The three types of 'learning journey'

The building block topic:	Ideas build upon each other sequentially making and increasingly sophisticated model
The big model topic:	An important model is shared at the beginning but detail and complexity is added through the topic.
The multiple context topic:	An important over arching concept or idea is taught at the beginning and then applied in a number of different contexts through the topic.

Years 3 and 4

Light

Multiple context	**Chapter 1: Light and sight** 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: What light does when it hits materials** 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 wont be able to see through it.
Problem solving ideas	• The shiny coin problem. A coin is lost what would be the best way to find it, turn out the lights and see it shine or use a torch to see it reflect? • How does the distance from a light source affect how bright it looks? • How does being in darkness affect your sense of hearing? Is this how nocturnal animals survive?	• Give children lots of objects and a torch and they decide if they are transparent, opaque, translucent or reflective (Do they notice that many materials exhibit more than one property or partial properties. Encourage them to think about how they might display this information). • What colour would be best to make a safety jacket from? How does the colour of a material affect how reflective it is? • What would be the best material to make a blind for a baby's room? How does the thickness or colour of a material affect how much light can pass through it. • How many pieces of tracing paper are as translucent as a single piece of white paper? • How does the size of a candle affect its brightness? • How does the shape of a mirror affect how the light reflects? • How does polishing a piece of dirty metal affect how light behaves when it hits it?

Animals: Skeletons and movement

Building block	**Chapter 1: Skeletons protect vital organs** • All vertebrates have internal skeletons that protect vital organs. • Invertebrates have exoskeletons that protect vital organs	**Chapter 2: Skeletons support weight** Skeletons support the weight of land animals. Stronger bones can support more weight	**Chapter 3: Skeletons support movement** 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
Problem solving ideas	• Compare X-rays and skeletons of animals looking for similarities and differences and predicting where vital organs are.	• Look at X rays to identify broken and healed bones. • How does the length of a bone affect its bending strength and compressional strength? (You could use paper tubes) • How does the diameter of a bone affect its bending strength and compressional strength? (You could use paper tubes) • Consider why might some bones need to be stronger than others and then get them to predict relative size of bones from some animals based on how they move.	• 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. Show a real or model skeleton and ask them to identify similarities and differences. • Children draw round their own hands, they feel their hands and look at how it can move and draw in where they think there are bones and put circles wherever they think there are joints, they then compare their ideas with a picture of a real hand. • Give children some bones from a chicken skeleton that is not assembled. They try and identify what each bone does and justify their choices, they again compare with a complete chicken skeleton. • Make a model arm from pieces of wood, string, sellotape (provide other materials including elastic, does the opposite of a muscle because it contracts when relaxed.). • Look at X rays to identify broken and healed bones. Investigate if the length of a bone affects its strength using card tubes. Or could compare thicker real chicken bones. Consider why might some bones need to be stronger than others and then get them to predict relative size of bones from some animals based on how they move. • Compare X rays of animals and predict how they moved. • Show some video footage of an animal moving and children predict what the skeleton of that animal may be like. • Look at a cleaned chicken leg to see how it moves and then let children remove the skin from another one to see how muscles are attached.

Solids, liquids and gases

Building block	Chapter 1: Properties of solids, liquids and gases.	Chapter 2: Changing state.	Chapter 3: Melting, freezing, boiling and condensation temperatures.	Chapter 4 What happens at the melting temperature?
	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. The more viscous a liquid the less runny it is. • **Gases** move everywhere and are not held in containers by gravity.	• 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.	Different substance change state at different temperatures but the temperatures at which given substances change state are always the same.	• 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. • Liquids evaporate slowly, even below their boiling temperatures.
Problem solving ideas	• Give children a variety of materials (including powders, gels, foams and things like blu tac) ask them to classify them as solids, liquids or gases. • How does the amount of water added to flour affect its state? • We need to make the best water slide possible. How does the amount of detergent added to water affect how slippy it is? • How does the temperature affect how viscous a liquid is (use cooking oil)? • Put a series of liquids into order of viscosity (choose ones that are similar so they have to perform an accurate test). • Spray perfume or water (children don't know which) at one end of the room and they raise their hands when they can smell it. They then draw diagrams of their choice to show what happened to the smell (gas) and explain the pattern of its movement. • Dancing raisins. Place a handful of raisins in a small bottle of lemonade. Children explore why they behave the way they do. • Place a peach in a glass of lemonade and watch it spin. Why does it behave that way and can you prove it?	• Demonstrate the water cycle by melting ice, heating water to let it evaporate, showing the steam condense on a cold surface and letting it run off and drip like rain back into the original container. • Children are shown the following equipment and asked to predict what will happen and why, and then they do it.  • The council put salt on ice and snow to melt it. How does the material sprinkled on ice and snow affect how quickly it melts?	• What is the freezing temperature of water? (Mixing ice and salt produces mixtures that can be as cold as -15°C and make good baths for freezing water in). • Does the volume of water affect the temperature at which it freezes? • Chocolate smugglers. Children have been trying to smuggle chocolate into class by putting it in their pockets, but it always ends up as a squidgy, liquid mess. What chocolate would be best to smuggle? ***How does the type of chocolate affect its melting temperature?*** • Give children a range of substances and ask them to put them in order of what they think their melting temperatures may be. Include metals, rocks, and oils. Can they estimate the melting temperatures?	• What is the melting temperature of ice and how does it compare with the freezing temperature of water? • Is the melting temperature of wax the same as its freezing temperature? Investigate. • What do we think will happen to an ice cube if it is left out for a few days? What do we think would happen to a lump of wax and why is there a difference?

