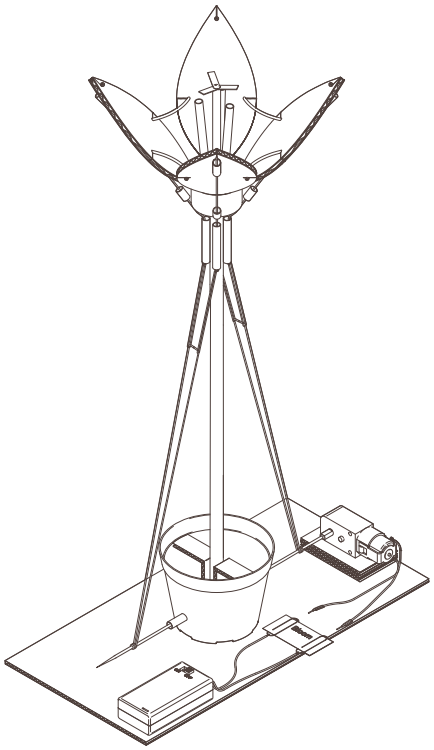


MECHANICAL FLOWER WORKSHEET

GETTING STARTED

5-10m

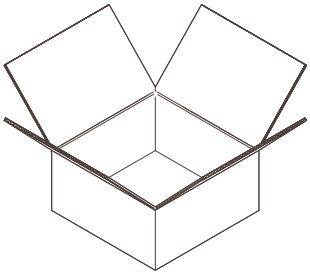
Did you know that bees have been around for millions of years, pollinating our plants and producing delicious honey? However, a world without these hard-working, winged invertebrates is becoming more of a possibility, as these important insects are in decline.

Engineers are developing new technologies to help support bees around the world. There are projects redesigning hives, so they are more resistant to disease, and robotic replica flowers that can automatically produce nectar and pollen when bees are nearby.

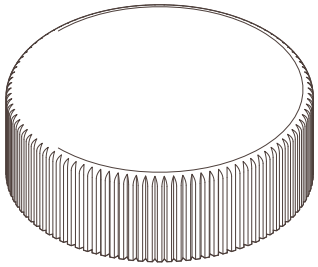
In this session, we will show you how to make a mechanically blooming flower model. You will learn all about the features of flowering plants that are so important to pollinating insects and their supporting ecosystem. You will also consider how engineers might be able to use robotics to artificially pollinate bees and help save them from extinction.

This activity is best suited to more advanced students aged 10+ with the supervision of a teacher or adult.

