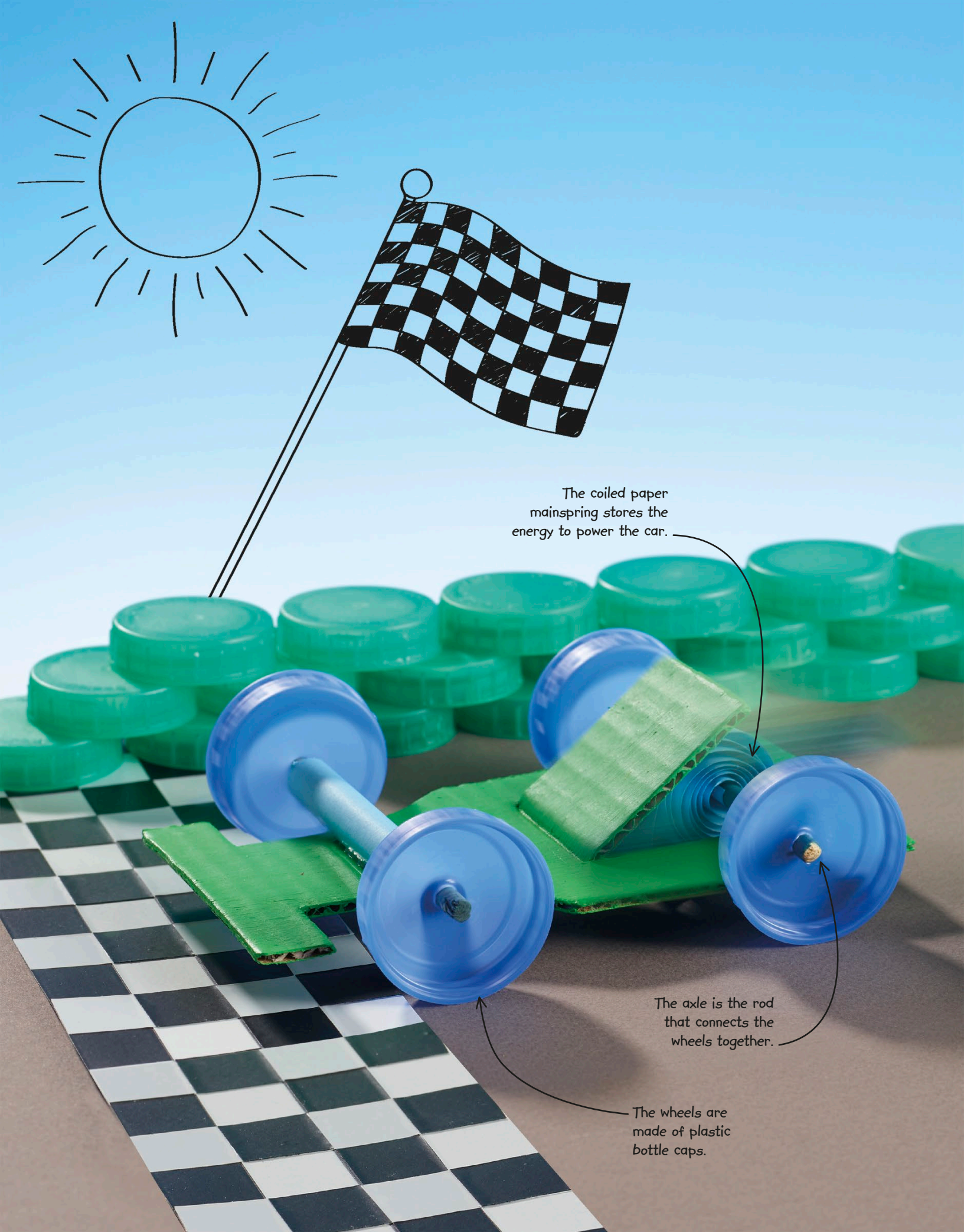