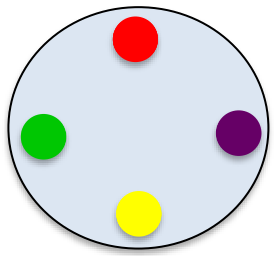
Mixtures and separating them

<table>
<tr>
<td>Building block</td>
<td>Chapter 1: What are mixtures?
When more than one substance are present in the same container it is called a mixture</td>
<td>Chapter 2: What does dissolving mean?
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. (Always be aware that if too much substance is added it may appear as if it hasn't dissolved but some may have, so add small quantities)</td>
<td>Chapter 3: Deciding how to separate mixtures.
All mixtures can be separated if they have a difference in property. This is because both (or all) of the materials are still present.
<table>
<tr><td>Separating technique</td><td>Difference in property required</td></tr>
<tr><td>Filtration and sieving</td><td>A solid that does not dissolve in a liquid.
Different sized solid bits</td></tr>
<tr><td>Magnets</td><td>Some materials magnetic others not</td></tr>
<tr><td>Evaporation</td><td>A solid dissolved in water and the solid has a high boiling temperature</td></tr>
<tr><td>Floating</td><td>Some materials float and other sink</td></tr>
</table>
</td>
</tr>
<tr>
<td>Problem solving ideas</td>
<td>

Give a range of mixtures and ask children to say what they think is in each. If they can't tell allow them to say that. (Sensible mixtures: flour and currants, sand and stones, sand and salt, hole punch paper bits and sand, water and salt, water and oil)

</td>
<td>

Which of the following dissolve in water: sugar, bicarbonate of soda, oil, chocolate, coffees, dark vinegar and wax?
How does the amount of water used affect how much sugar will dissolve in it?
Which sweets dissolve in water?
Place skittles in a shallow flat saucer (agar plates work well) so that water comes half way up them. Children predict what will happen. Set and leave without touching (one of the real wonders of the universe!)


</td>
<td>

Each of these techniques will need to be taught and then give children the freedom to decide which method would be appropriate to separate other mixtures:

Plastic covered steel wire from strands of string and plastic.
Separate out the bits of wood from stones and sand in soil.
Get pure salt and sand from a salty sandy mixture.

Give children some card and a sharp pencil; challenge them to make their own sieve to separate sharp sand from fine sand.
When water evaporates slowly from a solution, large crystals can form. Who can make the largest crystal (sugar works well).

</td>
</tr>
</table>

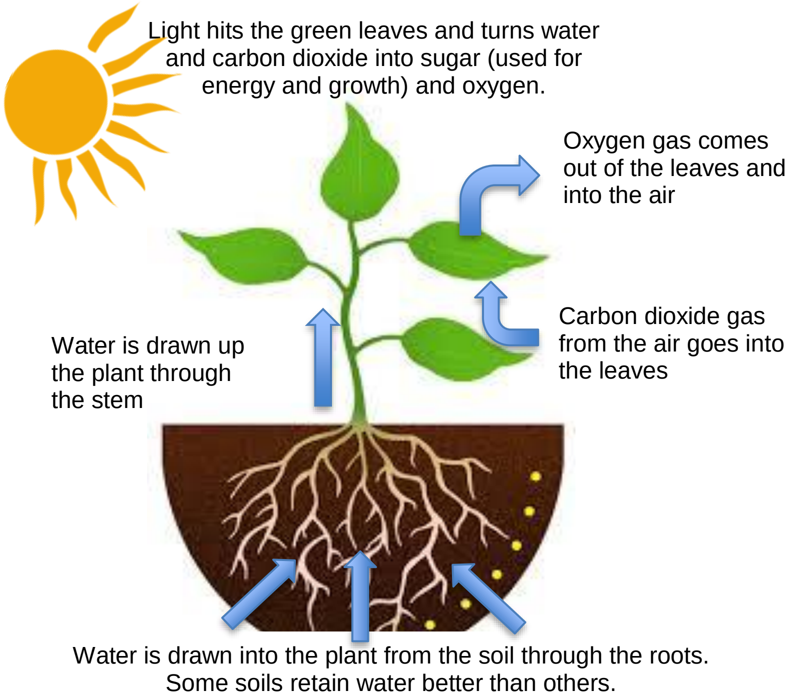
Feeding relationships and the environment