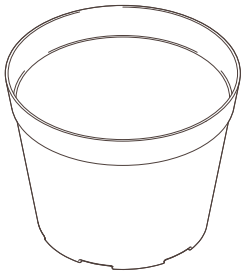
YOU WILL NEED



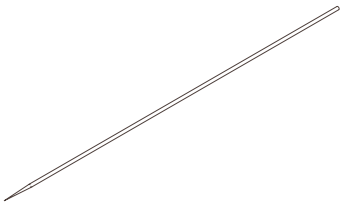
Cardboard
30cm long



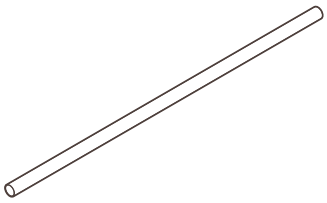
Plastic Bottle Top
1



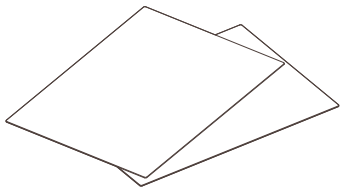
Plant Pot
1



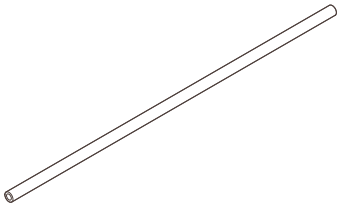
Kebab Stick
1



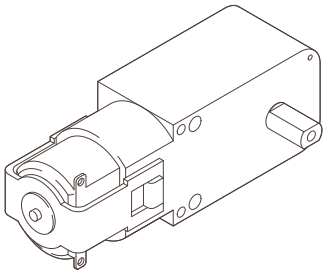
Straws
5



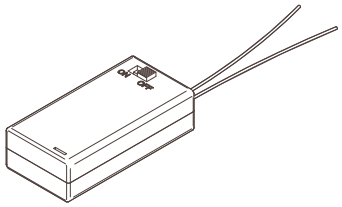
Felt
2 x A4 Sheets



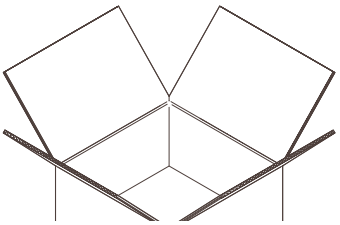
Thick Bamboo Cane
40cm



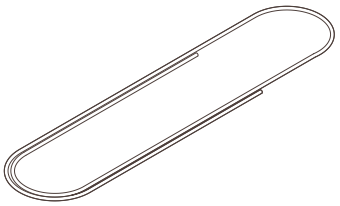
Geared Motor
1



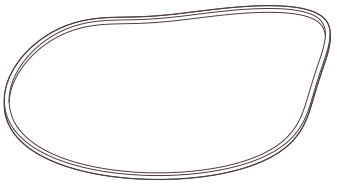
2 x AA Battery Pack
1



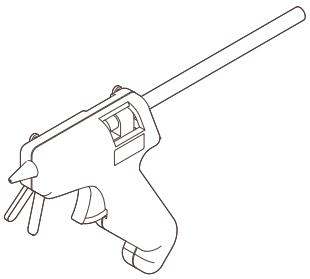
String
3m



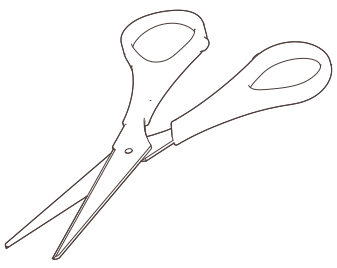
Paper Clips
4



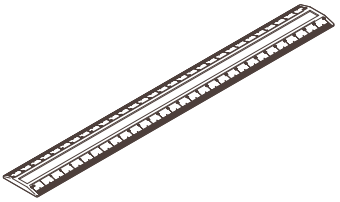
Elastic Bands
8



Glue Gun
1



Scissors
1



Ruler
1

VOCABULARY

Perpendicular - At an angle of 90 degrees to a given line.

Winch - A hauling or lifting device consisting of a rope or chain winding around a horizontal rotating spool, typically turned by a crank or motor.

Spool - A cylinder which material is wound around.

Stopper - A knot that creates a fixed thicker point, on an otherwise-uniform thickness line. This is to prevent the line, at that point, from slipping through a narrow passage.

Stamen - The male part of a flower that produces pollen and is made up of an anther and a filament.

Stigma - The upper, sticky section of the female carpel part of a flower.

Sepal - The part of a plant that protected the flower when it was a bud.

Pollination - The act of transferring pollen from the male anther of a flower to the female stigma.

Fertilisation - When the male pollen joins with the female ovules and starts to develop into a seed.

Switch - A device for making and breaking the connection in an electric circuit.

Electrical Conductor - A material that lets electricity pass through it easily.

WARM-UP ACTIVITIES

A

10-15m

Almost 70% of the crops we grow and eat in the United Kingdom are reliant on pollination by insects and animals.

To begin to identify the features of flowering plants that are responsible for pollination and fertilisation, carry out a close observation of a flower.

Can you identify the following features?

- Petals
- Stamen (anther and filament)
- Carpel (stigma, style, ovary)

Can you explain each feature's role in the pollination and fertilisation processes? Thinking about the process of pollination and fertilisation will help you understand why engineering solutions to help declining species of pollinators are so important for protecting habitats and food security in the future.

B

20-30m

Switches can be used to control whether or not electricity flows in a circuit.

The Mechanical Flower model uses paper clips attached to a section of card to create a switch. Paper clips are made of steel, a material which conducts electricity.

Before attaching your motor and battery pack to the flower model, try designing and making some different switches using materials you might find at home or in the classroom.

Investigating switches will give you inspiration for engineering your own in the Blooming Flower Build.

You could try experimenting with other materials that conduct electricity like tin foil, pegs, split pins, coins or springs.

MAIN CHALLENGE

2h

Building the Mechanical Flower is a great way to explore winch systems and learn about the flow of electric current in a circuit.

It will also get you thinking about how robotic systems could be developed in the future to imitate the function of flowering plants in struggling ecosystems. Therefore, saving important species, like bees, from extinction.

