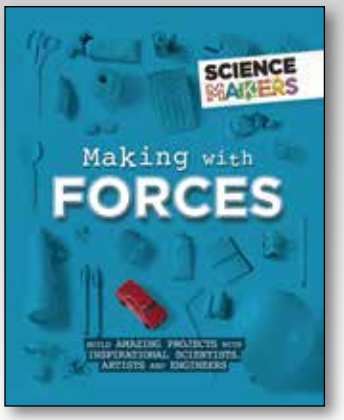

SCIENCE MAKERS

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Science Makers: Making with Forces

Speeding car stunt ramp: Galileo Galileo (pages 6-7)

Galileo Galilei was one of the greatest science experimenters and discoverers in history. Do some research on him and see if you can find out the answers to these questions:

- What did Galileo find out about pendulums?
- Why did Galileo drop objects off the Leaning Tower of Pisa?
- What shocking new fact did Galileo discover about the planet Jupiter?
- Why was Galileo put under house arrest in 1633?

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Galileo rolled balls down slopes, or "inclined planes", to study the way they speeded up. To do this, use a long, straight strip of wood or card to make a gentle slope, and mark it every 20 cm along the edge with a small piece of paper or cocktail stick.
Roll a ball down the slope from the top, and use a stopwatch or smartphone timer to measure how long it takes to reach the first marker. Repeat this for all the markers, and write down your results.

Marker 1 **0.9 seconds**
Marker 2
Marker 3

... and so on.

Can you see a pattern? You could also make a graph with distance and time axis, and mark the results as a curve.

The car ramp project on pages 6-7 makes a toy car take off and fly through the air. You might also be able to make it land safely on a landing ramp. But can you make it loop the loop? See if you can figure out how to make a looping track, and position it so that the car is going fast enough to zoom all the way around the loop.

Whale race: Agnes Pockels (pages 20-21)

Agnes Pockels made a career as a scientist despite not being allowed to study at university. Research and write a report on her life and work, including pictures and diagrams if possible. Can you find out these facts?

- How did Pockels get a paper published in the leading science journal *Nature*?
- Why did Pockels end up spending most of her time at home?
- Pockels' work helped to kick-start the modern field of study known as surface science. What kind of everyday items involve surface science?

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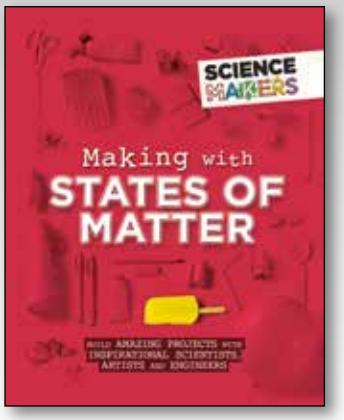
Besides the racing whales on pages 20-21, there are many other fascinating surface tension experiments. Try these:

- Pins, needles and paperclips are denser than water and usually sink, but if you are very careful, you can lie them on the surface of still water.

- Fill a glass to the brim with water, then carefully add more water, drop by drop. Surface tension holds the water together, allowing it to bulge up above the rim. How high can you make it go before it spills?

- Put some milk in a shallow dish or plate, and add several drops of food colouring, or sprinkle the surface with glitter. Drop a little washing-up liquid into the middle, and see what happens.

Pond skaters or water striders are insects that use surface tension to rest on the surface of still water in ponds and rivers. Do some research to find out more about pond skaters. How do they move around on the surface so fast, and how do they find and catch their prey? What happens if a pond skater gets wet? Can they fly? Can you find any other animals that make use of surface tension?



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Science Makers: Making with States of Matter

Chocolate art: Prudence Staite (pages 6-7)

Take melted chocolate art further, using the method described on pages 6-7. Instead of creating artwork in a foil tray, spread out a large piece of foil and use the bags of melted chocolate to draw designs, such as people, eyes, flowers, hearts or animals, or to spell out messages. Leave them to set in a cool place. You can then use a flat butter knife or palette knife to gently lift them off the foil. They make great decorations for cakes. You can also use melted chocolate in the same way to draw designs directly on to a plain chocolate bar or chocolate egg.

