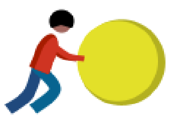
EYFS to KS2 Physics Progression Models

Ben Rogers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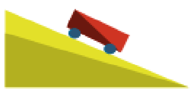
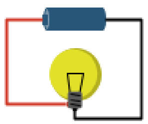

motion


electricity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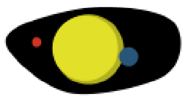
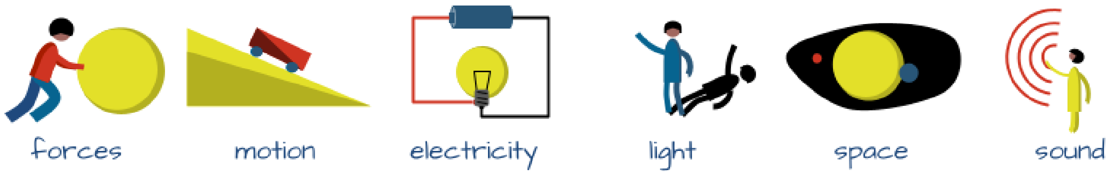

space


sound

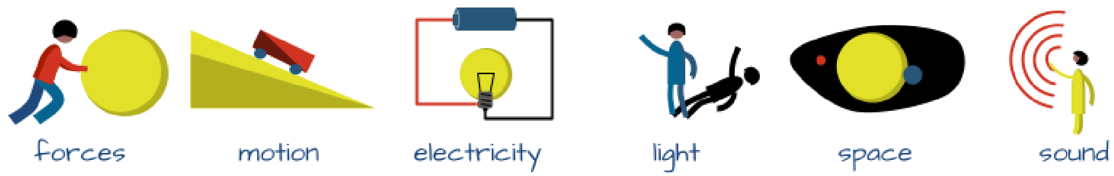
EYFS to KS3 Physics Progression Map for Forces

EYFS/KS1

Feeling Forces (Hands on)	Talking Forces	Measuring Forces	Drawing Forces	Concrete Examples	Common Misconceptions	Thinking Questions
Make sure pupils have experienced forces - both those they produce (lifting, pushing, pulling, twisting etc.) and those they feel on their bodies (e.g. those they feel on playground apparatus, such as swings, slides, see-saws etc).	As they are experiencing the forces, draw their attention to the experiences. Ask questions like: •Are you **pushing** or **pulling** the truck? •Are you **twisting** the rubber block? •Are you **bending** the toy? •Are you **stretching** •Are you **squeezing** the peg? •What does it feel like when someone **pushes** you on the	Before measuring forces, learners need to have a sense that forces have a size. •Is the push/pull big or small? •Do you have to push harder when you push the trolley on the carpet? •Is the bag heavy or light? •If I add another block, will it be heavier or lighter? •Does it hurt if someone pushes you too hard?	As a precursor to later drawings and visualisations, use gestures to 'draw with the body." Show your pupils how to mime pushes, pulls, twists etc. Get them to apply the gestures to examples - e.g. show me a big push. Show me a tiny twist. Show me an elephant pushing against a tree. Show me a very gentle push. This is the first stage towards abstract representations of forces. Later they will	The concrete examples in the 'feeling forces' column plus everyday pushing/pulling examples: •Trains pulling carriages. •Cars towing trailers / caravans •Tugboats pulling ships. •Horses pulling carts. •Kicking and throwing balls •Pushing shopping trolleys.	A common early misconception is that only living things and machines can exert forces . They don't realise that the floor holds us up; a table holds up a cup or a balloon holds in the air. All of these are providing forces.	•How can you make the bag heavier? •How can you make the ball squash more? •What do you have to do to make someone swing higher? •How could you make the truck travel faster? •What do you need to do to open/close the drawer?

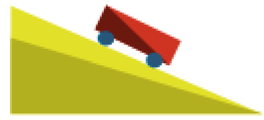


	swing? •What does it feel like when someone pushes up on the see-saw? •What does it feel like when you go round on round- about?	•Which rubber band is harder to stretch? •Which ball is harder to push under the water?	draw stick people pushing objects. Eventually, they will represent forces by drawing arrows.			



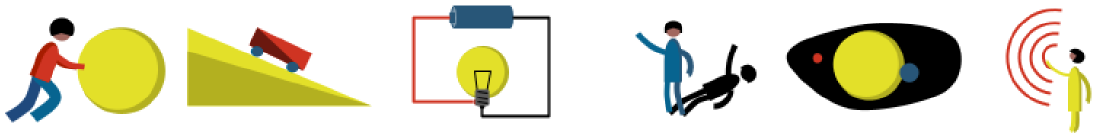
EYFS to KS2 Physics Progression Map for Motion

This progression map is intended to supplement your scheme or the national curriculum. You can use it to emphasise the key learning you want at each key stage.