Longitudinal study	**Idea 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 the others. **Idea 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.	**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). Questions should require children to consider how environmental change (the seasons, human activity, climate change) affects different organisms within their environment differently and therefore different habitats differently because all organisms in a habitat are interdependent.
Problem solving ideas	Ideas for longitudinal studies: ➢ Research a food chain for a minibeast in the local environment that is easy to find (e.g. woodlice and snails). Each group of children is allocated a small habitat, they monitor the plants and animals that live there over the course of the year and relate any population changes to the seasons and the change in populations of other organisms in the food chain. ➢ Identify as many plants and mini beasts in the pond. Research how these might be related in a food chain. Investigate how the populations change over the course of a year and use the food chains to help them explain these changes. ➢ Cover a patch of grass with two planks of wood, and a mark a similar area and leave uncovered (before doing this identify the mini beasts and plants that are in the covered patch). Monitor the changes in populations over time and after a period of time remove one of the planks and monitor how it responds and compare it with the covered and uncovered area. ➢ Set up a series of water butts, put different things in each (all the kinds of things you might see in a pond). Monitor what happens in each butt over a year (even better if you carry it on for a few). What are the most important things to add to a pond to help it develop? Notes about monitoring the seasons: Children need to learn how the temperature, light and water affect food chains in the local environment. They need to learn how these weather factors change through the seasons. One powerful way of helping children do this is to monitor the weekly temperature, rainfall and daily hours of sunlight and construct a large wall chart of this data. This will help them see the patterns and relate them to changes in populations. The Longitudinal study will be what is assessed.	

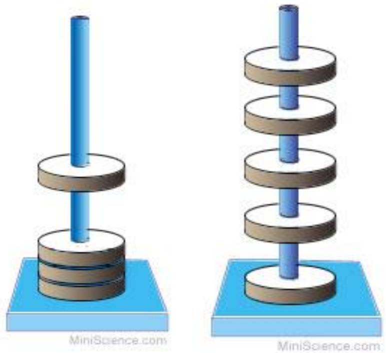
How plants reproduce

Building block	**Chapter 1: Reproductive parts of a flowering plant** 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 flowers are similar but different** 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. Most plants use insects to pollinate and so have colourful petals and strong scents, a few plants use the wind, these often have less colourful petals and little scent.	**Chapter 3: Seed dispersal** 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: What does a seed do?** 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)
Problem solving ideas	Teach children how pollination and fertilisation occur, let them dissect a flower (lilies and daffodils are good) and identify the parts of the flower. Use a microscope to observe the pollen. Children then chose a flower from the school and try and identify the reproductive organs.	Bring in as many different flowers as possible, including grasses and trees. Children try and work out of they are wind or insect pollinated. They could check their predictions using the internet.	• Leave a tub of compost outside and let weeds develop. Where did they come from? Were the seeds already in the compost or have they come from elsewhere? Plan and carry out an investigation to find out. • Collect as many different 'helicopter' seeds as possible and ask which ones would be able to go further (will need to explain that the longer it takes to fall the further the wind could blow them). Draw out questions like 'how does the wing length affect how long it takes to fall. This could be investigated with real seeds or modelling it with paper helicopters. • How does the space between seeds affect how well they grow?	• Plants grow best when they are damp, warm and in light. Is this true for seed germination? • What can you predict about a plant and how it grows from the size of its seed? Plan and carry out investigations to test your ides.

How plants make their food.

Big model	**Chapter 1: Plants don't eat.** Plants don't eat and so have to make their own food to provide them with energy and material to grow.	**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. 
Problem solving ideas		• Provide children with small pots of already growing grass and cress. Cut back each plant to about 1/2 inch, predict and monitor how they both respond. • How does the amount of light affect how well a plant grows? • Do plants take in water through their roots alone, their leaves or both leaves and roots? How could you find out? • Does the carbon dioxide enter at the top of the leaf or the underside of the leaf? How could you find out? • How are soils that retain water well different from those that don't? Do all plants prefer the same type of soil? • How is the growth of a plant affected by removing different amounts of leaves? • If we stop gases from getting in an out of leaves what will happen? How can we find out? • If you set up a sealed glass dome containing damp soil, normal air and some small flowering plants, what would you predict to happen over a long period of time?

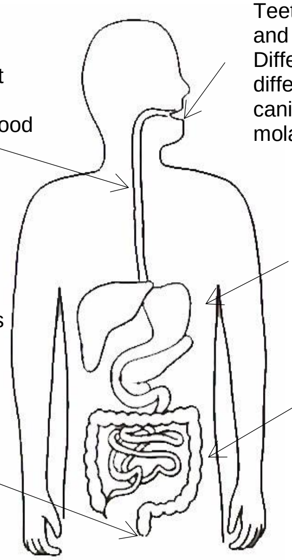
Magnets and their effects

Building block	**Chapter 1: What magnets do.** Magnets exert attractive forces on some metals	**Chapter 2: Magnets don't need to touch.** 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 3: Magnets attract and repel.** 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 4: What affects magnetic strength?** 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.
Problem solving ideas	• Magnetic material hunt, what can they say about magnetic materials? • Can I make a magnetic material non-magnetic?	• How far away does a magnet need to be before it attracts a magnetic material?	• How far away can the magnetic attraction between two magnets be experienced? Is the repulsive force the same size? • 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.  • How is the magnetic attraction or repulsion force affected by putting materials between the magnets?	• Are bigger magnets stronger? (You could make larger magnets by putting together lots of smaller neo or super magnets) • How could you use magnets to measure the number of pages in a book?