What is chocolate? For a chocolate science project, see if you can find out the following:

- What kind of plant does chocolate come from, and what part of the plant is used?
- How is a bar of chocolate made?
- What is the melting point of chocolate?

- How healthy a food is chocolate? Are some types healthier than others, and if so, why?

Do some research to find out which five countries produce the most chocolate, and which five countries consume the most chocolate. Make an infographic world map to show your results. Mark the countries that grow the most chocolate with an icon of a chocolate plant, making it bigger or smaller to represent how much they grow. Do the same for the countries that consume the most chocolate, but use an icon of a chocolate bar. Do any countries have both icons?

Melting ice people: Nele Azevedo (pages 16-17)

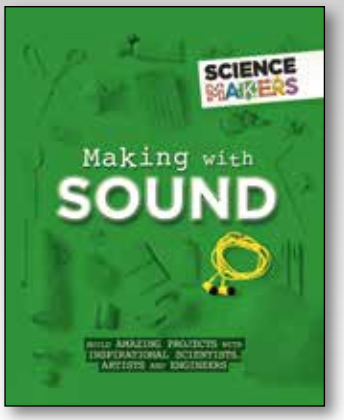
With a freezer, or just a freezing cold day, you can make other things from ice too.

- Use the method on pages 16-17 and see if you can make ice animals, such as a bird, spider or snake, letters and numbers, or mini buildings.

- Fill balloons with water (you could add food colouring too), tie them closed, freeze them solid, then cut the balloon off to make ice globes to use as garden decorations.

- To make an ice bowl, put some ice cubes in a large round plastic bowl, and put a smaller round bowl on top of them. Fill the space between the bowls with cold water, and use strong sticky tape to hold them together. Freeze until the water is solid, leave for a few minutes, then remove the tape and bowls. Put the ice bowl on a tray, and use it for cold drinks, ice cream or fruit salad.

Azevedo's ice people are sometimes seen as representing the melting of the world's ice thanks to climate change. Research climate change, global warming, and melting of ice caps and glaciers, to find out how this is happening. Make a map of the Arctic to show how ice cover patterns have changed there over a



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Science Makers: Making with Sound

Found sounds: Evelyn Glennie (pages 6–7)
AKB48 bottle train: AKB48 (pages 12-13)

The projects on pages 6-7 and 12-13 show you how two make musical instruments. As Evelyn Glennie's work demonstrates, the possibilities for making your own instruments are almost endless. Try designing, inventing and making more musical instruments using household objects and craft materials. Here are some ideas:

- Paper cups: Attach them to moving parts to make sounds easier to hear. The base of a paper cup also makes a good drum skin.
- Elastic bands: Stretch them over a tissue box, matchbox or chocolate box to make strings that play different pitches when plucked.
- Dried beans or lentils: Make good shakers when sealed inside a container or tube.

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- Glass bottles: Fill matching bottles with different amounts of water to make a xylophone, and play it with a spoon or stick. You can also make a sound by blowing over the opening of a bottle.

- Tubes and pipes: Cardboard, plastic and metal tubes all make different sounds when you blow down them or make sounds through them. Try blowing a raspberry into the end of a tube – this is how brass instruments are played.

- Lolly or craft sticks: Press or fix one end of a lolly stick down firmly and twang the other end to make a musical note. Experiment with making the free end different lengths.

- Balloons: Cut the neck off a balloon and stretch the skin over a tube or container to make a drum skin.

- Straws: To make a straw trumpet, flatten one end of a straw, cut the tip into a point, put the pointed tip in your mouth (just past your teeth) and blow. Try attaching the straw to other parts to alter the sound.

- Funnels: Make good horns to stick on to the ends of tubes and other instrument parts.