EYFS

Feeling Motion	Talking Motion	Measuring Motion	Drawing Motion	Thinking Questions
Running at different speeds is a great way of experiencing motion. Also use buggies, toy cars, pushchairs etc. If you are on a bus or in a buggy, talk about the motion you can feel - especially speeding up and slowing down. Compare forwards and backwards. Feel the motion on your body in a playground.	Talk about fast and slow and speeding up and slowing down. Include not moving (stationary). Talk about the direction things are moving in.	Compare speeds of different things (hare and tortoise?) Fast and slow. Further, less far. Talk about directions: e.g. which direction is the snail going?	As a precursor to abstract representations of motion, use gestures (thinking with your hands). Encourage your pupils to use gestures to represent different speeds (including stationary), speeding-up and slowing down and changing direction.	

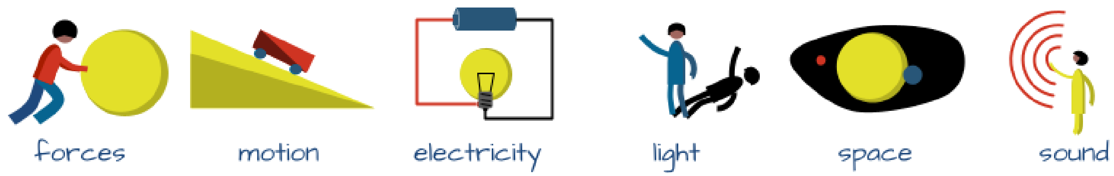


KS1

Feeling Motion	Talking Motion	Measuring Motion	Drawing Motion	Thinking Questions
Feel the motion in a playground: •Swings - forwards and backwards - you are speeding up and slowing down. You are fastest at the bottom. You are momentarily motionless at the top. •Roundabouts - these are handy because the speed stays the same but the direction changes. •Slides - these are handy because you accelerate at the top and decelerate at the bottom.	The hare and the tortoise story is useful for talking about motion. Use comparative language - *faster than* and *slower than*. Talk about the motion in the playground. • What does it feel like when you are speeding up? • What does it feel like when you are slowing down? • What does it feel like when you are going round the corner?	Races are the introduction to measuring speed. Who or what reaches the finishing line first? (note for teachers: when we measure speed, we need to know the distance and the time. Races are a clever way to determine speed without measuring either - you keep the distance the same for everyone and you can see who took less time by the order the racers arrive).	You can start to make the gestures more abstract - for example high speed and low speed can be represented by a high hand and a low hand. Stick people or cars with cartoon speed lines can be used to draw motion. 	If you run around a track and you are back where you started, have you moved? In a race, why does everyone need to start at the starting line and finish at the finishing line? (the answer should include ideas about the distance being the same). Is it easier to go around a corner when you are going fast or slow? (it's harder when you are fast).

LKS2

Feeling Motion	Talking Motion	Measuring Motion	Drawing Motion	Thinking Questions



<table>
<tr>
<td>There is no harm in continuing to use playground equipment and also experiences like fairgrounds and amusement parks to develop a physical sense of forces on the body. Make sure you spend time talking about the physical sensations and looking at the motion that caused them - e.g. where did it make your stomach lurch the most? Where did you feel yourself pushed back into your seat? What was happening to the motion at those points?</td>
<td> The less time you take, the faster you have travelled. Talk about speeding up and slowing down. Talk about how hard it is to change direction when you are running or cycling quickly. Talk about what it feels like when you are in a car, or on playground equipment when you change direction or change speed (e.g. a swing, a slide or a roundabout). </td>
<td> Keep the distance the same and measure the time for people or toy vehicles to travel the distance. If you can find stopclocks which only show whole seconds, you'll find everything much easier. Record the times in tables:
<table>
<tr><th>Person</th><th>Time (seconds)</th></tr>
<tr><td>Raj</td><td>20</td></tr>
<tr><td>Sam</td><td>25</td></tr>
<tr><td>Mary</td><td>15</td></tr>
</table></td>
<td> Arrows are the way that we visualise many useful ideas in physics - motion is one of them.  There is no rule about where the arrow goes (above, below or to the side) as long as it is clear the object it is referring to. (note - arrows are useful because you can show the size (speed) and direction). </td>
<td> The KS1 questions above are equally appropriate for KS2 (and KS3!) If you are in a car or on a bus and you pass the person sitting next to you a pen - how fast is the pen travelling? Can you feel any difference between the pen when you are moving and the pen when you have stopped? (If you had a really smooth vehicle, you wouldn't be able to tell you are moving - you could be travelling forwards at a thousand miles per hour or backwards - everything feels normal. But if you change speed or direction, you can feel that). </td>
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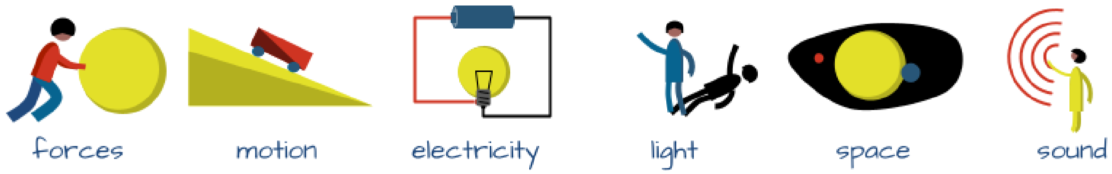
UKS2

Feeling Motion	Talking Motion	Measuring Motion	Drawing Motion	Thinking Questions



Notice what smooth motion feels like - e.g. on a train or car or bus. Can you feel how fast you are travelling? (Answer - no. You can only tell if the motion is changing - speeding up / slowing down or changing direction).