Making electrical circuits work

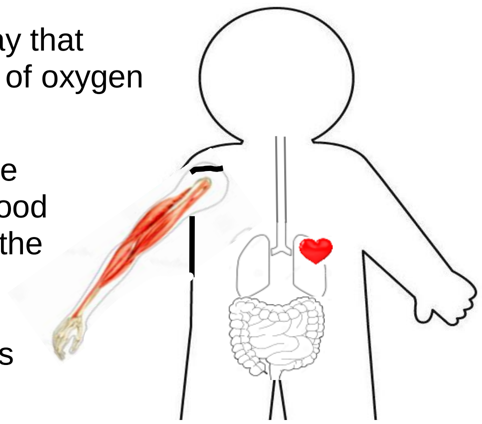
Building block	**Chapter 1: Electrical power sources.** Lots of devices are powered by electricity; these need a source of electricity, which could be mains or battery.	**Chapter 2: What batteries do.** The battery's job is to push electricity to the device, but it needs something to carry the electricity all the way from the supply to the device, this is what we call a circuit.	**Chapter 3: Making devices work harder.** If there are more batteries they push harder and so the device will work harder e.g. brighter or faster.	**Chapter 4: Insulators and conductors.** 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)
Problem solving ideas	• Identify and name devices and justify if it is mains or battery powered and if battery powered, find it. • give children a range of different battery powered devices and ask them to predict how the battery would need to be different. They remove the batteries and categorise how batteries need to be different and why.	• Give children leads, batteries and lamps and let them get it to light. • Give children some broken circuits. they have to identify what is wrong and make it work. • How does the length of time a battery is on for affect how well a device works?	• How does the number of batteries added to the circuit affect a device?	• Give them a battery and a bulb and lots of junk material and they have to make the lamp light. • Scenario where they have to make a switch from junk (maybe a light or/and buzzer goes on when burglar steps on a mat)

Digestion: how the body get's nutrients into the blood

Building block	**Chapter 1; Food groups.** Animals need a variety of foods to help them grow and 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. These are essential to keep our bodies working well and protect us from illnesses.	**Chapter 2: Variation in animals diet.** 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: How humans digest food.** 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't enter the blood and be transported. Humans achieve this as below: 
Problem solving ideas	• Provide children with a variety of different foods and they predict what nutrients they provide. Show them the food labels to check their ideas. • Children keep a food diary for a day and then check tally up how much of each food group was in their diet. How does this compare with a healthy diet?	• Compare the diets of athletes with different demands e.g. cyclists and sprinters, marathon runners and weightlifters. How are they different and why? • Give information about the poor diet of someone who is trying to be super skinny, predict the effects on the persons health and body	• Children keep a food diary for what they ate the previous day. Provide a large torso outline and ask children to annotate what has happened to the food they ate the previous afternoon and evening. • After washing hands children feel their teeth, describe what they are like, then look in a mirror and draw them. They then eat a variety of foods; identifying which teeth they use and hypothesise which teeth do which job. • Show pictures or fossils of animals teeth and jaws, predict what the animal eat. • What liquids make teeth rot? (Use marble chips rather than eggshells as they fizz gently in lemon juice and acid). (This is interesting because sugar does not corrode teeth, only acids do. Sugar does result in tooth decay because bacteria in the mouth eat sugar and excrete acid; it is this acid that corrodes teeth). • Construct a food chain from animals teeth found in the local area (or ones you have bought!) • Bread is a carbohydrate and so provides our muscles with energy, but it needs to dissolve in the blood before it can be transported to the muscles. Where in the body does this happen? Does chewing make it dissolve? Does chewing with saliva make it dissolve? Does mixing with acid make it dissolve? They can test all of these things. The point is that one of these things causes bread to dissolve, this happens in the intestines. (They don't need to know how it happens just that this is where it does)

Years 5 and 6

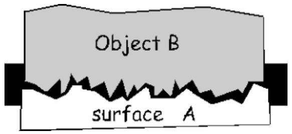
Circulation; how nutrients get to where they are needed in the body.

