symbols are not key ideas because they are not used to explain things, but they are international conventions and so it helps to learn them.

Electricity: Year 3 and 4

Key ideas	Ideas for lessons
Electricity powers many common appliances.	• Explore a range of moving toys, including some battery powered toys. Which toys use electricity? How many batteries do they need? Does it matter which way round the battery is put in?
A source of electricity (mains or battery) is needed for electrical devices to work.	• Investigate a range of different batteries, including those made from lemons, potatoes. Which will light a bulb? Which will turn a motor? (This could be linked to a *shipwrecked* scenario: we have got the radio, but no battery.)
Electricity sources push electricity round a circuit.	• Give each child a bulb. Set the challenge: *"I am going to allow you to collect one piece of apparatus at a time, let's see who can light their bulb with the smallest number of components."* • What happens to the bulb in a circuit if we use a really old battery? (Or allow the battery to fade over a period of days.)
A complete circuit is needed for electricity to flow and devices to work.	• Look at a range of circuits that do not work: how can we make them work? • Build a *burglar alarm* (using a pressure pad and buzzer). • Make a buzzer maze game. • Make steady hand testers. • Create a multiple choice quiz game that lights up when you get the right answer. • Make circuits with aluminium kitchen foil. • Mrs Grinling has sent across everything that Mr Grinling needs to make his lighthouse light up, but those pesky seagulls thought one of the wires was a tasty worm and have swiped it. Now he has a gap this long in his circuit (show with string). All he has is a drawer full of odds and ends (like everyone has), but none are long enough and some might not work anyway. What can you suggest? • The deeply misunderstood troll is having terrible trouble with the Billy Goats Gruff damaging his nice bridge. Can you make a switch device so that he will know when the goats are on the bridge as he cannot see round corners (maybe also a *mirrors* investigation!).
Some materials allow electricity to flow easily and these are called conductors. Materials that do not allow electricity to flow easily are called insulators.	• Test different materials using a simple circuit. • Shipwrecked scenario: we found some batteries and the radio, but how can we connect them? • Crazy circuits: make some electric circuits using unusual conductors. • Electricity can be dangerous: what could we use to insulate these uncovered wires?
More batteries will push the electricity round the circuit faster	• How can I make my homemade torch brighter so that I can read under the bedclothes? • If I want more light do I need another battery or another bulb or both? • I need a better torch than this for my visit to a haunted house!
Devices work harder when more electricity goes through them.	• How can we adapt a simple circuit to make more bulbs light up? • How can I wire up the most lights for our Christmas tree? • Will more batteries make my buzzer louder and if so how much?

Key idea: light

Year 6

Animals see objects when light is reflected off that object and enters their eyes

Animals see light sources when light travels from the source into their eyes

Light reflects off all objects (unless they are black). Non-shiny surfaces scatter the light so we do not see a single beam

Light travels in straight lines

Year 4

Shiny materials reflect light beams better than non-shiny materials

Beams of light bounce off some materials (reflection)

We need light to see things, even shiny things

Transparent materials let light through them and opaque materials do not let light through

There must be light for us to see. Without light it is dark

Light comes from a source

How we see

What happens when light hits objects?

How light travels

Year 2

Possible applications and activities related to new NC

- That light travels in straight lines underpins many phenomena that need to be explored. It might help pupils to communicate their ideas by drawing light as arrows showing direction. For example, how mirrors are arranged to help us see round corners, driving mirrors that give different views and periscopes. How curved mirrors distort, shrink and magnify images.
- Pupils could hypothesise why shadows change size when the relative positions of the light source, object and screen change. Pupils could explore what happens to shadows when there is more than one light source and then try to explain their observations.
- Children should find patterns that determine the size of shadows and use these to construct simple shadow clocks and sundials. They might explore why some people think that structures such as Stonehenge might have been used as astronomical clocks.
- Pupils could explore how the pupil changes size in different light conditions.