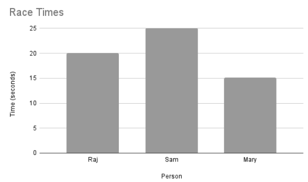
Synonyms for not moving:

- Stationary
- Motionless
- Still
- Static (static electricity is charge which doesn't move).

Be more explicit about the **distances** and the **times.** Measure time with stopclocks (still stick to whole numbers of seconds) and various metre rules, trundle wheels and tape measures.

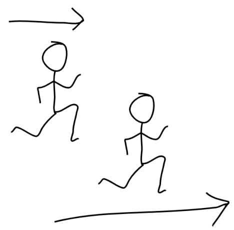
Person	Distance (metres)	Time (seconds)
Raj	75	20
Sam	75	25
Mary	75	15

Present your times as barcharts:



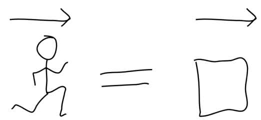
Advanced: speed is a ratio (distance:time), so if you double the distance a car is travelling you have to double the time. Your pupils will have the maths skills to

The length of the arrow represents the speed, so a short arrow shows something moving slowly, and a long arrow shows it travelling quickly.



(Arrows are super useful because you can represent **speed** (length) and the **direction** easily)

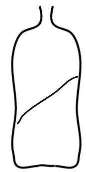
Your diagrams can become more abstract by replacing drawings with a square or a circle:

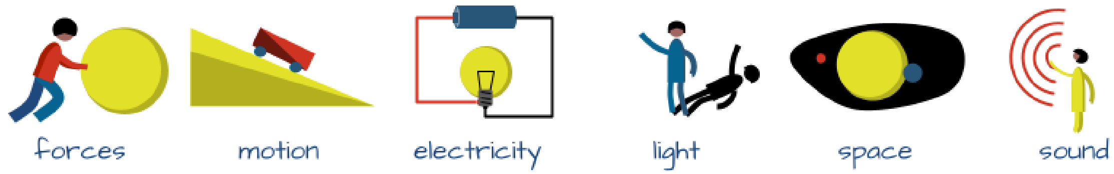


(If you get this far, you are

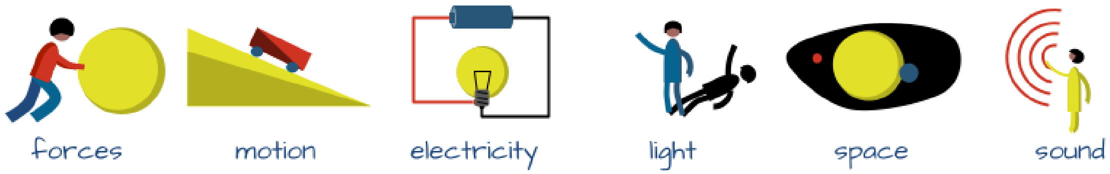
You are on a train travelling smoothly at 100 miles per hour. If you walk towards the rear of the train at 2 miles per hour, how fast are you travelling?

You have a bottle of water on the train's table in front of you. What happens to the water when the train speeds up / slows down, goes round a bend?





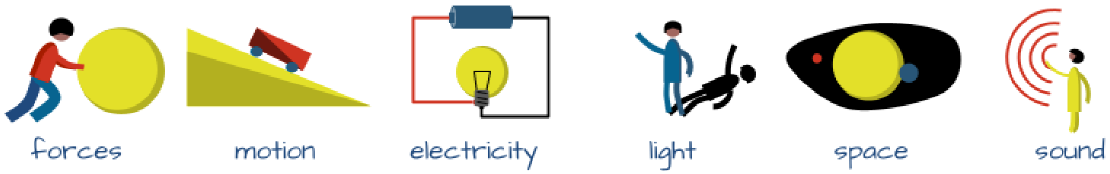
		deal with this. For maximum stretch, you can calculate speed using speed = distance divided by time. This can also be plotted on a bar chart. **Speed has different units -** depending on what you are measuring. Vehicles measure speed in miles per hour or kilometres per hour (still a ratio of distance:time). This is because we tend to drive miles and it takes hours. Physicists use metres per second (m/s) - still a ratio. This is because we are measuring smaller distances in less time. **Speedometers:** 	**well** on the way to GCSE).	



		Speedometers are used in lots of data dashboards - they are worth teaching explicitly.		

Elaboration

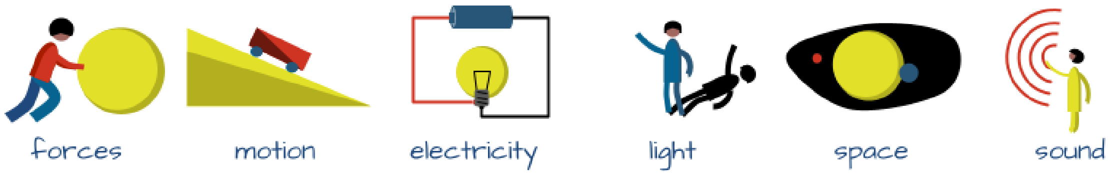
Forces and motion are usually taught together, because there is significant overlap. I would recommend making sure pupils understand each concept separately before exploring the connections - just to reduce the cognitive load. However, once the separate ideas are embedded, make as many links as you can. Elaboration has a powerful learning effect.