We have provided you with an example of how to build a mechanical flower and suggested some materials to use, but if you are feeling creative, we encourage you to design your own.

Every time an engineer is faced with a problem, they approach it using the Engineering Design Process.

Ask - What's the problem?

Imagine - Choose a solution.

Plan - Design and choose materials.

Create - Make it.

Test - Test your creation.

Improve - Redesign as needed.

Using this design process, see if you can create an electrically powered winch system that opens and closes the flower with a natural and gentle motion.

Good luck!

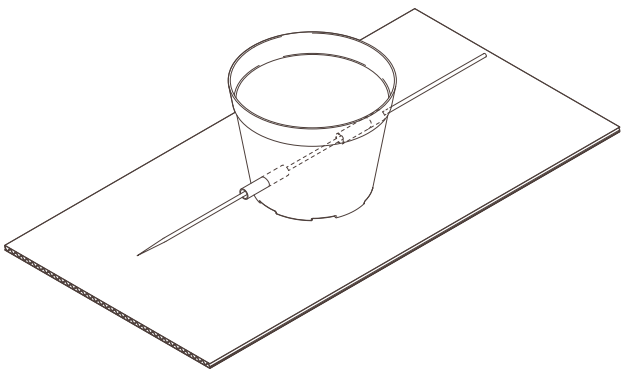
BUILDING THE MECHANICAL FLOWER

Follow these steps to make a mechanically blooming flower.

A

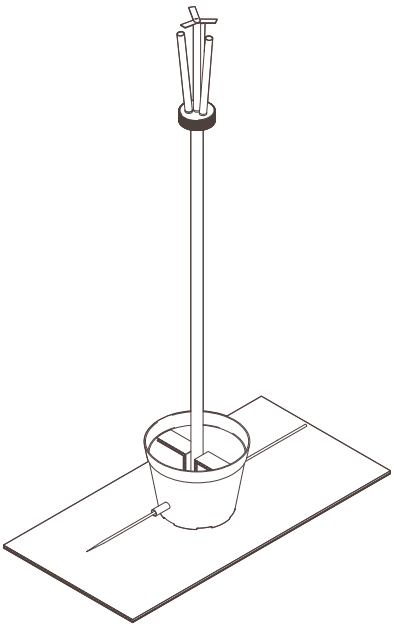
To build the winch system for the mechanical flower, use a sharp skewer to make a hole in either side of the flower pot, 2cm from the base. Ask an adult for help with the skewer if you need it.

Rotate the skewer to enlarge the holes, then push a short length of straw through each one. Thread the kebab stick through the pot to form the spool of the winch system. Then, glue the base of the pot to a 30 by 15cm cardboard base.



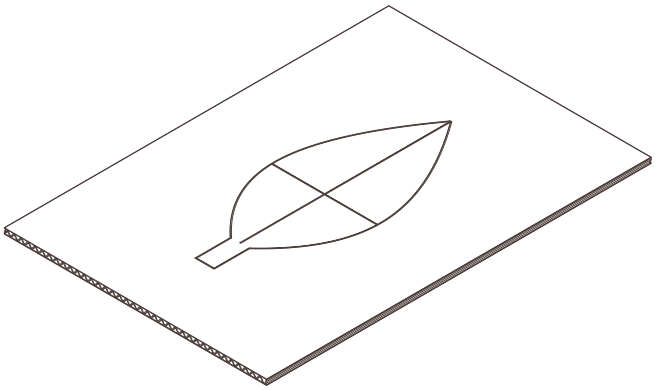
B

Trim the bamboo cane to 40cm, which will form the stalk of the flower. You may need to ask an adult to help you with this if the cane is very thick. Attach the stalk to the bottom of the plant pot with hot glue. Adding some pieces of cardboard inside the pot will help to stabilize the stalk and keep it upright. Glue the plastic bottle top on to the top of the stalk and use coloured straws to make a stamen and stigma for the flower.