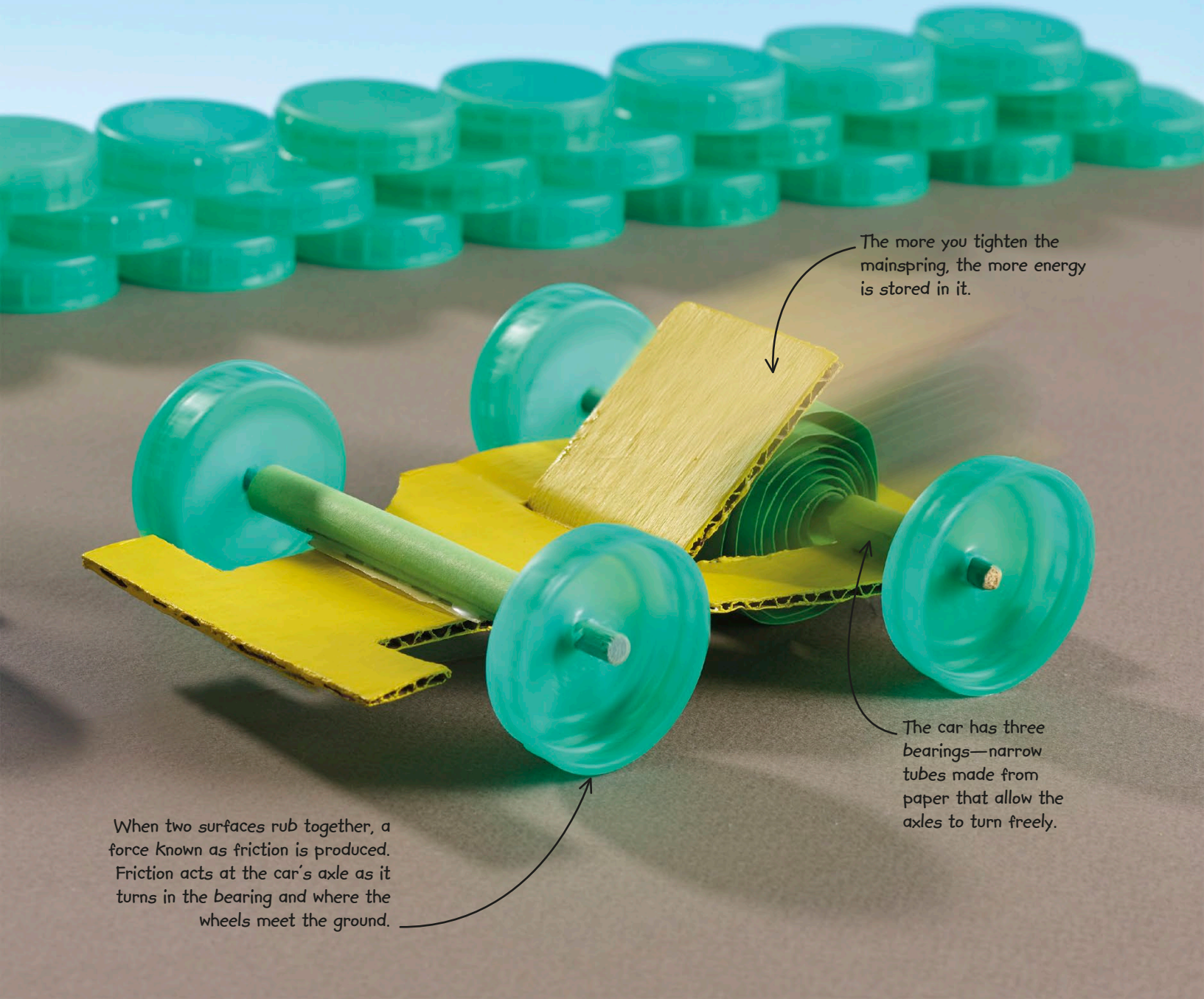