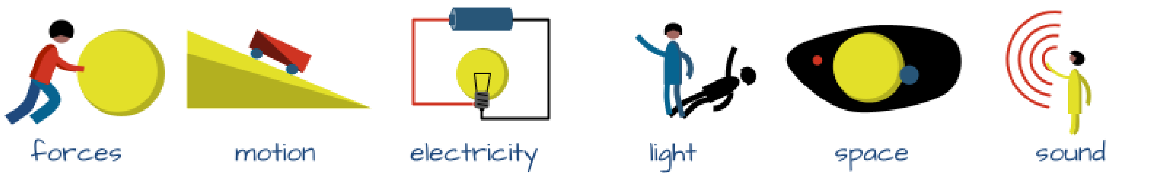
EYFS to KS2 Physics Progression Map for Light

This progression map is intended to supplement your scheme or the national curriculum. You can use it to emphasise the key learning you want at each key stage.

	Experiencing and Talking about Light	Measuring Light	Light Misconceptions	Representing Light	Thinking Questions
EYFS /KS1	• Making shadows • Mirrors				
KS2	What happens to torch light as it travels further?  (It spreads out to cover a bigger area AND it is less intense). (**Note**: this is a useful concept for later on. It is also true of light and has direct parallels with the gravity from an object).	You can measure the intensity of the light with a smartphone and a lightmeter app.	Pupils often believe that shiny objects, such as mirrors and cat's eyes produce their own light. The University of York Team has developed diagnostic questions (here). PSST Common Light Misconceptions	Arrows are an effective way to represent rays of light.	Why does a torch get dimmer, the further away from it you are? (Answer, the spot of light gets bigger, because the beam is spreading out. The same amount of light is spread out over a larger circle - an analogy is jam on toast - the more you spread the jam out, the thinner it gets.)



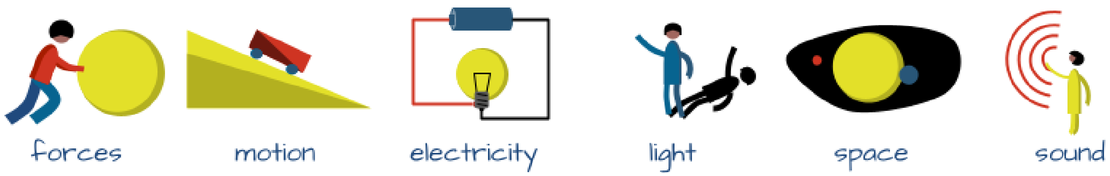
	Splitting white light into colours with a prism - classic experiment showing that white light is actually a blend of all of the colours of a rainbow. Looking at objects through water - including Picking up objects in water.				

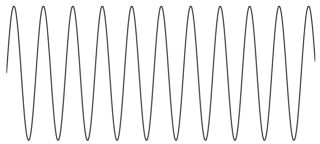
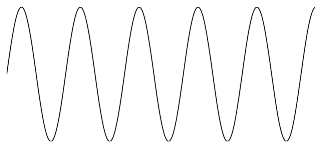


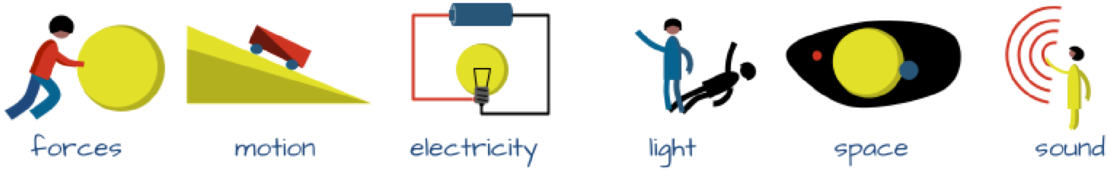
EYFS to KS2 Physics Progression Model for Sound

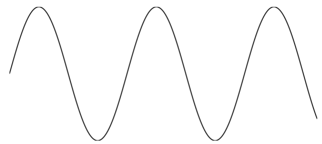
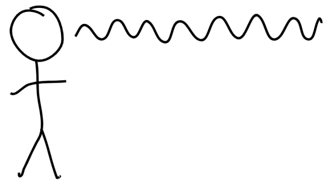
This progression map is intended to supplement your scheme or the national curriculum. You can use it to emphasise the key learning you want at each key stage.