Learning journey	**Parts of the story**	
Big Model	**Chapter 1: Getting oxygen into the blood.** All animals need oxygen to survive. Air is breathed into the lungs where the oxygen in the air is passed into the blood. 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 blood circulation model** The blood circulates around the body in a way that ensures all muscles in the body get a supply of oxygen and sugar The heart pumps blood to every muscle in the body. The circulatory route must allow the blood to collect oxygen from the lungs, sugar from the intestines and visit muscles. The blood then returns to the heart where it is pumped again. 
Problem solving ideas	• How does the size of a person affect their lung capacity? • Candles need oxygen to burn. How is the time a candle burns for affected by the amount of times I have breathed in and out the air that it burns in?	• How does the size of the muscle we exercise affect our pulse rate? • How does sustained, gentle exercise affect our pulse rate? • Use the model to predict the body wide symptoms of: 1. A disease that reduces the lungs ability to transfer oxygen to the blood. 2. A disease that restricts the amount of blood that can flow around the body. • How might the circulatory system be different for an elephant or a humming bird? • Does your exhaled air always contain the same amount of oxygen or does exercise change this? (Use the burning candles in jars test) • How might doing exercise at the top of a mountain affect the body (less air at altitude)

Making new substances

Multiple context	**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: 1. The properties of the material are different (colour, state, texture, hardness, smell, temperature) 2. If it is not possible to get the material back easily it is likely that it is not there any more and something new has been made (irreversible change)
Problem solving ideas	The key question we want children to interrogate is “have we made a new substance?” • Wet clay → air-dried clay → fired clay. • Flour and water → dough → bread • Add sugar to fizzy water; it fizzes up. Has a new substance been made? (No, the gas was dissolved in the water and adding sugar made it become un dissolved) • Add baking powder to vinegar, it fizzes up. Has a new substance been made? (Yes the gas was not in the vinegar as it wasn’t fizzy, so it must have been made) • Add water to instant snow. • Use lemon juice as an invisible ink, heating gently makes the ink visible. Is this a new substance? • When water is added to jelly and it is set, is it a new substance.

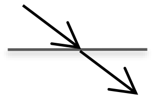
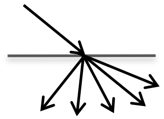
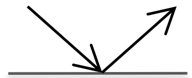
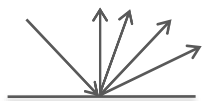
Forces that oppose motion

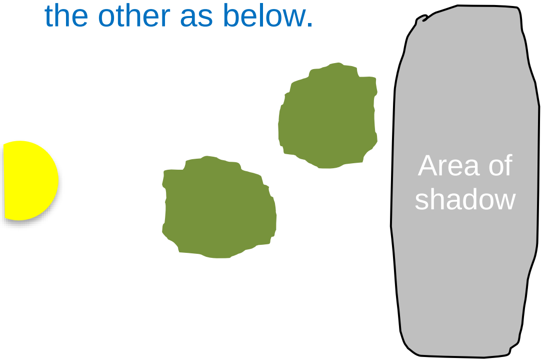
Building block	**Chapter 1: Water and air resistance.** • When objects move through air and water they have to push it out of the way. The water and air push back with forces called water resistance and air resistance. The harder it is to push the material out of the way the greater the resistance. • Gases weigh less than liquids and so water resistance is greater than air resistance	**Chapter 2: Friction.** • 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:  1. The surfaces must rise slightly 2. The bumps on the surface must bend 3. The bumps on the surface must break All of these actions requires a force, this is what causes friction	**Chapter 3: Managing forces.** Some objects require large forces to make them move; gears, pulley and levers can reduce the force needed to make things move. (These are particularly complex ideas. It might be better to teach them through a design technology project where children make toys using cogs, pulleys and levers)
Problem solving ideas	• How does the saltiness (salinity) of water affect water resistance? • How does the length of a paper helicopter's wings affect the time it takes to fall? • How does changing the shape of a piece of plasticene affect water resistance? • How does adding holes to a parachute affect the time it takes to fall?	• How does the amount / depth of tread affect the friction between a shoe and a surface (model this with a material they can change the tread on rather than a real shoe). Is the same conclusion reached if the surface is rough and smooth? • Modern racing cars have very wide tyres; is this to improve grip? How does surface area affect friction? • Putting small granules (cous cous is effective) under a block allows it to be dragged more easily. How does the amount of cous cous affect the friction? • How does the type of liquid put between two surfaces affect the friction between them? • How does the roughness of a surface affect the effectiveness of a lubricant in reducing friction?	

How light behaves and how we see.

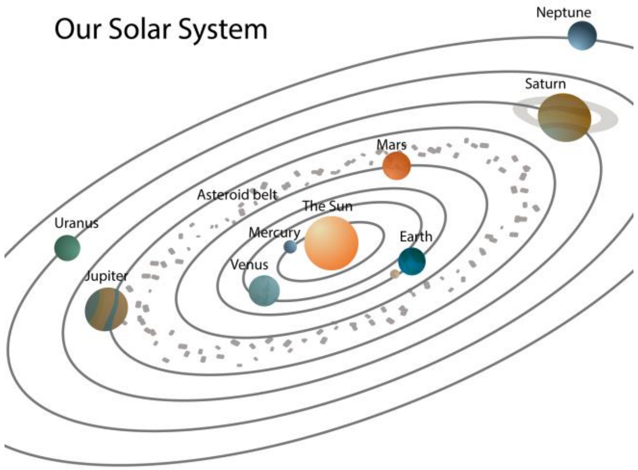
<table>
<tr>
<td>Building block</td>
<td>Chapter 1: How light travels

• 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.
• Shadows form when light hits an opaque object, the area behind is in darkness because light can only travel in straight lines</td>
<td>Chapter 2: How light behaves when it hits objects

• When light hits a transparent object it goes through it in a straight line so we can see a clear image through it. 
When light hits a translucent material it goes through it but is scattered, this means light can pass through but we can’t see an image through it. 