- Pupils should investigate problems that allow them to see light reflecting off different materials. They could investigate which reflective materials reflect light the best. They do not need to know yet that non-shiny materials reflect light, so it is sensible to look at how light beams behave.
- There are relatively few ideas in Years 3 and 4 related to light; it might be sensible to teach these ideas through materials by investigating reflectiveness.
- Pupils should investigate problems that help them to understand the differences between transparent, translucent (knowledge of vocabulary not essential) and opaque objects, and possibly compare the degree to which materials have these properties, eg best curtains for blocking light, brightest candles or torches, are expensive sunglasses better at blocking light than cheaper ones?
- They need to explore what happens when light is removed or blocked to form shadows. They could investigate what happens to shadows when the material becomes better at blocking light (eg shadow puppets), they could investigate the best natural conditions for good shadows to form.
- Pupils need to experience complete darkness to make them realise that without light we cannot see anything. Exploring questions like *"How can we find a lost shiny penny?"* are helpful because they bring out the misconception that shiny reflective objects shine in the dark.
- **Pupils should be warned never to look directly at the sun, even through sunglasses.**

Light (teachers notes)

Light does travel

This is not so obvious for young children because when we switch the light on it is instantly light; we do not see the light leave the bulb and travel towards us. It does travel, it just moves so fast we cannot perceive its movement. Blocking light using opaque objects is one way to help children understand that light moves outwards from a source.

Imagine a darkened room that is dusty enough to see a beam of light. At the ends of the room are tables and under one a powerful torch is switched on producing a narrow beam of light across the room.

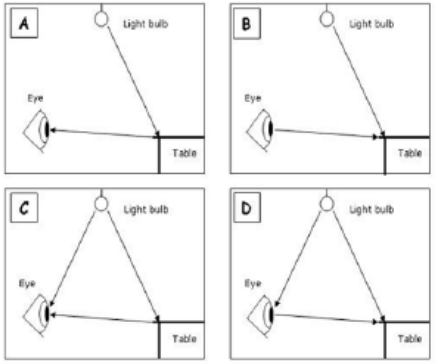
If looked at from above it will be impossible to tell which table the torch is under (if a normal torch is used the light will spread out but if a laser is used the beam will look exactly the same at both ends).

Placing an opaque object in the beam will block the light's travel, showing that light must have travelled from the torch to the object.

Representing light using arrows

Light can be represented as an arrow because it travels in straight lines from a source. If this form of representation is to help children it is important they use it accurately. The arrow must depict exactly where the light begins, ends and how it behaves in-between (ie if it reflects off an object the arrow must touch the object). Such representations are likely to generate further questions. Light arrow diagrams help children communicate what they think happens to light as it is reflected and absorbed, they help children explain how shadows form and predict how the size of shadows change as the light source, *screen* and object move in relation to each other.

Light arrow diagrams, like those below, allow us to explore children's misconceptions about how we see. It is always important that children discuss and articulate what they think is happening to light as well as drawing diagrams.



Lesson ideas

Light: Years 5 and 6

Key ideas	Ideas for lessons
• Animals see objects when light is reflected off that object and enters their eyes. • Animals see light sources when light travels from the source into their eyes.	• How do we see the moon if it does not produce any light? Does the type of rock the moon is made of make a difference to how easy it is to see? • Research how the eyes of nocturnal and non-nocturnal animals differ. • Explore the effect of changing light conditions on pupil dilation. • Research eye defects that might affect how much light can enter the eye. • Compare the similarities and differences between a camera and children's eyes (keep it simple!). They then take a picture in a dark room (with flash) and explain how the camera can see in a dark room but we cannot. • If you were to use a torch rather than a flash to take a photograph in the dark, where should you point the torch and why? • How come people sometimes have red eyes in photographs but we cannot see that? • How have nocturnal animals adapted to allow them to survive in the dark (probably need to use the internet).
Light reflects off all objects (unless they are black). Non-shiny surfaces scatter the light so we do not see a single beam.	• Compare reflections from polished and tarnished metals, smooth and scrunched aluminium foil. Describe and explain the differences. Extension: does white paper reflect light? If so, how come we cannot see reflections in it? • What would be the best stones for Hansel and Gretel to leave as a trail to find their way back at night? (Of course they had discovered battery-powered torches before the discovery of electricity!)
Light travels in straight lines.	• Explore how and hypothesise why different curved mirrors give different images. • Make shadow puppets. How could we make it appear as though the puppet was moving towards us (getting bigger)? • Could we make a shadow puppet play with different characters using only one puppet? • What would happen during a solar eclipse if the moon were bigger or smaller? • How does a shadow change over the course of the day? If the sun were brighter/bigger predict how the shadow would change? How could you find out?