The coiled paper mainspring stores the energy to power the car.
The axle is the rod that connects the wheels together.
The wheels are made of plastic bottle caps.

POTENTIAL ENERGY

WIND-UP CAR

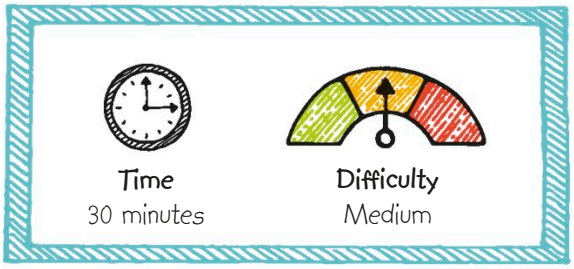
Used for centuries to make clocks and moving toys, wind-up mechanisms have long, coiled strips of springy material called mainsprings that store energy as they're tightened. Energy can't be created or destroyed—it can only be transferred. So as you wind up the car, its mainspring stores the energy you put into turning it. Let it go, and VROOM! The energy is released, and your car is off!



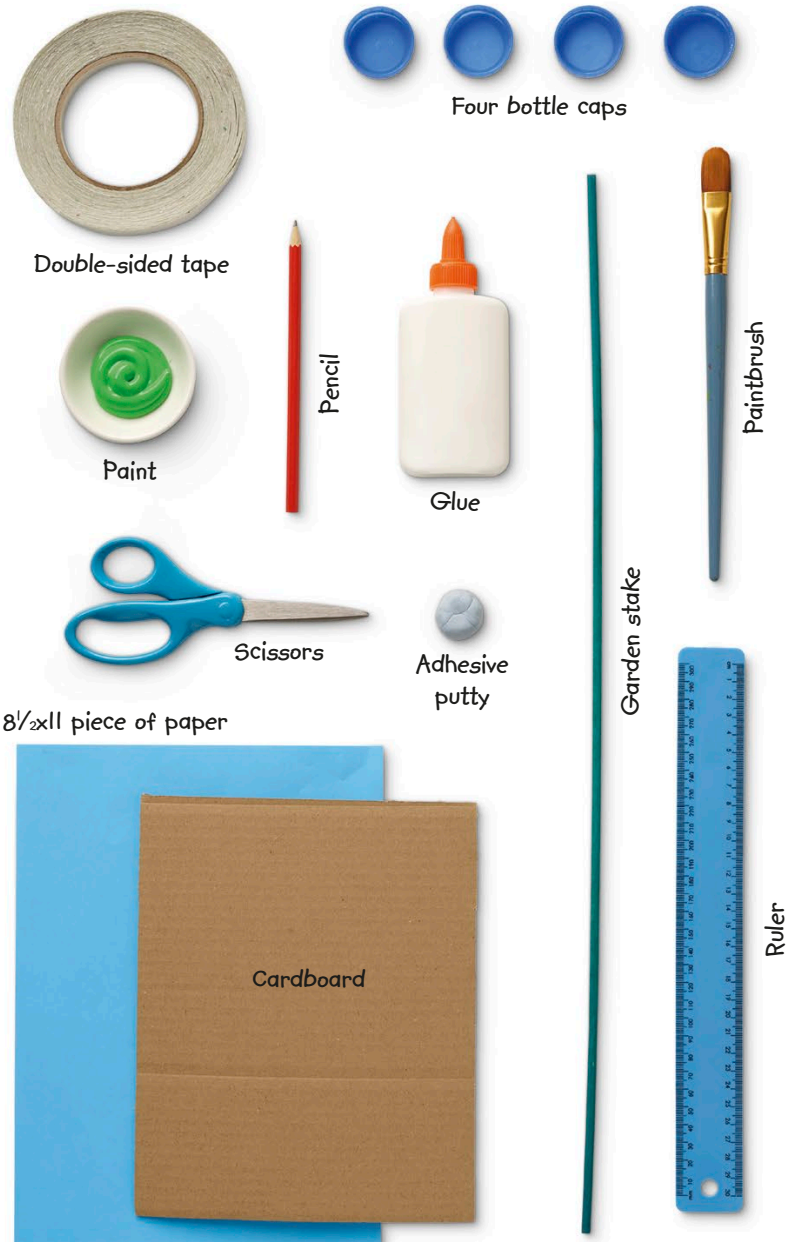
HOW TO MAKE A

WIND-UP CAR

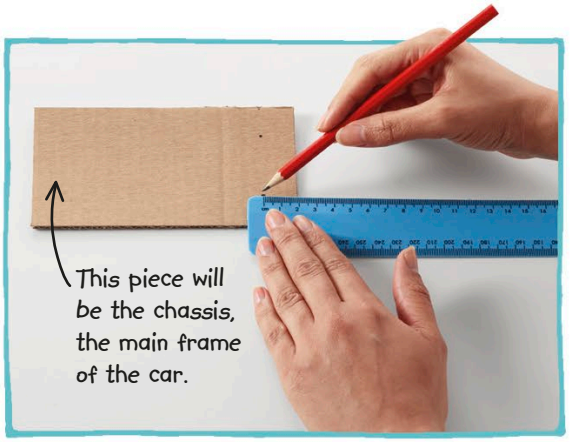
This wind-up car is powered by energy stored in a coiled mainspring made of paper. Its axles (the rods connecting the wheels) are made from a garden stake, while its bearings (the tubes that allow the axles to turn freely) are made with paper. The axles and bearings are attached to the car's frame, or chassis.