• When light hits a mirrored surface it reflects off it in straight lines, so we can see an image in the reflective material 
Some times when light hits a material it reflects off it in many different directions (it is scattered). In this case light will be reflected but no image will be seen in the material
Shiny surfaces are better reflectors and rough surfaces scatter light more. Opaque objects don’t allow any light to pass through them.</td>
<td>Chapter 3: How we see.
Animals see objects when light is reflected off the object and enters the eye through the pupil. The pupil changes its size to allow enough, but not too much light into the eye. Too much light damages the eye and too little results in poor quality images.</td>
</tr>
</table>

Problem solving ideas	• Drawing upon idea about light taught in years 3 or 4: a) How does the size of an object affect the size of the shadow? b) How does the distance between the light and the object affect the size of the shadow> c) How does the distance between the object and the screen affect the sixe of the shadow? • How would a solar eclipse be different if: a) The moon was a different size? b) The earth span faster or slower? c) The sun was large or smaller. d) If the earth and moon were the same size but further away in the solar system. • Two trees in a field, one in front of the other as below.  Predict if where the shadows over lap will be darker, lighter or the same as where they don't and plan an investigation to find out. (Give them card and a torch). To what extent is solid card a good model for a tree? Adapt the experiment to make it a better model; does this affect your conclusion?	• How does the amount aluminium foil is scrunched affect how much light is scattered? • How does the amount of polishing affect how well a piece of metal scatters light? • How perfect are our mirrors? Do some scatter more light than others? • What happens to light when it is shone through water? How is the affected by putting glitter in the water, or salt in the water, or talc in the water?	• How does the eye adapt to different light conditions? • Predict how nocturnal animals are adapted to living in low light conditions; check predictions through research. • Set up some mirrors so you can see a candle that is hidden behind several corners. • Give children a periscope that doesn't work very well, they work out what is wrong and try to correct it.

Space and gravity

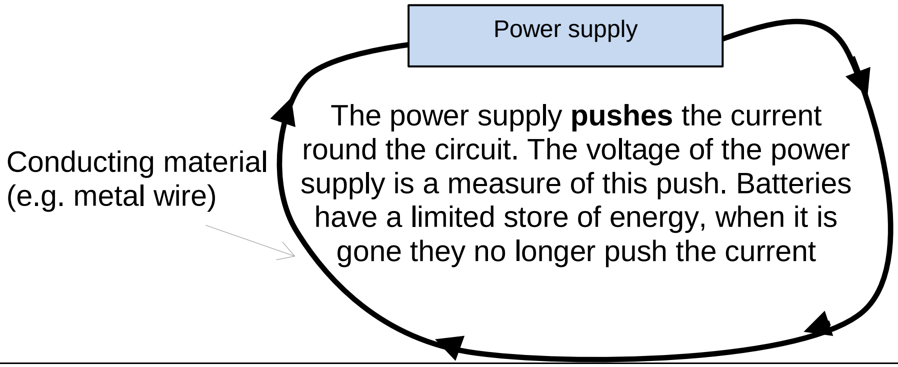
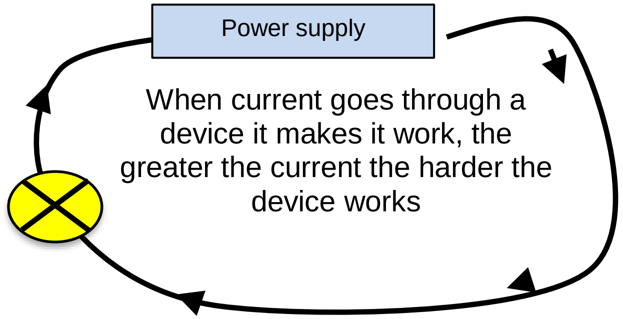
Building block	**Chapter 1: Where the Earth is in space** • The universe is vast and contains billions of stars. • The solar system is a collection of planets and moons orbiting our nearest star, the sun. It can be represented using a model.  • All objects in the solar system are spinning as well as orbiting. • The time it takes for an object to spin once is called a day • The time it takes a planet to orbit the un is called a year	**Chapter 2: Stars and other objects** • 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 and its effects** • 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)

Problem solving ideas	• Predict and explain how the temperature of each planet may vary. Use data to check and then consider which planets could possibly host life (it must contain liquid water for at least some time) • Predict how long each planetary year might be and compare with data.	• How does the distance from a light source affect how much light hits an object? Apply this to the solar system and predict how much light each planet receives. • Does having more moons result in more light hitting a planet? How could you test this idea? • Using knowledge of the solar system and the importance of water and light for life, predict the temperature and light levels on different planets and suggest which planets might be possible to support life in the future. They then look at real temperature and light data and reflect upon what they suggested.	• Investigate moon craters. How does the speed / size of a meteorite affect the size of a moon crater formed? • If the moon became heavier as a result of meteorite collisions what would happen to its position relative to the Earth? • Imagine that somewhere in the universe is a vast (bigger than the solar system) cloud of dust of varying sized bits and varying distances apart. What might happen to this cloud over many years? (This can be modelled using a handful of pom poms of varying sizes randomly dropped onto a table) • Consider a spacecraft travelling from the Earth to the moon. Predict the forces acting on the craft at various stages in its journey. (The mass of the earth is 80 x that of the moon) • If the mass of the earth is 80x that of the moon why is the gravity at the Earth’s surface only 6 x greater than that at the surface of the moon?