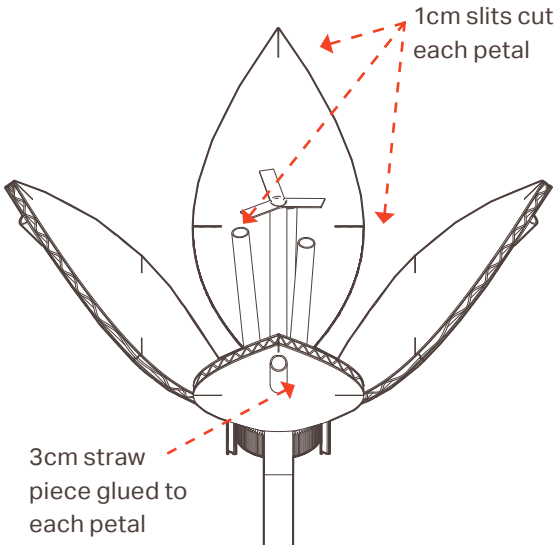
C

Next, use the corrugated cardboard to make some petals. To draw the shape, mark a 12cm long line, then measure 6cm along it and draw a perpendicular 6cm long line. Join the ends of the two straight lines with curved lines to create a petal shape. Then add a tab at the end, which will connect the petal to the top of the stem. Cut the petal shape out and use it as a template to make three more. Finish the petals by covering them in felt, you might like to choose a bright colour to attract pollinators!



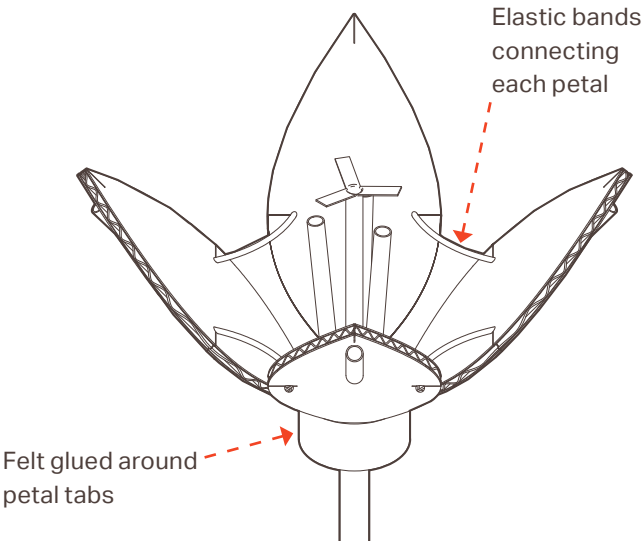
D

To prepare the petals for connection to the winch system, cut a 1cm long slit in the tip of each petal and two more 1cm long slits in the sides where the petals are widest. Then, glue a 3cm length of straw just below each of the slits at the tips of the petals. Attach the petals to the stalk by glueing the cardboard tabs around the edge of the plastic bottle cap. The side of the petal that has the straw stuck on it should be facing outwards.



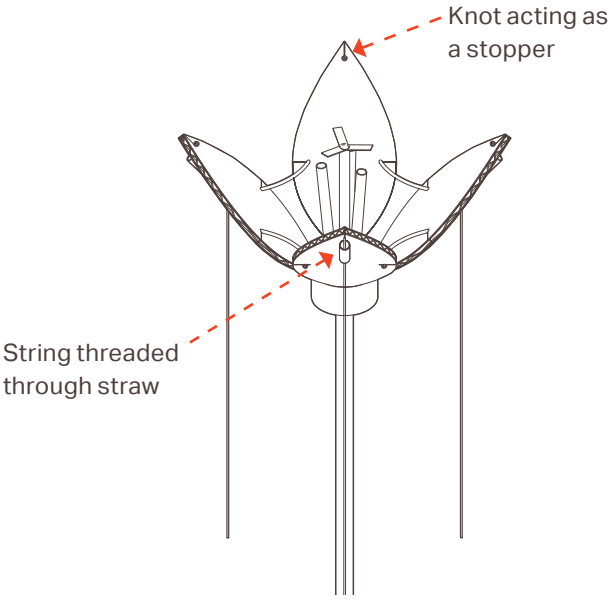
E

Cover the cardboard tabs with a length of felt, this will form the sepal of the flower. So that the flower closes again after blooming, the petals need to be connected with elastic bands. Cut four elastic bands in two and tie knots on both ends. Slide the bands into the slits on either side of the petals so the knots act as stoppers. The bands should be long enough to connect the two petals without being pulled tightly when the flower is in a closed position.