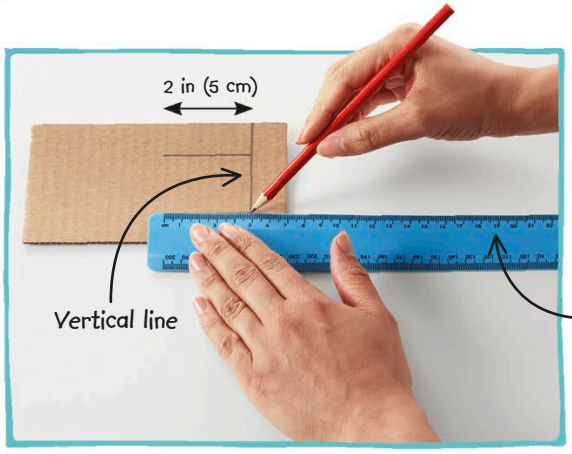
WHAT YOU NEED



1 Draw a rectangle 6 in (15 cm) long and 3 in (8 cm) wide on the cardboard. Use a ruler to make sure your lines are straight. With the scissors, carefully cut out the rectangle you drew.



2 At one end of your chassis, draw two dots, each ¾ in (2 cm) in from the end and from the side. Draw a line that passes through the dots.

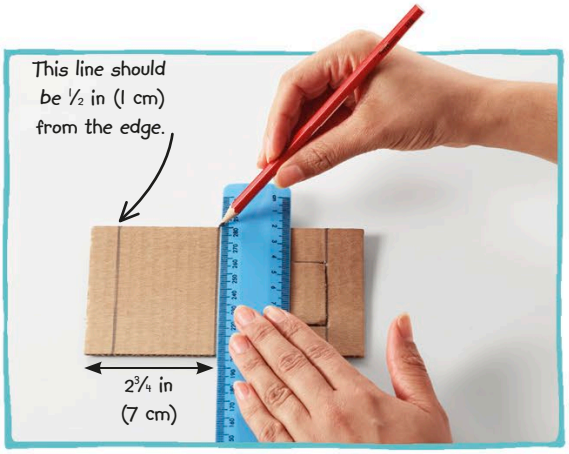


Make sure when you draw the two lines that they are parallel to each other.

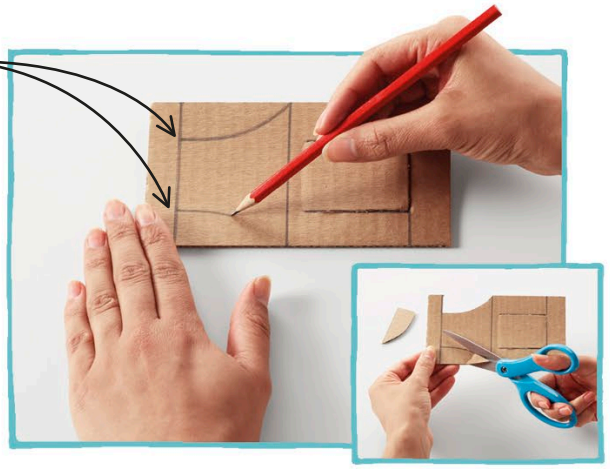
3 Draw two lines 2 in (5 cm) long at right angles from the vertical line you just drew, each one starting at one of the dots.

Ask an adult to help you if you find this step difficult.

4 Using scissors, carefully cut along the middle of the vertical line, then down the two lines you just drew, to create a flap.