Key ideas	Ideas for lessons
	• Lie on the playground in the morning and draw round the body. Predict how it will change over the day. Redraw at different times and discuss the differences. (Is it just length that changes?) • How many ways can you make light change? Describe how it has changed and always ask, *"Has it travelled in a straight line?"* Offer mirrors, slits, prisms and glass blocks, coloured filters. (The point is that light may change direction but then travels in a straight line.) • Test the idea that light reflects off a mirror at the same angle it hits it. • When looking at a torch in a mirror is it possible to predict where the torch was? • Construct a mirror maze on paper first (draw the maze with predicted light rays drawn and mirrors shown, children then construct the maze to see how accurate they were). • Plan and construct a periscope. • When I have a torch in a dark room, why can I not see all of the room? • Is it possible to tell how large an object is from the size of its shadow? • If you had two torches shining on two objects so their shadows overlapped, would the overlapping shadow be darker than the single one? • Light beams through chalk dust or through a tank of milk show the direction of the beam. (We are not seeing the beam but the light reflecting off the fat particles in milk or dust particles.) • Look at candles through tubes; carefully bend the tube until you cannot see the light.

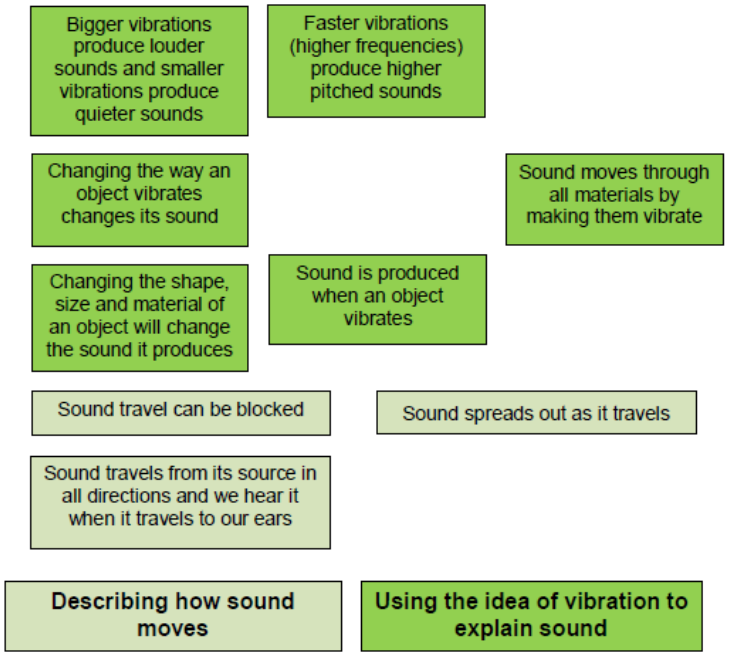
Light: Years 3 and 4

Key ideas	Ideas for lessons
• Shiny materials reflect light beams better than non-shiny materials. • Beams of light bounce off some materials (reflection). • Transparent materials let light through them and opaque materials do not let light through.	• Explore the best material to make a safety jacket for walking to school (many similar scenarios). • What would be the best material to make a shield from if you want to blind your enemy? You could relate to materials and smooth surfaces being better reflectors. • *Can't you sleep, little bear?* Which material would make the best curtains to reduce the light? • Which material would make the best shadow puppets? • Which sunglasses block out most light? • Could you make sunglasses by putting holes in black paper that cover normal glasses? • If we put lots of pieces of translucent material together will it become opaque, transparent or not change? How could you find out? • Which natural objects produce the best shadows and why? • Investigate the effects of using different materials on the quality of a shadow. • Can you tell if you are in a light or dark room when you are blindfolded? If so, how? • Apply knowledge of opacity when investigating the effect of light on grass growth. • Which candle is the brightest/do bigger candles give off more light? What do you think and why? How could you find out?
• We need light to see things, even shiny things. • There must be light for us to see. Without light it is dark.	• Find different objects (shiny, non-shiny, dark and pale) in dark places. Will children need a torch or not? • Sitting in a dark tent/room; what can you see and what happens as we get used to the dark? How long would it take to get used to the light if it were pitch black? Try and test it. • Does being in a dark place improve your other senses? • Roll up a piece of black sugar paper, place it over some writing and ask if the children can read it. Make a small hole near the top and repeat. Make holes closer to the bottom and repeat. • A ball has been lost under a bed; you need a bright torch to look for it. Which torch is brightest? (test) and then use to find the ball. • Dark room: which characters from *Bright Stanley* can be seen with and without torches? • Do shiny materials shine in the dark? • Which materials and colours are the shiniest?