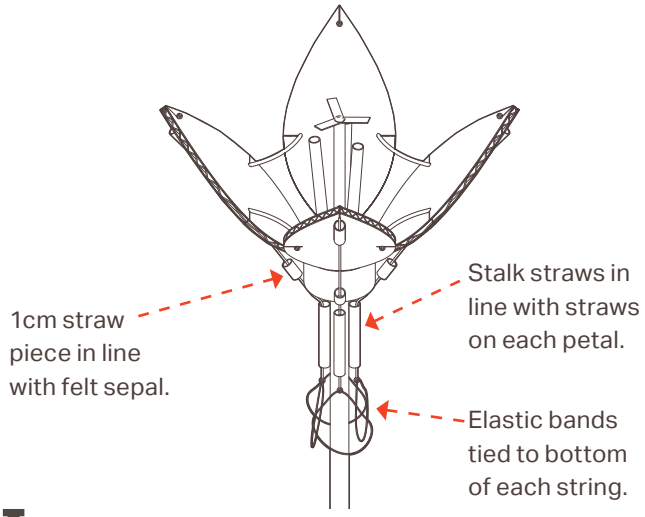
F

To begin connecting the petals to the winch system, cut four 30cm lengths of string and tie a knot in the end of each one. Slide the string through the slits in the tips of the petals so the knots act as stoppers. Then, thread each string through the straw on the back of the petal.



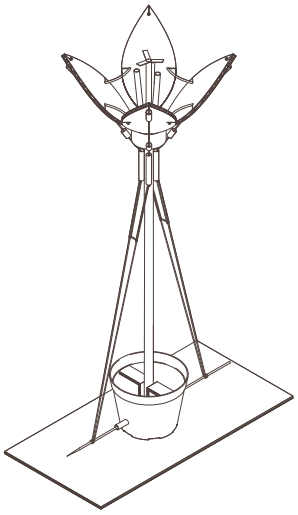
G

Now, create a stopper system that will prevent the flower from opening too widely. First, tie a large knot in each of the 4 strings, so that they hang in the middle of the felt sepal section. Next, thread a 1cm long piece of straw over each knot and glue it in place. Stick four 4cm long pieces of straw to the stalk in line with the straws on the petals above and 1.5cm below the bottom of the felt sepal. This will provide a narrow opening which the stopper will be unable to pass through. Then, thread the ends of the strings through the straws on the stem. Trim the strings and tie an elastic band on the end of each one.



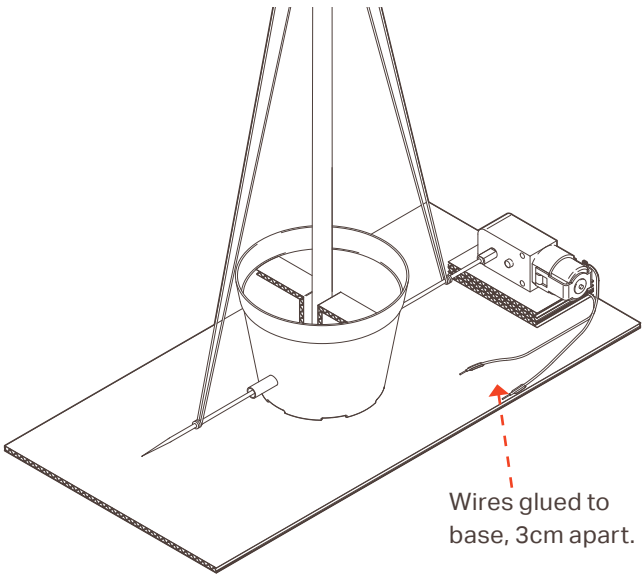
H

To complete the winch system, thread a long length of string through the two elastic bands hanging on the side of the stem. Then, wrap the string around the kebab stick spool. Tie the ends together to create a continuous loop. Adjust the string so it is not too tight when the flower is in a closed position. Then use hot glue to secure the string on the spool. Repeat this step for the two remaining elastic bands on the other side of the model.



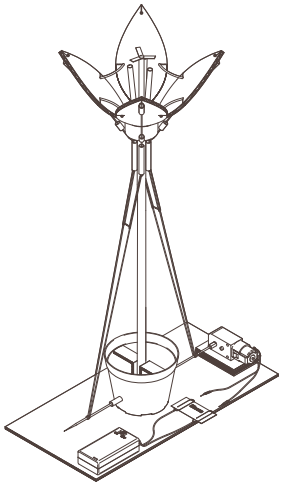
I

Now, connect the motor to the winch spool. Push the end of the kebab stick into the hole on the side of the motor and use hot glue to secure it. To keep the motor still while it is on, stack some small pieces of card below it, so it is raised to the height of the spool, then glue the card and motor to the base. Arrange the ends of the motor wires so there is a 3cm gap between them. Then, secure the wires to the base using hot glue.