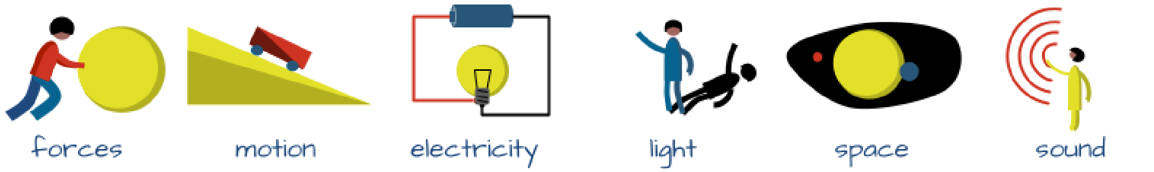
	Experiencing and Talking about Sound	Measuring Sound	Representing Sound	Thinking Questions
EYFS /KS1	Let pupils blow through tubes Twanging elastic bands Banging sticks together Glockenspiels Use a keyboard (or any instrument) to practise loud and quiet, high and low.	Focus on comparisons: • Loud / quiet • High / low • Louder than / quieter than. • Higher than / lower than	Use gestures to represent sound visually - loud and quiet could be the distance apart of your hands, high and low pitch by lifting a hand higher or lower. Learners can find this tricky - there's no problem with practising this all the way through primary.	How can you make a sound louder / quieter?
LKS2	Experience vibrations from phones etc. You can often feel vibrations from passing vehicles. Point out vibrations when you are	Use touch to compare the size of vibrations. You can compare the size of vibrations of the ruler / stringed instrument.	Using a wiggling hand gesture to represent vibrations would lead well into a wave representation for vibrations / sound. A high frequency back and forth gesture would represent high pitch, and slow back and forth for	How can you make a sound higher pitch / lower pitch? What is the connection between vibrations and sound (this isn't obvious). All sounds are vibrations, though we can't always hear vibrations, especially if the



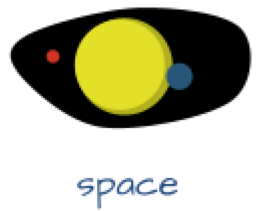
	travelling. You can feel the vibrations when you touch a bell or buzzer. You can see the vibrations in a string telephone or stringed instrument.		low pitch. Loud can be an exaggerated gesture, whereas a small amplitude would represent a quiet sound.	frequency is too low.
UKS2	Use a ruler over the edge of a desk to observe vibrations. When you reduce the amount of overhang, the pitch increases. (Note: a metre rule lets you see the vibrations much more clearly, but you won't be able to hear the 'buzz'	You can get apps which measure sound intensity (e.g. science journal) - you could investigate the loudness of different instruments etc. and plot the results on bar charts. A more sophisticated experiment would be to 'ping' the ruler on the edge of the table by different amounts (in 5mm steps) and use the sound sensor to measure the sound of vibration. Definitely worth trying this before the lesson!	It would be useful to represent vibrations visually as a wave (though not strictly KS2):  High pitch  Medium pitch	What can sound travel through? • Water? (yes - think whale song) • Air? (yes - think singing birds in flight and the sound of aeroplanes). • Solids? (yes - if you put your ear onto a table and get someone to scratch it really quietly, you can hear the vibrations). • Space? Can you hear the Sun? (no).



			 Low pitch  Quiet  (How you might choose to use these sound wave representations).	



EYFS to KS2 Physics Progression Map for Space



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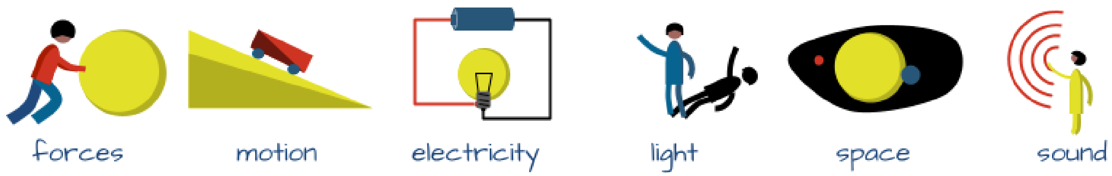
Teaching space is about awe and wonder and models. There is a lot of factual knowledge which isn't necessary for assessments or progress, but provides rich background knowledge. And there are models.

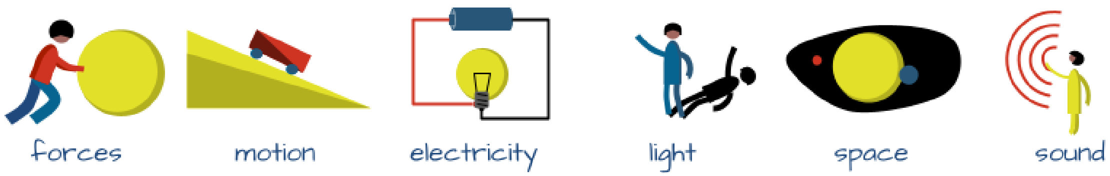
Physics is all about models and space has some good ones. Every school should have a Solar System model (an orrery) - even if it's made from cornflake packets. Globes, spot lamps and various sized balls are all useful. As are decent window blinds.

A really good simulation is stellarium.org. It lets you see the sky where you are

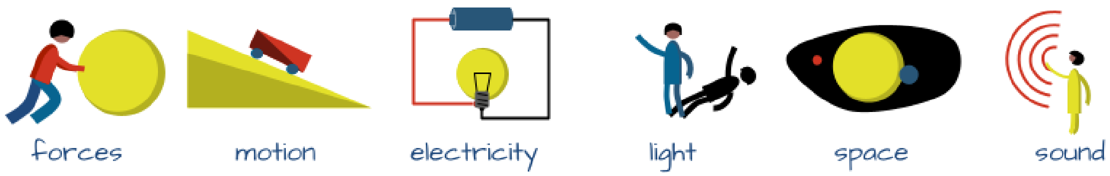
The other big idea comes from the history of astronomy: how scientific ideas change. From the Ancient Greeks to the Renaissance, the models scientists have used have changed as new evidence is found. Space provides an opportunity to tell these stories to your pupils.