Key ideas	Ideas for lessons
	• Can we detect colours more or less easily when it is darker? • Cats can see in the dark because their eyes shine. True or false? (Love to see the experiment!) • Pupils make their own blackout box: discuss and improve, and explain why it works. • Show pupils a photograph of what is in a dark room/tent and ask them to identify what they think they will be able to see and why. Take them inside and compare. • How much light do we need to be able to begin to see things? (Test using blackout boxes and put an increasing number of pin pricks in it.) • Paint some objects with phosphorescent paint and put them in a dark room. Remove an object and shine a light on it, then replace in the dark room. Is the object a light source?
Light comes from a source.	• A school hunt for light sources. Divide into natural and artificial. • Use data loggers to measure the amount of light in different places (this may be better linked to questions where the level of light might affect something else, eg the temperature, the number of plants, how long puddles last, etc). • Use data loggers to measure the amount of light over the course of 24 hours. Construct a bar chart and discuss the pattern. How do children think the chart would be different in different places or at different times of year? • Set a firework off at the end of the school field so the children can see the flash before the bang. This is to make the point that light travels but does so really fast. • If a room was lit from one side by a torch, how would you know which side it was coming from?

Key idea: sound

Year 6



Year 4

Year 2

Possible applications and activities related to new NC

Everything children investigate should be related back to how materials vibrate. Children should:

- 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. This might include blowing across the top of bottles, changing the length and thickness of elastic bands and their own instruments
- explore how the pitch and volume of simple instruments and objects changes and relate this to vibrations
- explore the ways in which sound is transmitted as vibrations, eg using string telephones
- explore how sound can be blocked by using materials that absorb, eg ear muffs and soundproofing walls
- have opportunities to use sound meters or data loggers to collect data to test their ideas.

Children should explore various ways of making sounds and investigate questions to do with how sound is made, eg using a range of musical instruments to explore how to make louder and softer and higher and lower sounds.

Children should investigate how the loudness of a sound varies with distance from the source, or if there are barriers between them and the source, for example, carrying out tests to find the best places to locate fire bells in school.

Children can test out a range of ideas, such as: Are two ears better than one? Do bigger ears help you hear better? How do we know that other animals can hear what about slugs?

Sound (teachers notes)

How are sounds produced and heard?

When an object vibrates it pushes the surrounding air causing it to compress; as the vibrating object moves back and forth it creates pulses of compressed air that radiate in all directions. It is important to understand that it is not air that is being sent through space but the little compressions. As the vibrating object pushes forward against the air it moves it, that bit of air bashes into the next one and so on through the air. This can be seen in the YouTube clip:

www.youtube.com/watch?v=aPswnDcteS4.

Imagine a long slinky spring stretched between two people; when one person pushes the spring forward, rapidly compressing it, the compression moves along the spring. This is how sound travels, by compressions within the material it is moving through. If the object making the sound is vibrating in and out, then it sends out a regular series of compressions interspersed with *spaced out bits* called rarefactions. The number of pulses or air compressions sent out per second is called the frequency. The frequency of the vibrating object is what determines the sound's pitch; the higher the frequency the higher the pitch.

When the compressions hit another surface they will push against it with the same frequency with which the original object was vibrating and it too will vibrate with that frequency. If that object is an eardrum then it will vibrate with the same frequency and the sound heard will be of the same frequency as the original sound, ie we hear the same pitch of sound as that made.

www.youtube.com/watch?v=27a26e2CnuM

An object that vibrates with greater force squashes the air more so that each compression is more pronounced. When these compressions hit the eardrum they make it move in and out a greater distance, we say the amplitude of the sound is greater causing it to be louder.

As the compressions move out in space they spread out and become less pronounced. They will still have the same frequency but the compressions will become less pronounced, ie of lower amplitude. So the volume of a sound becomes lower the further from the source, it is just that the total sound volume is spread over a wider area.

Exploring vibrations

It is not straightforward to investigate the relationship between how an object vibrates and the sound it makes, because humans can only hear sound made by objects vibrating faster than 20 Hz (20 times per second). Objects vibrating this fast are difficult to see and impossible to count. However, it is possible to see a ruler vibrate faster, as it is made shorter, and produce a higher pitched sound. Once pupils appreciate the relationship between pitch and frequency, they can use the idea to explain why tighter strings make higher pitched notes yet plucking the same string does not change the pitch. The relationship between amplitude and volume can be explored using drums and stringed instruments and rulers. Putting a speaker next to a candle and turning up the volume also demonstrates that the air must be being pushed with a greater force.