Pitch means how high or low a note is. It depends on how quickly an object vibrates as it makes a sound. Faster vibrations make higher-pitched sounds, and vice versa. Experiment with pitch using elastic bands, string, filling bottles and jars with different amounts of water, and making sounds with tubes of different lengths. What ways can you find to change the pitch that different kinds of object make? Can you make instruments with a range of pitches that sound like a piano, and use them to play a tune?

If you like both music and writing, being a songwriter could be a great career for you (and it's often very well paid, too!). Try writing a hit song, alone or working with friends. Sing or use a musical instrument to work out simple, catchy tunes for the verse and chorus. For the words, think of a short, meaningful phrase, slogan or statement to use in the chorus, repeating it several times if you like.

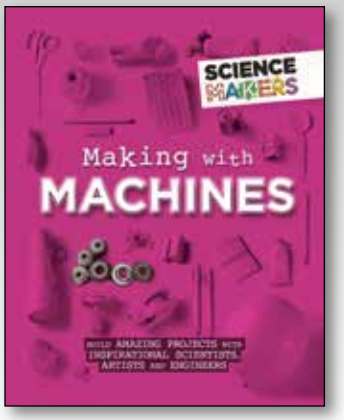
Use the verses to tell a story or add more detail. Listen to some of your favourite pop songs to see how this works, and how songs are made up of verses, choruses and sometimes other sections too.

Intruder alert! Augustus Russell Pope (pages 26-27)

If you've made Augustus Russell Pope's burglar alarm and got it working, try an experiment to test how heavy the weight on the mat needs to be to set the alarm off. Weigh different objects using bathroom scales, or for smaller objects, kitchen scales. Put them on the pressure mat and see which set the alarm off and which don't. Write down the different weights of the objects in increasing order. What weight is needed to set the alarm off? If you wanted to make an alarm that was set off by people but not by passing cats or dogs, what would be the best weight to trigger it? You can research this by finding out the weights of these animals. Engineers have to consider this when they design alarm systems and automatic doors, so that they are not set off too easily.

If you enjoy making electrical circuits, you could try working on more ways of using them to make sounds. Solenoids are electrical components that move back and forth when a current flows through them. They can be used to make circuits that play bells, strings or other musical instrument parts by hitting them. You can buy simple solenoids online or at an electronics store, and try making circuits that play musical instruments.

The burglar alarm is just one of many sounds used as warnings, sirens and alarms. These sounds, such as police car sirens, foghorns, fire bells and attack or disaster warnings can have a powerful effect on us, as we have learned that they stand for danger or an urgent emergency. Try collecting a selection of sounds like these, either by recording them in real life, or from recordings or videos on the web. You could combine them together to make a piece of avant-garde music, or make a game by playing them to friends or family, who have to guess what each one is.



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Science Makers: Making with Machines

Powered flight: Wilbur and Orville Wright (pages 10-11)

In 1903, American brothers Wilbur and Orville Wright made the first sustained, controlled, powered flight in a heavier-than-air aircraft. That was an incredible achievement, but it wasn't the first time a human being flew. Research how people took to the air before the Wright brothers' plane, the *Wright Flyer*, and how other inventors and experimenters led the way for the Wright brothers. Who were they and what did they do? Make a timeline of the discoveries, breakthroughs and famous flights in the centuries leading up to 1903. You could illustrate it with the most important pioneers involved, or their flying machines.

The powered plane make in the Machines book is a simple, basic project using only household objects. Can you improve on it and make a plane that flies further or better, using different materials or methods? Here are some ideas to try:

- Use balsa wood, a type of very lightweight wood, available from an art or hobby store, to make a plane. It can be cut with a craft knife and fixed together with strong glue.

- Make a more lightweight propeller made using plastic from a disposable plastic bottle.

- Is there any way to make the wings or tail lighter? What happens if you cut holes or shapes out of them?

- Is it possible to make a twin-propeller plane? Try designing and building one.

- Try adding ailerons, or tilted flaps, to the wings to control the way the plane flies. Research ailerons first to find out how they work on real planes.