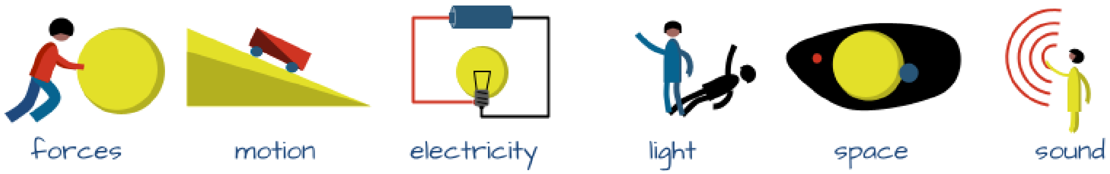
	Observing and Discussing 'Space'	Using Models	Stories	Misconceptions	Thinking Questions
EYFS	Use play, including small world play, to explore space. Talk about the Moon, planets, aliens, spaceships and spacesuits. Dressing up is great - talk about needing air tanks to breathe.	Role play space scene - small world explorative play - pupils naming planets at EYFS.	There are plenty of age appropriate story books - fiction and nonfiction.	You can only see the Moon at night - not true - you can see it during the day (it's harder to see because the Sun is so bright).	Where does the Sun go at night? Why can't we see the Moon during the day? What are stars? How far away are they? Can you travel to the Moon?
KS1	**The Moon - things to notice:** •Sometimes you can see it during the day (especially early morning and late afternoon - you might see it on drop off or pick up). •Moon phases - don't try to explain these yet - just notice it with them. **The Sun - things to notice:** •The Sun seems to move across the sky - it isn't	Introduce the globe as a model of the Earth. You can stick model people on the northern and southern hemispheres to point out people don't fall off.	There are plenty of age appropriate books - fiction and nonfiction. History and fact books are good. You can tell the stories of the constellations. Stellarium is a great way to explore space while in school - pull the blinds down and tour the night's sky.	Why don't people fall off the world? Stars are pointy - every picture book shows the stars are pointy - but they aren't: they are spherical. We only see the Moon at night - this isn't true - you can often see the Moon in the morning or evening.	What don't people in Australia just fall off? (Answer - gravity pulls everything towards the centre of the world - you definitely need a globe to show this).



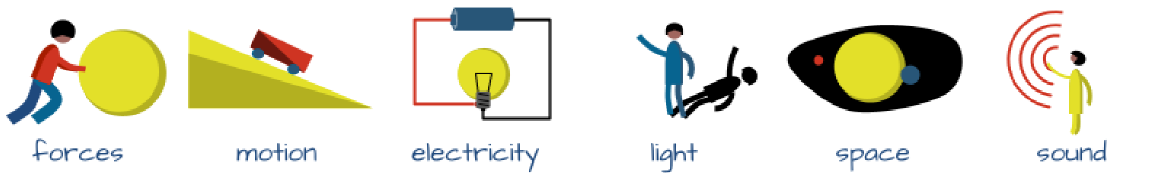
	always in the same place. •In the winter, the Sun rises later and sets earlier. •You might be able to notice that in the summer, the Sun reaches a higher point in the sky (this is tricky). **Stars - things to notice:** •some stars are brighter than others (as the even gets dark, the brightest appear first) •stars aren't pointy! **Planets:** •you can see Venus and Jupiter clearly if you know where to look and when (you can google it). In the winter you may be able to see them at pick up or drop off - they look like very bright stars).				



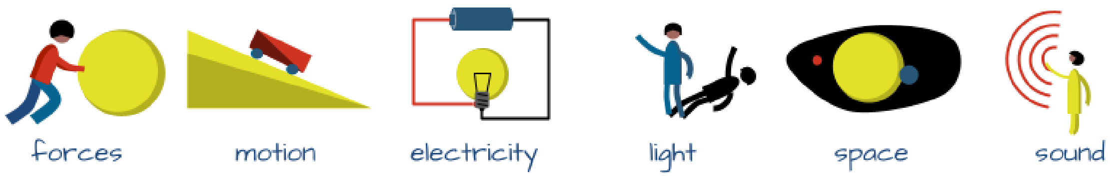
	Observing and Discussing 'Space'	Using Models	Stories	Misconceptions	Thinking Questions
KS2	A key confusion learners have later on is the difference between rotation and orbiting. It is worth getting your pupils to act it out with their bodies - but also to model with balls. When you go down in a lift, you feel momentarily weightless. That doesn't mean there's no gravity in the lift, it just means that the lift and you are falling together. Talk about that feeling, and the feeling of weightlessness you have on a roller coaster. Orbiting in space gives you the same feeling.	**Model Solar System.** If you can do this on a field, you can get a better scale. **Model Earth / Moon / Sun** "Use the idea of the Earth's rotation to explain day and night and the apparent movement of the sun across the sky" - NC To model this in a convincing way, you want a globe and a smaller ball to represent the Moon. Find a strong light source - something with a beam is best. Mobile phone torches are rarely strong enough. If you can make the room dark - even better.	Copernicus and the heliocentric model. Galileo and the use of evidence to prove Copernicus was correct.	**Misconception - There is no gravity on the Moon** - there is! It's less than on the Earth, but if there was no gravity, the astronauts would just fall off! **Misconception: There is no gravity in space** - watching astronauts float about convinces most people that there's no gravity in space. However, gravity is the force which causes the Earth to move in a curved orbit around the Sun and the Moon to orbit around the Earth (remember - if there is no force, an object will travel in a straight line). The reason astronauts float about in spacecraft is because the spacecraft, the astronauts and	How do we know there is gravity in space? (Answer: you can tell when gravity is acting on a planet, moon or spacecraft if its motion is changing - is it speeding up or slowing down, or is it moving in a curve?) Why don't spacecraft use their engines when they are travelling between planets? (Answer - there's no air resistance to slow them down, so they turn their engines off to save fuel). **Advanced**: Why do astronauts seem weightless if there is still gravity acting on them? (Answer, they are just moving in exactly the same way as their spacecraft - it's like in the