Lesson ideas

Sound: Years 5 and 6

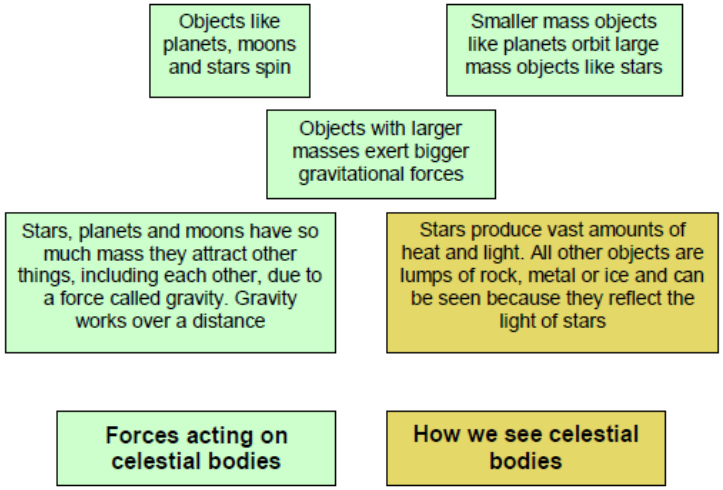
Key ideas	Ideas for lessons
• Bigger vibrations produce louder sounds and smaller vibrations produce quieter sounds. • Faster vibrations (higher frequencies) produce higher pitched sounds. • Changing the way an object vibrates changes its sound.	• Twang a ruler on the edge of a desk and look for the relationship between how it vibrates and the pitch. • Make a guitar with elastic and a box so that it makes four different notes. Children have to explain what they did to change the vibration and how it changed the vibration. • Place a wind-up music box on different surfaces and try and explain why the sound is a different volume. • Make a paper oboe from a long art straw and make holes along its length. Pupils try to explain and experiment to find out what must be vibrating differently to make the different pitched sounds. • Experiment with different straws to make a variety of different sounds, all the time thinking about how the vibration is changing. • How does a drum vibrate differently when hit harder? How can we make drums of different pitches? • Make different thunder tubes to produce different sounds and identify what is vibrating differently and how. • What is vibrating when a sound is made by blowing over the top of a bottle containing water? How could you find out? • What can we change about a string to change the sound and how does this affect the vibration? (Length, thickness, tightness, how hard plucked.) • Compare bowing and plucking strings and describe how the sound has changed and relate this to vibrations.
Sound moves through all materials by making them vibrate.	• Make a soundproof box for a buzzer or alarm clock, but apply the children's ideas of vibrations to predict the best material. • Place objects that vibrate in water to see how the object makes the water vibrate (tuning forks work well). • Make a string telephone (given a range of wires and strings and cups) to make the clearest and loudest signal. • Use an old speaker to show how the speaker makes the air in front of it vibrate by placing a candle in front of the speaker. • Hum on one side of a balloon and let someone place their lips on the other side of the balloon to feel the vibrations. • Use the story of Helen Keller and how she learned to speak.

Key ideas	Ideas for lessons
Sound is produced when an object vibrates.	• Given many different instruments, identify what is vibrating to make the sound. • Go on a *sound* walk to identify sounds and then think about what was vibrating to make that sound. • Place rice on drums and on Clingfilm stretched over a speaker. • Given a pile of junk, make as many different sounds as possible. Describe each sound using the terms *high*, *low*, *loud* and *soft*. • Hang ping pong balls from string and touch with a tuning fork. • Get children to feel their throat when making a sound. Show videos of vocal chords vibrating.
Changing the shape, size and material of an object will change the sound it produces.	• Given a pile of junk, make as many different sounds as possible. Describe each sound using the terms *high*, *low*, *loud* and *soft*. • Blow over a narrow pipe to make a flutey noise and then ask pupils to find out why some pipes have different pitches than others. • Do a similar thing with a bottle containing water. • How does the length of a Boomwacke' change the sound? • Investigate how children can change the sound of homemade thunder tubes.
Sound travel can be blocked.	(Later, pupils need to apply understanding of vibration but here we are just establishing that sound can be blocked.) • Do all transparent materials let sound through as well as light? • Are fish silent or is it just that the water blocks the sound they make? • What material is best to use inside ear protectors for babies? (*Peace at last* scenarios.) • Should children be banned from wearing hoodies when they cross the road?
Sound spreads out as it travels.	• Measure/compare the sound at different distances from a source until it can no longer be heard. • Use sound recorders at different distances and *spreadoutness* from sounds to show that it travels, spreads out and gets quieter as it does. (Could set up a concept cartoon where different children have different ideas about where to stand to watch a concert.) • Does sound travel and spread out through water also? • If someone is running towards you and honks a horn, will the sound be louder?