How sound is made, travels and can be changed

Building block	**Chapter 1: Describing sounds**	**Chapter 2: How sounds are made and travel.**	**Chapter 3: Why does pitch and volume change?**
	• 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.	• 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.	• 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.
	• Given a variety of objects (e.g. water in bottles, elastic bands, rulers, tuning forks, those wind up music box things). Children try and change the pitch of the notes and try and summarise what they have found. • If the volume of a sound decreases with distance what happens to it? If it spreads out how could you prove it? • How does the size of an ear trumpet affect the volume of sound detected?	• How does the type of material affect how well it blocks sound? • How does the thickness of a material affect how well it blocks sound? • Which materials vibrate better and produce louder sounds? Can we identify any patterns? • Which materials make the best string telephone components? Tin cans, plastic cups, paper cups; or for the cable wire, string or elastic. Predict and test.	• Blow up a balloon with a 10p coin inside it. Swirl the balloon so the coin rolls around the inside (not slides). See clip https://www.youtube.com/watch?v=aAMW_3kWUhE Challenge children to use their knowledge of pitch and volume to investigate what made the squealing noise. • Make a straw oboe. See clip https://www.youtube.com/watch?v=yCmXhDZhqKQ There are many exciting investigations this can be used for, a simple one is how does the length of the tube affect the pitch and volume? • Partially fill a glass bottle (or use test tubes) with water. Tap it to make a sound and blow across it to make a sound. What is vibrating to make the sound in each case? Plan and carry out an investigation to find out. • Can you predict the relative pitch of tuning forks from the patterns of ripples they make when struck and placed in water?

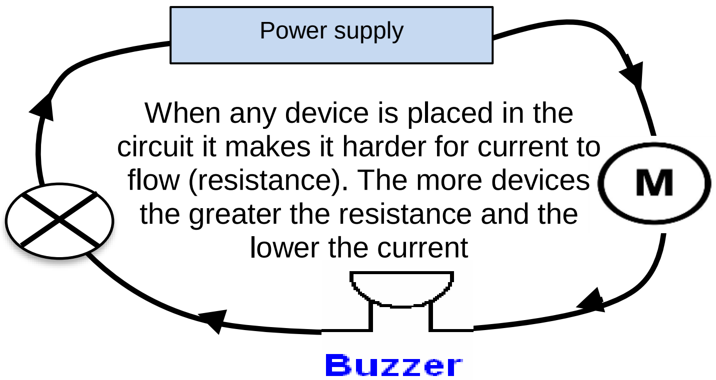
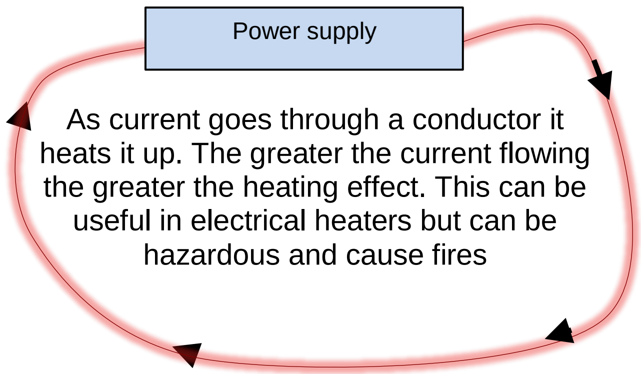
Controlling electrical circuits

<table>
<tr>
<td>Building block</td>
<td>Chapter 1: Pushing electrical current

</td>
<td>Chapter 2: Electrical current makes devices work

</td>
</tr>
<tr>
<td>Problem solving ideas</td>
<td>

Do all batteries push as hard as each other?

</td>
<td>

Design a circuit that will allow us to quickly compare how well different batteries push current.
How does the voltage of a battery affect how much current is pushed?
How does the length of time I leave the current flowing for affect the brightness of the bulb?
How does the number of batteries used affect the current that flows?