J

The mechanical flower will be controlled by a switch that can reverse the direction of the spool. To create the switch, wrap the metal ends of the battery wires around paper clips. Then slide the paper clips onto a piece of card and position them 3cm apart from one another. Draw a design on either side of the switch so you can distinguish between them. When the paper clips make contact with the ends of the motor wires, the circuit will be complete and the winch will begin to wind. Removing the paper clips will break the circuit, stopping the winch. To reverse the winding motion, flip the switch over to reconnect the circuit with the batteries wired in the opposite direction.



MECHANICAL FLOWER

10-15m

ENGINEERING AND NATURE

KS 2
UNDERSTAND THE SCIENCE

Why do flowering plants need bees?

Most plants reproduce by forming seeds. For plants to produce seeds, pollen grains from the stamen (the male part of the flower) have to be transferred to the stigma and ovary (the female part of the flower). This process is called pollination. The pollen then joins together with, or fertilises, the ovules and produces new seeds.

Since plants can't move, they must use other methods to ensure pollen is transferred from the stamens of one plant to the stigma of another. For many of our everyday fruit and vegetable crops, the pollination process is carried out by animals. The most important of all the pollinators are bees.

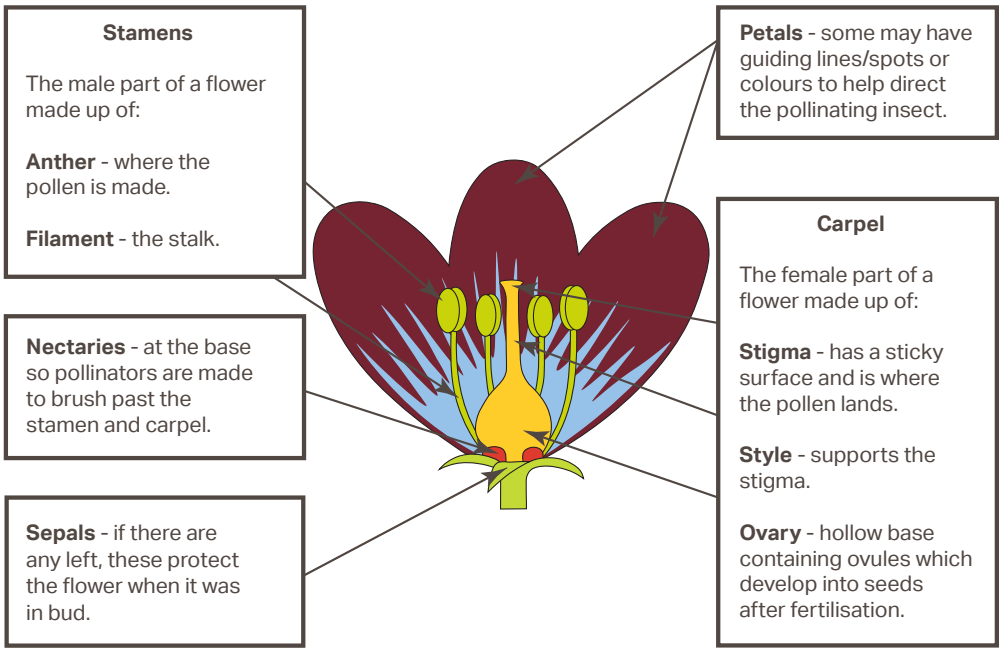
Bees are attracted to the brightly coloured petals of flowers and the sweet scent of the nectar. Bees collect nectar, which is a sugar rich liquid, to provide them with energy and to produce honey. They also collect pollen, as it is a source of protein for them.

When a bee arrives at a flower, it crawls inside to reach the nectar. As the bee crawls past the stamens, it's back is dusted with pollen. When they visit the next flower, some of this pollen rubs off and is collected on the sticky surface of the stigma.

Bees are incredibly hard-working invertebrates. A forager bee may visit 2,000 flowers a day to collect nectar and pollen. Each bee can travel about 500 miles in its lifetime and if it is not eaten by a predator, the bee usually dies of exhaustion after about three weeks. During that time, it will have produced about a twelfth of a teaspoon of honey – probably the amount left on your knife after spreading honey on your toast!