Key ideas	Ideas for lessons
Sound travels from its source in all directions and we hear it when it travels to our ears.	• Let off a firework to see the flash before the sound to get across the idea that sound has to travel. • How could we prove that we hear sound through our ears rather than our eyes or even through our skin? • How far away can different sounds be heard? • Is it just the volume of a sound that determines how far away it can be heard? (Can children's voices be heard as far away as adults?) • Can the school bell be heard in all parts of the playground? • Make the most effective sound trumpets. • Eyes closed, where is the sound coming from?

Key idea: earth and space

Year 6



Year 4

Year 2

Children need to learn about how a number of things change with the seasons, including the weather, the temperature and the number of daylight hours. They do not need to know why these things change. It would be best to teach these phenomena through exploring the local environment rather than on topics to do with *Earth and space*.

Possible applications and activities related to new NC

- Children should be introduced to the solar system and asked to make predictions, eg which planet they would expect to be the warmest, the coldest, have the most moons, have the longest year. They should then check their predictions through research. Children should relate the spin of the planets to the length of their *day* and the distance from the sun to the length of their year.
- They should consider how it is we are able to collect this information when people have not visited the planets. The size and relative emptiness of the solar system should be explored through models.
- Children should be encouraged to view the night sky and record what they see, in particular the position of the moon over the course of the night. They could note down what objects they see and consider why virtually all of these are stars (because they produce their own light).
- They could consider why it is so difficult to detect meteorites and comets that may be on a collision course with earth.
- Children should be introduced to the moons of other planets, in particular Jupiter. Our changing ideas about Jupiter and its moons can be used to exemplify how science has to change its ideas as new evidence becomes available. This can be linked to 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.
- There are now many software applications that can also help us find objects in the night sky.

Lesson ideas

Earth and space: Year 5 and 6

In KS1, children need to learn about how a number of things change with the seasons, including the weather, the temperature and the number of daylight hours. Children do not need to know why these things change. It would be best to teach these phenomena through exploring the local environment rather than on topics to do with earth and space.

Key ideas	Ideas for lessons
Stars, planets and moons have so much mass they attract other things, including each other, due to a force called gravity. Gravity works over a distance.	• Do heavy objects fall faster than light objects? • Create a scale model of the solar system (perhaps one for the sizes of objects; and one for distances).
Stars produce vast amounts of heat and light. All other objects are lumps of rock, metal or ice and can be seen because they reflect the light of stars.	• Explore some of the stars in our night sky and log how their positions change over a period of half a term (homework). Google Sky Map and similar apps can be useful for this. • Look at a diagram of the solar system. Which planet do you think will be the coldest? The hottest? Why? Check to see if your ideas match what we actually measure. • Are all stars the same size as our sun? • If the moons of Jupiter are all about the same distance from Earth, why are some bright and some not so bright? • Why are Mercury and Venus often only seen in the early evening or just before sunrise?
Objects with larger masses exert bigger gravitational forces.	• Examine data on the mass of planets and the number of moons they have orbiting them. Does a pattern emerge? • We know that we need a big rocket to launch things into space from Earth, but what size rocket would we need to launch from the moon or the other planets in the solar system?
Objects like planets, moons and stars spin.	• How many times does the Earth spin in the time it takes for the moon to orbit us once? • Wonderwall activity: how could we find out whether planets and stars spin? Look at video clips such as: – www.youtube.com/watch?v=OZEUE0Ys3z8 – www.youtube.com/watch?v=03iT7zZBiZw – www.spacetelescope.org/videos/astro_n/.
Smaller mass objects like planets orbit large mass objects like stars.	• Using the horizon as seen from your home, record how the moon moves across the sky over the course of an hour (homework). • What things on Earth might change if the moon disappeared? • Record the changing phases of the moon over a month (homework). (These activities need to be tried by the teacher and are weather dependent!)

Also check out:

- www.schoolsobservatory.org.uk/
- www.winchestersciencecentre.org/page/?pid=38
- www.astro.soton.ac.uk/~s.jones/.