Since 1903, powered flight has transformed modern life. Every day, millions of people use aircraft to get around, and it's become far easier and quicker to travel long distances. But imagine it hadn't happened! What if the Wright brothers were working today, and had only just made the first successful flight in the *Wright Flyer*? Write a news article, as if you were a present-day journalist, describing and explaining the event for the public. Can you find quotations from the Wright brothers about how the flight felt, to include in your piece? And if this did happen today, what do you think Orville and Wilbur Wright would post on Twitter or Instagram? Use photos from the time to create their posts.

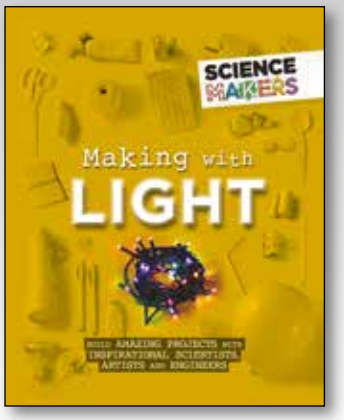
At the Touch of a Toe: Lillian Gilbreth (pages 16-17)

Lillian Gilbreth developed the foot-pedal bin in the 1920s as part of a series of inventions for making housework easier and more efficient. There have been many other inventions designed to do this too. Can you research and find out who invented the washing machine, the dishwasher, the the vacuum cleaner and the microwave, and when and how they did it? Imagine how long some household jobs must have taken before we had appliances like these – and still do, for people who can't afford them or don't have access to an electricity supply. You could even test this out. Try washing and wringing out a basket of clothes in the sink or bath instead of using a washing machine, or sweeping up a room with a dustpan and brush instead of a vacuum cleaner. Time them both, and write down how much longer you have to spend on each one.

SCIENCE MAKERS

Gilbreth's pedal bin worked using a simple system of levers, and so does our version on page 16-17 of the book. Can you use levers to design other fun or useful machines? What about a pedal-powered cupboard door or toilet seat, or a toy seesaw? What else can you think of? You can draw your designs on paper, make models using construction toys such as Lego, or try making working models using household materials.

Gilbreth was famous for her birds-eye view plans of kitchens, designed to make them as efficient and easy to use as possible. Look up some of her designs, and other room plans, and use the same style to design your own perfect room. It could be a kitchen, a hobby room, your bedroom, or the ideal classroom – or whatever else you like. You could even design a whole apartment or a building. Kitchen builders, architects, garden designers and many other professionals use plans like this to work out what to put where, before anyone does any actual building or moving things around. You might even be able to put your planning skills to real-life use, to rearrange your bedroom, help make a classroom more user-friendly, or help to design a house extension.



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Science Makers: Making with Light

Art in Shadows: Kumi Yamashita (pages 6-7)

Besides Kumi Yamashita, there are several other artists working in shadow art, including Larry Kagan, Fred Eerdekens and Rashad Alakbarov. They often make sculptures that look abstract and random themselves, but cast a shadow that clearly shows an object or writing, or creates a pattern or effect on a wall. Try making an artwork like this, using wire, coins, crumpled up paper, cotton wool, or other everyday objects. Shine a desk lamp at a plain wall, and turn off any other lights too you have only one light source. Arrange the objects, wire or other materials in the light, so that they create an interesting or recognisable shadow.

People have used shadows to make puppet theatres since ancient times. To make a shadow theatre, cut the base out of a large cardboard box, and tape thin white paper, tracing paper or tissue paper over the hole to make a screen. Cut two slots down the sides of the box, near the screen. Put the box on its side and shine a lamp into it. For the puppets, draw shapes of people, animals, monsters, vehicles and so

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on, and tape them to wooden skewers or pieces of wire. Put the shapes through the slots, and move them around behind the screen.

Did you know that shadows can come in different colours? You need clear coloured sweet wrappers or coloured acetate in red, yellow and blue. Tape them over the ends of three small torches. In a darkened room, shine all the torches at the same area of a white wall, or a large sheet of white paper. Try holding your hand, or an object such as a spoon, in front of one of the torches.
What happens?