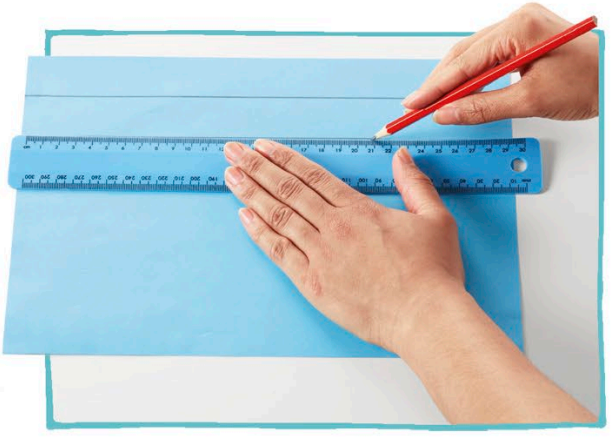
The dots should be ¾ in (2 cm) in from each end of this line.



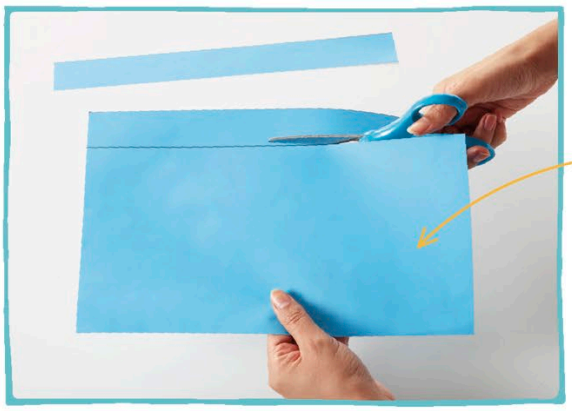
5 Draw two more lines parallel to the first one, about ½ in (1 cm) and 2¾ in (7 cm) from the other end of your chassis.

6 Make dots ¾ in (2 cm) in from each end of the line nearest the end, and draw a smooth curve from the dots to the ends of the other line. Cut along the curves.

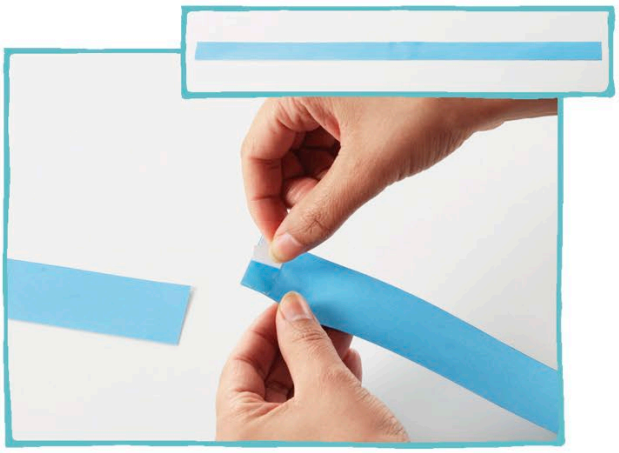
7 Paint the chassis. We've used green paint, but you can choose whatever color you like.



8 On a piece of paper, draw two lines, 1¼ in (3 cm) and 2½ in (6 cm) in, from one of the long sides of the paper.

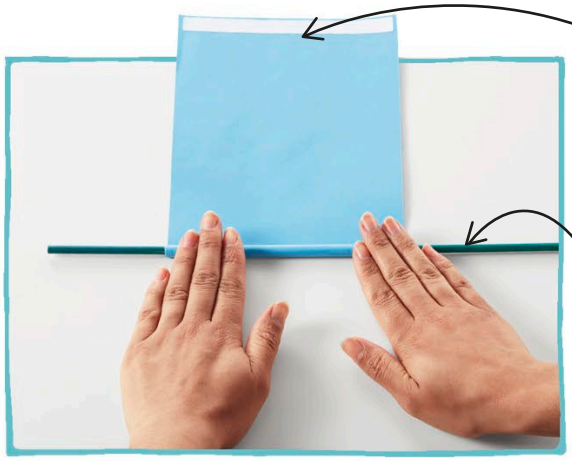


Paper is a thin, versatile material made from mashed-up wood fibers.