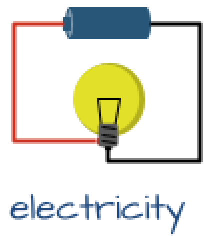
		Moon Phases: there is no requirement to understand or explain Moon phases.		everything else in the spacecraft are all following exactly the same orbit - it makes them look like there's not gravity acting on them. **Misconception: the speed an object falls depends on its weight.** This is incorrect, though it looks to be true. If it weren't for air resistance, it would be obvious that all objects fall at the same rate. However, air resistance makes it difficult to see this effect. The best way to demonstrate it is to drop two dense but different sized objects - e.g. a 1p piece and a 100g mass. They will land at the same time. Videoing it can be an effective way to show both fall at the same rate. **Misconception: Spacecraft need engines to keep**	descending lift - you feel weightless, but gravity is making you and the lift / spacecraft accelerate together.



				moving through space. They don't. This is a good link to the motion unit - objects continue in a straight line at a steady speed unless a force acts on them. There is no air resistance in space, so most spacecraft travel without their engines on. They only need an engine to change speed (speed up or slow down) or change direction.	



EYFS to KS2 Physics Progression Map for Electricity



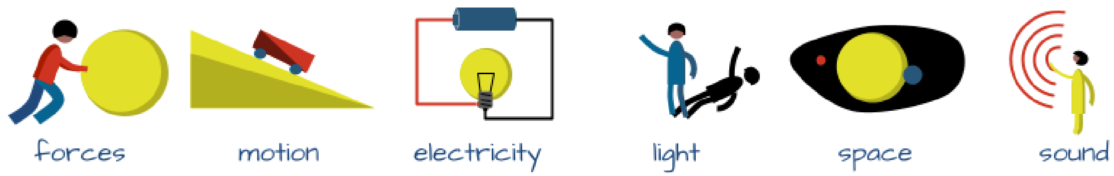
This progression map is intended to supplement your scheme or the national curriculum. You can use it to emphasise the key learning you want at each key stage.

Electricity used to be very well taught in primary school when the KS2 SATs included science. Pupils were able to make complete circuits and troubleshoot. In my experience this is now less common. So I have included troubleshooting in my progression model.

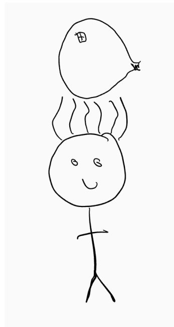
I have also included static electricity, not least because of the magic of forces at a distance.

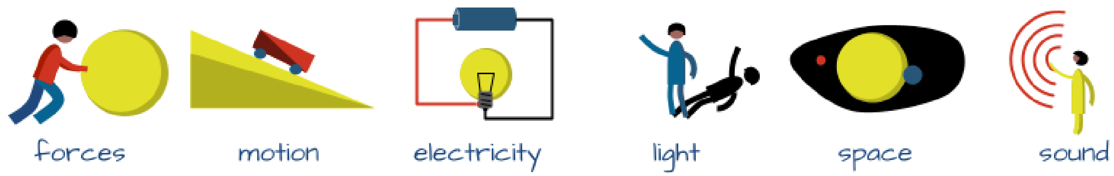
I find the rope model for electric circuits at KS2 does the job of helping pupils ‘see’ what is going on inside the wires - making the invisible, visible and the intangible, tangible. I have included key ideas to point out and ask questions about.

Finally, for EYFS and KS1 I assert that water play helps pupils learn about electrical current later on. I have no evidence to back this up, other than my own visceral understanding of electric current. I can almost feel the current flow around a circuit, like water along a channel - splitting and recombining at a junction. Give your pupils the opportunity to experience this.