Many of the nutritious foods we enjoy in our diets also rely on pollination for a successful harvest. For example, apples, strawberries, carrots, tomatoes, cucumbers and chocolate.

Parts of a Flower



KS 3
DEEPER LEARNING

How Does an Electric Motor Work?

Direct current (DC) motors are devices designed to convert direct current electrical energy to mechanical energy.

When a wire is connected to a battery, negatively charged electrons flow away from the negative terminal of the battery.
They flow towards the positive end, because opposite charges attract each other, while like (similar) charges repel each other. This flow of electrons through the wire is electric current, and it produces a magnetic force around the wire.

Inside a DC motor, two permanent magnets are positioned so that the north pole of one magnet faces the south pole of the other magnet. A coil of wire is mounted in the gap between the two magnets. Two half rings, called commutaters, link the wire coil to two brushes, which are each connected to the battery.

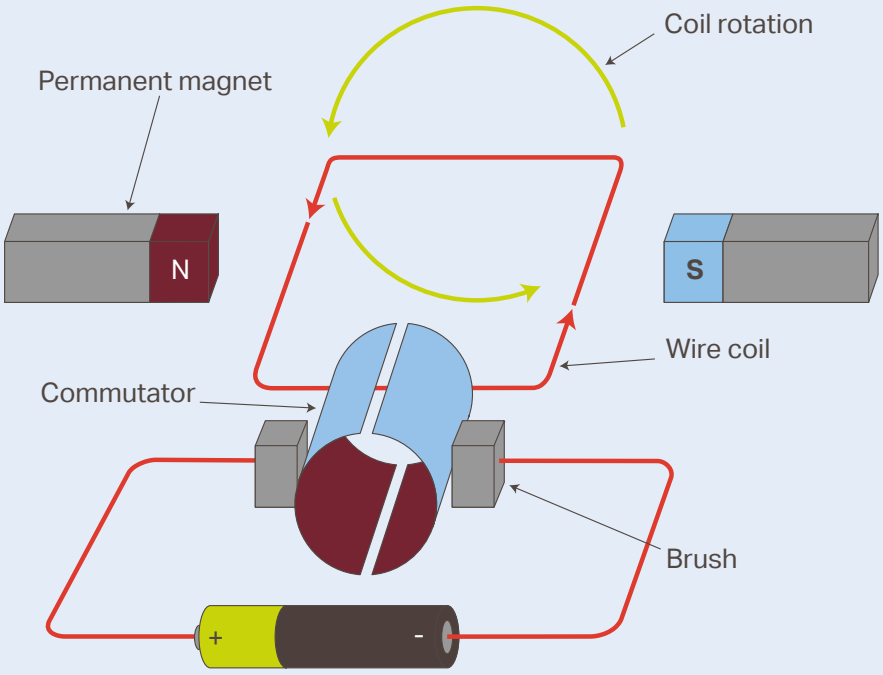
When electric current is passed through this coil of wire, it becomes a temporary magnet, with the location of the north and south poles dictated by the direction of the electric current flowing through it. The magnetic poles formed on the wire coil repel the magnetic poles of the permanent magnet, causing the coil to flip 180 degrees.

Without the commutators, a DC motor would only ever be capable of turning 180 degrees. However, because of the gap in between the commutators, every time the coil rotates 180 degrees, the brushes make contact with the opposite commutator segment and this reverses the direction of current flow within the wire coil. The north and south poles within the coil swap, leading to the coil again repelling the permanent magnets and performing another 180 degree flip.

A DC motor relies on swapping the magnetic poles of the wire coil every 180 degrees, so that it is always being repelled by the permanent magnets surrounding it and therefore creates constant rotational motion.

DID YOU KNOW?

Self-taught British scientist Michael Faraday built the first primitive electric motor in 1821, shortly after the discovery that an electric current produces a magnetic field.



QUIZ

5-10m

At what angle do perpendicular lines cross?

.....

.....

Which part of the flower produces pollen?

.....

.....

Why do bees collect nectar?

.....

.....

How do plants attract pollinators?

.....

.....

How could the declining numbers of pollinating insects affect humans?

.....

.....

QUIZ

What kind of material is needed to make a switch?

.....

.....

Who was responsible for building the first electric motor?

.....

.....

Why do negatively charged electrons flow away from the negative terminal of a battery?

.....

.....

Name some of the parts found inside of a DC motor.

.....

.....

What new technologies are engineers developing to stop the decline in the number of bees?

.....

.....