9 Cut along the two lines to make two long strips. These will be used to make the mainspring.

10 Use a small strip of double-sided tape to join the two pieces of paper together into one long piece.



The double-sided tape will allow you to seal the paper's top edge onto the tube.

Don't roll the paper too tightly, as your car's axle will need to turn inside it.

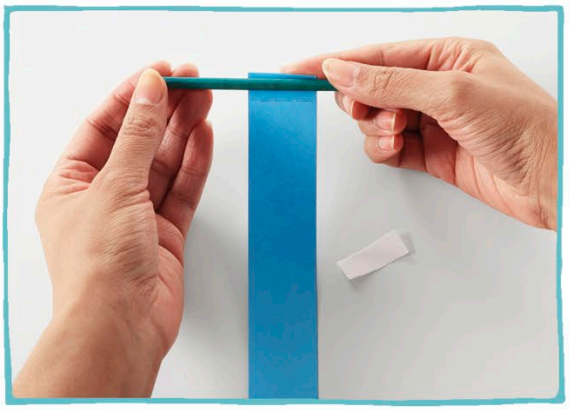
11 Take the rest of the sheet of paper and roll it lengthwise around the garden stake to make a tube. Secure the tube with double-sided tape.

12 Draw lines on the tube at distances of ¾, 1½, and 5 in (2, 4, and 12 cm) from one end. These pieces will be your bearings.

Paper becomes very strong when it is rolled up.

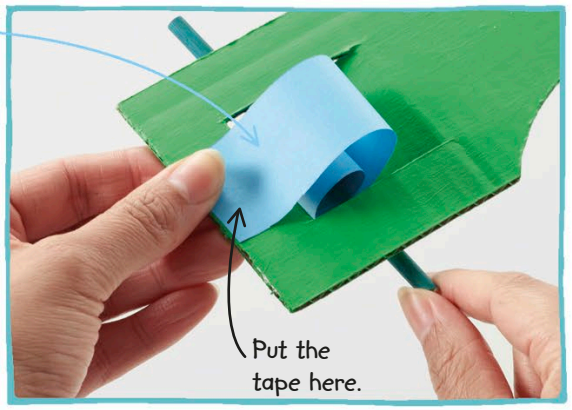
13 Cut the tube along the lines you drew. You should end up with two pieces ½ in (1 cm) long and one piece 1½ in (4 cm) long. You don't need the rest of the paper tube, so try to recycle it.

14 Carefully cut two 4½ in (11 cm) lengths of garden stake. If you have trouble cutting it safely or neatly, ask an adult to help. These will be your axles.

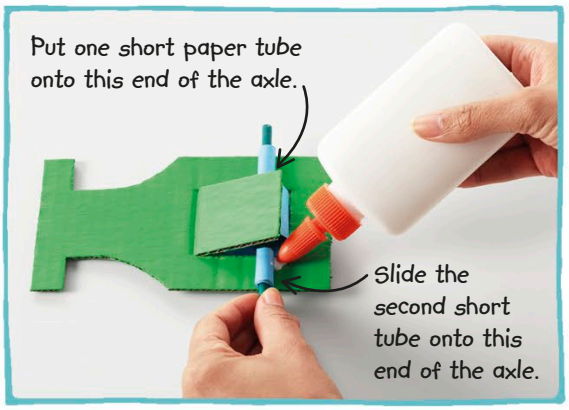


15 Tape one end of your long strip of paper to the middle of one of your garden stake axles. Coil the paper around the axle.

Once it is wound up, the car's mainspring will store potential energy.