Light box display: Jeff Wall (pages 24-25)

Jeff Wall's *A Sudden Gust of Wind* recreates an artwork by the Japanese artist Hokusai in the form of a photo. Try doing the same by choosing a famous painting, such as Leonardo da Vinci's *Mona Lisa*, Edvard Munch's *The Scream*, or any other painting you like. Recreate the painting as a photo, with yourself (or friends or family members) dressed like the people in the painting.

For a variation on the light box project on pages 24-25, use brightly coloured or multicoloured fairy lights, or lights that flash or gently glow on and off. You could draw or paint an artwork on tracing paper to put over it, so that the colours in the art appear to change as different-coloured lights flash behind it. How else could you use battery-powered fairy lights to make things? What about a lit-up bobble hat, sculpture of a robot or monster with lit-up eyes, or a glowing map of the night sky?

Many kinds of professionals use light boxes in their work. Photographers use them to look at slides and negatives. Biologists use them to look at bacteria growing in petri dishes, and doctors use them to get a clear view of x-rays.
Try using your light box along with a magnifying glass to take a brightly lit-up look at some everyday objects, such as sweet wrappers, onion skin, pictures on magazines, flower petals, thin fabric or human hair.

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Science Makers: Making with Living Things

Fast flowers: John Ott (pages 8-9)
Animal flick book: Eadweard Muybridge (pages 16-17)

The invention of animation allowed the real-life movements of living things, such as plants growing and animals running, to be captured as moving pictures that could be watched again and again. Early inventions such as the zoopraxiscope and the zoetrope paved the way for the development of film, TV, and the plethora of moving images we are used to seeing today. Choose a type of modern moving picture, such as film, digital video, or computer animation, and do some research to find out how it works. How does the technology capture, or create, many separate images, and combine them into a sequence that appears to move?

There are lots of apps available for making simple stop-motion animations. If you have a smartphone or tablet, or have access to one, research and find a free or low-cost app, and follow the instructions to learn how to use it. You can now make your own animation using plasticine shapes or models, small household objects, toy figures, or your own cartoon drawings – or a combination! The word "animation"

means to bring something to life, so that it seems to breathe. Can you make objects, toys or plasticine seem to move and behave as if they are really alive?

For a much longer-term project, make an animation to show how an animal or human grows and changes over time. Use an animation app to take a photo of your face, or your whole self standing in front of a mirror, once a day, at the same time, in the same place and in the same lighting. Or you can do the same with a younger sibling (if they and your parents agree!). Or even a puppy or kitten – you could give them some food to make sure they stay still and are in the same position each time. Over months, or even years, you'll be able to make an animation that shows a person or animal growing up.

Antony Gormley (pages 22-23)

Do a research project to find out more about the British sculptor Antony Gormley, and his human-body-based artworks. Look at some of the different ways he has used the body to make sculptures, and some of the interesting places they have been installed in. What are his most famous and popular works? Do you like them? If so, what's your favourite? Use photos of Gormley's work and work processes, along with your own written text, to create a leaflet, poster, or magazine or blog article about him.

Sometimes, Gormley uses the human body as a starting point, but changes or adds parts to make a new being or creation. His giant sculpture *The Angel of the North*, for example, has huge, wide, aircraft-style wings in place of arms and hands. Create an artwork that works like this too, based on your own body. It could be a drawing, a painting, a collage, or a 3D sculpture. Replace your head, your eyes, hands, legs, arms or feet with something else, in a way that says something about you or your ideas or interests.

The project on pages 22-23 shows you how to use alginate powder to make a cast of your hand. You could use the same method to make model body parts that have a useful function. A gently cupped hand could make a little bowl for jewellery. Cast your hand in an upright holding position to make a candlestick or pen holder. A large plaster foot would make a great doorstop! When you've made the cast, paint it with several coats of paint or varnish, to protect and stop it from chipping.