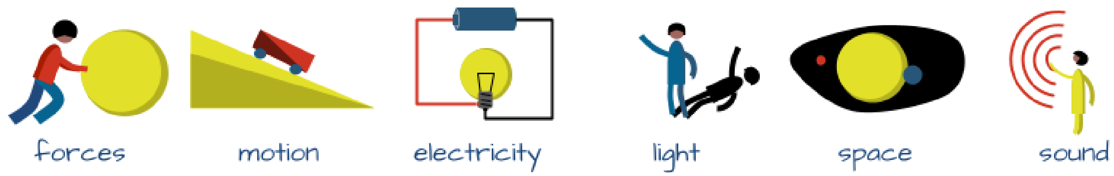
EYFS/KS1

Feeling Electricity	Talking Electricity	Measuring Electricity	Drawing Electricity	Thinking Questions
Static Electricity: rubbing balloons on jumpers and hair. Making balloons stick to walls. The forces will be too small to feel, but you can feel hair standing up. Pick up small pieces of paper using a charged ruler, comb or balloon. **Flow:** we use the idea of electricity flowing like a stream of water in KS2/3 - let your children experience and discuss how water flows through tubes, gutters, round corners etc. Let them get their hands wet. Hopefully they will be able to apply this physical hinterland to air their understanding of current in later years.	**Static Electricity** •Can you feel your hair standing up? •Can you feel the balloon sticking to the wall (probably not). •What does it feel like when the water flows past your hand? **Current Electricity** •What things have batteries? •What things do you need to plug in?	•How many pieces of paper can the charged comb / ruler pick up? •How much hair can the balloon hold up (lots / not much)		•Which materials can you “charge up”? (note - **charge** is a useful word for static electricity). •Does it matter how hard you rub? Will the balloon stay on the wall longer? Will the ruler pick up more pieces of paper? •Does it matter what material you rub it on?



KS2

Feeling Electricity	Talking Electricity	Measuring Electricity	Drawing Electricity	Problem Solving and Investigation	Thinking Questions
Static Electricity					
Current Electricity Use the rope model for electrical circuits (here). Encourage pupils to feel the flow of the rope and the resistance of pulling the rope through someone's hands. **Please take care - rope burns are unpleasant.**	Things to point out/discuss: •The rope represents the charge. •The movement of the rope represents electrical current. Current can also be modelled by moving water (current is the **flow** of charge. •The rope (charge) is already there in the wire - the cell doesn't provide it. •The rope doesn't get used up as it goes round - charge doesn't get used up. •The current is the same all the way around the circuit			9 times out of 10, circuits don't work the first time. Practical work with circuits can be a frustrating and demotivating experience. A useful skill to explicitly teach is finding and fixing problems with electrical circuits. Teach pupils to: Check the cell still has enough energy. Check the bulb works. Check the wires work. A good way of doing this is to have a couple of working example circuits around the room. Pupils can come and try out their component they suspect	Why do all the bulbs light up the moment you switch on the circuit? Why doesn't the electricity take time to reach the bulbs? (Answer - the rope model shows that the moment the cell starts moving the charge in the wires (the rope) the whole loop moves at once. Why are materials which are good at charging up all insulators? (answer: when you put charge onto an insulator (e.g. balloon) the charge stays put. If you put charge onto a conductor (e.g. a metal ruler) the charge can flow elsewhere. So, when you charge an insulator, the

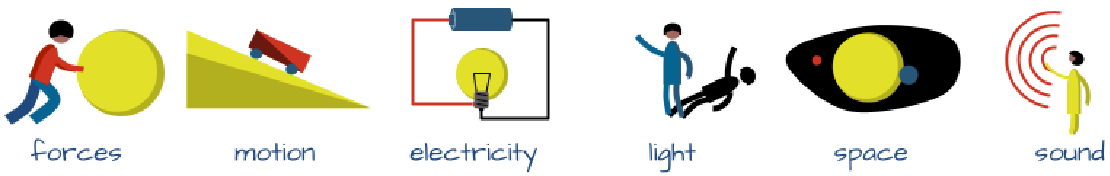


	- it doesn't speed up or slow down anywhere. •It is a model - charge isn't really a solid string - but it helps us explain what is happening. (It's like a simile). What happens when: •You add more components to the model (A: the rope is harder to move - it slows down - current is reduced). •You add more cells (A: the charges move faster - you get more current).			isn't working and replace it if necessary. Make sure suspect components are put into 'component hospital' and not put back in the main supply. Once you have working circuits, you can add multiple bulbs to see what happens and categorise materials into conductors and insulators (note - the materials you can charge up by rubbing on hair/wool are insulators.	charge stays there).

Misconceptions

Many pupils believe that charge (or current) gets used up by components like bulbs - it doesn't.

The word 'charge' is problematic in everyday English - we say we are charging a mobile phone when we mean we are storing more energy in the battery. This is different to 'charge' in physics, which means to put electrical charge onto an insulator.



Problem solving and investigations with circuits

9 times out of 10, circuits don't work the first time. Practical work with circuits can be a frustrating and demotivating experience. A useful skill to explicitly teach is finding and fixing problems with electrical circuits. Teach pupils to:

- Check the cell still has enough energy.
- Check the bulb works.
- Check the wires work.

A good way of doing this is to have a couple of working example circuits around the room. Pupils can come and try out their component they suspect isn't working and replace it if necessary. Make sure suspect components are put into 'component hospital' and not put back in the main supply.

Once you have working circuits, you can add multiple bulbs to see what happens and categorise materials into conductors and insulators (note - the materials you can charge up by rubbing on hair/wool are insulators.