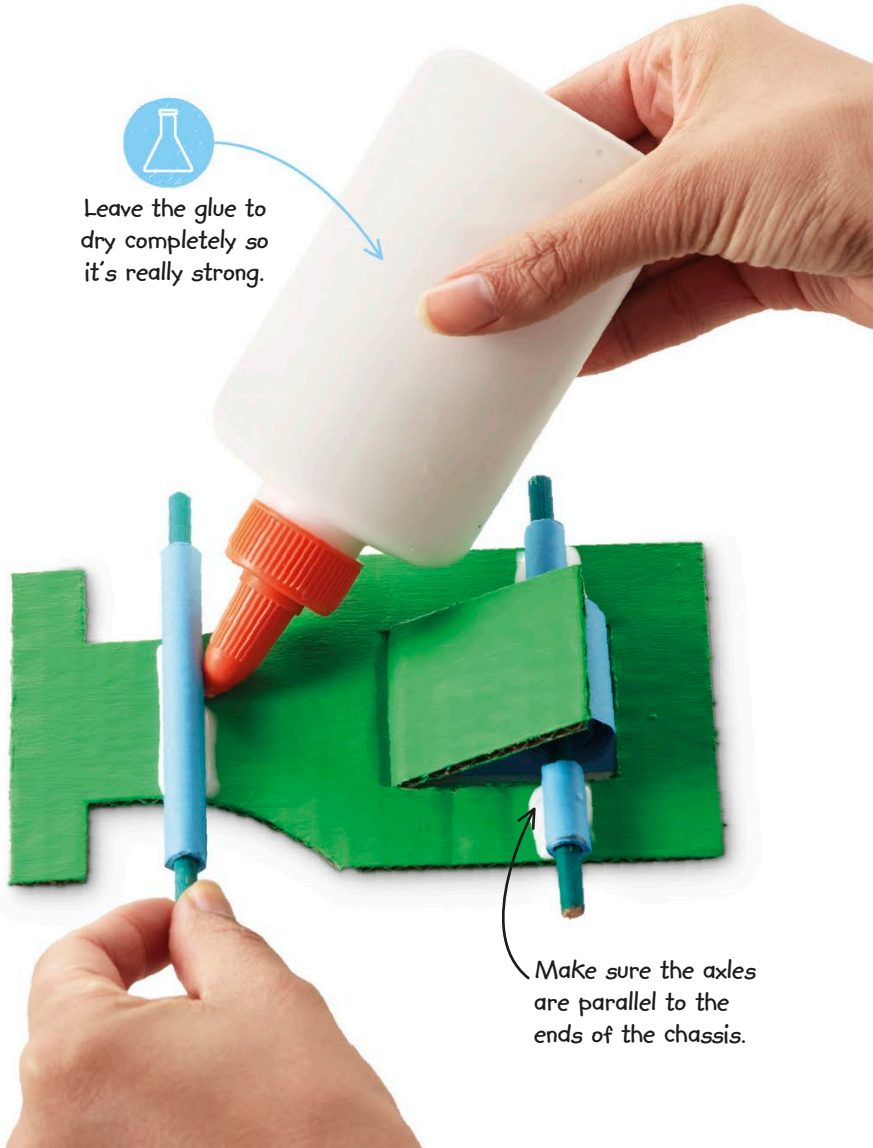
16 Turn the chassis upside down and push the coiled mainspring through the flap of cardboard. Use double-sided tape to secure it.



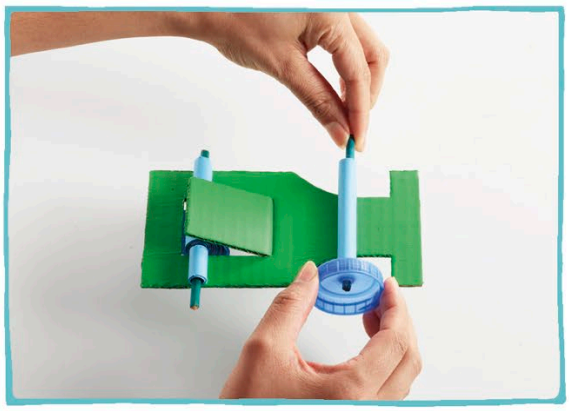
17 Turn the chassis over again and slip one short paper tube over each end of the axle. Glue them in place.

18 Slip the longer paper tube over the other garden stake axle and glue that in place near the other end of the chassis.

Leave the glue to dry completely so it's really strong.



19 Use the pencil to make a small hole in the center of each of the four bottle caps. Use adhesive putty to protect the table and your fingers.



20 Push the bottle caps over the ends of the axle to give your car wheels. If they are loose, secure them with adhesive putty or glue.

Energy can't be created or destroyed. It can only be transferred.

21 To make your car go, you have to wind up the mainspring. Do this by placing the car on the ground and pulling it backward. Let go and watch it speed off!