</td>
</tr>
<tr>
<td></td>
<td>Chapter 3: All devices resist current

</td>
<td>Chapter 4: Electrical current has a heating effect

</td>
</tr>
<tr>
<td>Problem solving ideas</td>
<td>

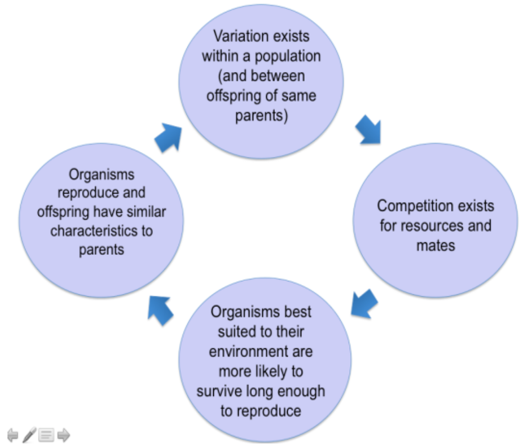
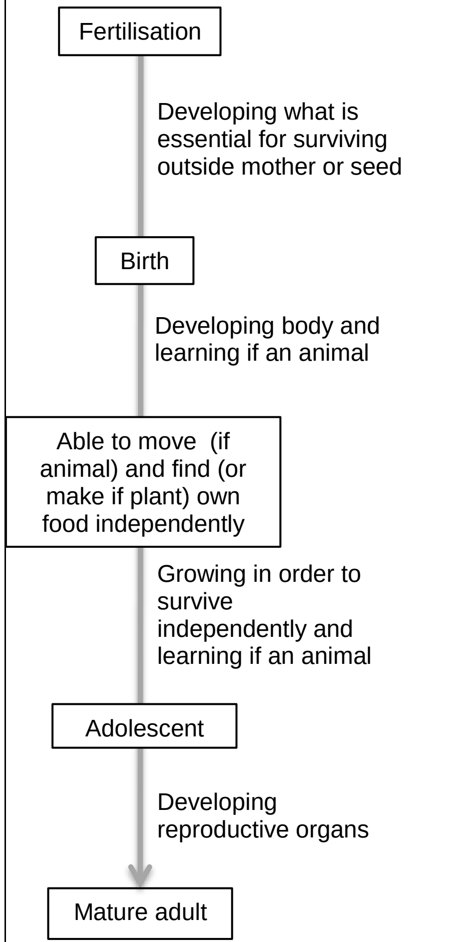
How does the length of a wire affect how bright a bulb is?
What can I do to make it easier (reduce the resistance) for current to flow from the battery to the bulb?
Are all wires equally good at conducting electricity?
How does the number of lamps in a circuit affect how long a battery lasts?

</td>
<td>

How does the length of a wire affect how hot it becomes when it conducts? (Test this carefully, you could rest the wire on chocolate as a way of testing the heating effect, you could also coil plastic covered wire and immerse it in a small amount of water and measure the temperature the water reaches.)
How does the number of batteries / devices in the circuit affect how much heat is produced in the wire?

</td>
</tr>
</table>

Evolution and natural selection

Building block	**Chapter 1: Evolution happens.**	**Chapter 2: Fossils provide evidence for evolution.**	**Chapter 3: How does evolution happen?**	**Chapter 3: Why are life cycles so different?**
	• 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.	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.	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. A sexual reproduction results in little variation in a population that makes evolution less likely.	All living things have similar stages of life.  Different animals have adapted these stages differently, which has enabled them to survive.

Problem solving ideas	• Construct a large time line along the class wall covering the last 1 billion years. Add to this timeline key events e.g. when life first appeared, when plants first appeared, when dinosaurs appeared and became extinct. Give groups an organism to research how it has evolved and hang this information from the time line.	• Fossil evidence suggests mammoths lived from 400,000 to10,000 years ago. What happened to them? Did they become extinct? Did they evolve into modern elephants? Are they still here? Children consider what scientists would have to do to find out which of these is the most likely. • Show some trilobite fossils and ask children to consider the possible reasons as to why no fossils younger than 250 million years have ever been found.	• Provide children with cards of the Simpson's extended family. They try and create a family tree based upon similarities and differences. • Some traits are inherited and others are not. Children don family research to try and work out if the following traits are inherited or not: earlobe attachment, hand clasping (when you link your fingers in a hand clasp which thumb do you place over the other?), cheek dimples, cleft chin, ability to remember random numbers, how far you can stand jump. • Provide children with a simple Darwinian and Lamarckian explanation for evolution (but keep anonymous). Children try and work out what the illogical arguments are and therefore workout which one is the better argument. They could try and apply both arguments to explain why giraffes evolved longer necks as available food became higher in trees. • Polar bears habitat is rapidly changing, what possible futures do they face and can we predict which is most likely? • "Dinosaurs became extinct, so they can't have been very well adapted." Pupils consider this question and do some research and prepare feedback to other groups. • All edible bananas have been bred so they have no seeds. All new banana trees are grown from cuttings of existing ones. If the climate changed would bananas we able to evolve? • Plants that grow from bulbs (daffodils, blue bells, snow drops and crocuses) can reproduce sexually by pollination (but at the time of year when few insect pollinators are active) and asexually by bulbs swelling and dividing. Children consider how this might give these plants advantages and disadvantages over plants that only reproduce sexually.	• Construct these time lines for different organisms and consider why there are such variations in the relative times for each of these stages. E.g. compare humans and horses and oak tree and a bean.