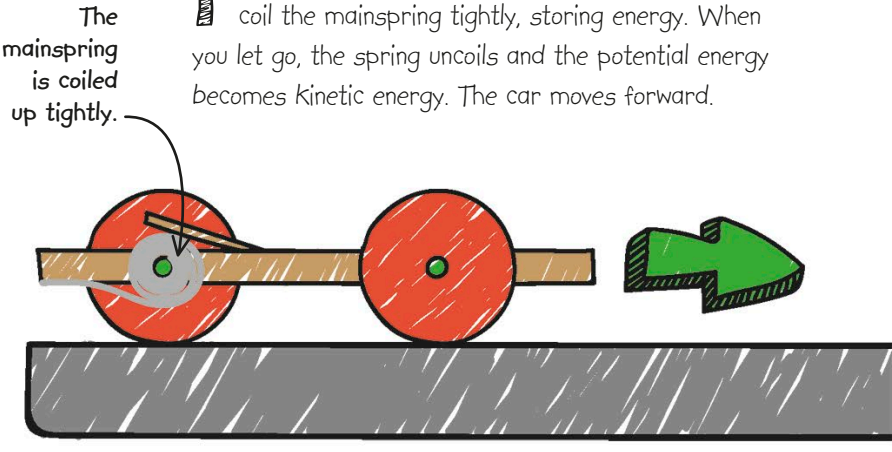
You can work out your car's average speed by dividing the distance it travels by how long it takes.

The mainspring's energy is converted into kinetic energy, then lost as heat at the axles and ground due to friction and air resistance.

HOW IT WORKS

Your car demonstrates potential and kinetic energy. Potential energy is stored energy, ready to make things happen. Kinetic energy is the energy objects have when they move. When you wind up the mainspring, you are storing potential energy, which will be used to make the car travel forward. The faster an object moves and the more mass it has, the more kinetic energy it has. You can calculate the amount of energy a moving object has: multiply its mass (the amount of matter, or stuff it is made of) by its speed squared, then divide by 2.

1 As you pull the car backward, the turning wheels coil the mainspring tightly, storing energy. When you let go, the spring uncoils and the potential energy becomes kinetic energy. The car moves forward.

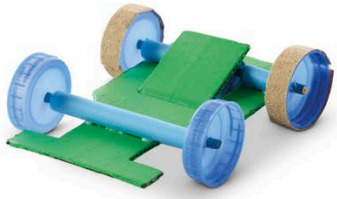


TEST AND TWEAK

Your wind-up car should zoom across the floor or table as the mainspring unwinds. Test it out on different surfaces and adapt its design to see if you can make your car go farther and faster.

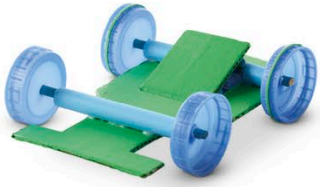
SANDPAPER WHEELS

Try wrapping sandpaper around the rear wheels to increase the amount of friction between them and the ground.



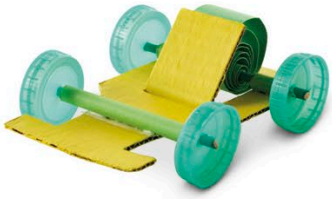
RUBBER BANDS

Putting rubber bands around the wheels gives the wheels extra traction, or grip, like the rubber tires of a real car.



CARD MAINSPRING

A mainspring made of cardstock should make your car go faster, as cardstock stores more energy than paper. But it will release this energy faster, so your car won't travel as far.



REAL WORLD: TECHNOLOGY
ELECTRIC CARS

Most cars use the chemical potential energy stored in gasoline to move, but not all. Electric cars have powerful batteries that store electrical potential energy. They can be recharged, like a smartphone.

REAL WORLD: MATH
AIR RESISTANCE

Moving cars encounter a force called air resistance, which slows them down. Air resistance increases with speed. If you double the speed of the moving vehicle, the air resistance quadruples.

2 The spring continues uncoiling and the car keeps moving. Its kinetic energy is lost as heat. This happens through friction (at the axles and the ground) and air resistance.

The mainspring has completely uncoiled and can provide no more energy for the car.

3 You can't feel the heat generated by friction and air resistance, as there isn't much kinetic energy in the first place. Once the kinetic energy is lost, the car stops.