INTRO TO ENGINEERING
SCIENCE KIT

guidebook

little labs™

SCIENCE EDUCATION SET

WARNING — This set contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision.

Thames & Kosmos®

General Recommendations and Advice for Parents and Users

Caution! Some components in this kit have sharp points, edges, or corners. They may cause injury.

Not suitable for children under 3 years due to small parts, balls, and balloons that could be swallowed.

Store the experiment kit out of reach of small children.

The right to technical changes is reserved.

WARNING!

CHOKING HAZARD — Small parts. Toy contains a small ball. Children under 8 yrs. can choke or suffocate on uninflated or broken balloons. Adult supervision required. Keep uninflated balloons from children. Discard broken balloons at once. Not for children under 3 yrs.

The supervising adult should select suitable experiments and discuss procedures and advice with the child in advance and ensure that they are followed. Small children and animals should be kept away from the experiments. Nothing should be swallowed or eaten in the process. After the experiments, the used parts should be rinsed, dried with paper towel, and put back in their spots in the experiment kit. The worktable should be wiped off and hands should be washed.

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intro to engineering

guidebook

Franckh-Kosmos Verlags-GmbH & Co. KG, Stuttgart, Germany
Thames & Kosmos, LLC, Providence, RI USA

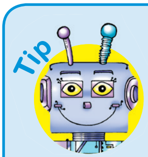
Dear Parents,
Children are curious. They want to explore and understand the world. With this experiment kit, even five-year-olds can carry out their first exciting experiments. Experimenting, wondering, and playing are all tied together, so they won't miss out on fun while they learn. In the process, they will develop an understanding of the fundamentals of engineering, and they will discover how fun it can be to do experimental research.

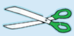
The experiments are easy, but they won't work without a little effort. Give support to your little explorers, since children's curiosity and ability to understand things are often more fully developed than their manual capabilities. Whenever the need arises, it will be particularly important to provide help when dealing with sharp or pointed objects, such as knives, scissors, wire, pliers, or thumbtacks. And if an experiment doesn't work right the first time, encourage your child to try the experiment one more time.

If an experiment is marked with this symbol it means that your help will be required to make sure it is safe and successful.

Help your child find a well-lit location that can take a little wear and tear, where you can both do the experiments without being disturbed. As with real researchers, it is advisable to wear old clothes that you won't mind getting dirty. We also recommend that you have all the experimental materials ready beforehand, so it won't be necessary to stop in the middle of an experiment to get something. Because the experiment kit was designed for young researchers, the descriptions and explanations have been kept as short and simple as possible. They should be organized and read together beforehand, so that the children can carry out the experiments independently with a good understanding of the background knowledge.

We wish you a lot of fun with them!



Scissors  + Solid line ——— = Cut
Dotted line ·········· = Line remains visible on outside when folded
Dashed line – – – – – = Line disappears on the inside when folded
Dotted pink surface = Gluing surface

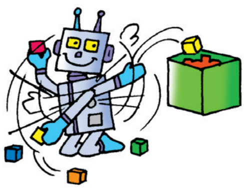
Additional household materials you may need:
Paper, pencil, tape, glue, scissors, knife, small pliers, coin, glass, plastic cup, mixing bowl, two small, empty yogurt containers, paper towels, water, sink, bathtub, long wooden board for a ramp, two broomsticks, rope (about 4 meters long and smooth, e.g. towing rope from the car), books, toy such as building blocks, marbles, dice, toy figure to serve as captain.

Your kit contains the following components:

No.	Description	Quantity	Part No.
1	Flip-book paper sheet	1	706516
2	Windmill and helicopter paper sheet	1	706526
3	Glider paper sheet	1	706522
4	Shuttle paper sheet	1	706523
5	Sail, water glass trick, and instruction sheet	1	706524
6	Die-cut cardboard sheet	1	706528
7	String	1	700078
8	Wooden stick	1	529119
9	Plastic film	1	000587
10	Flexible drinking straw	1	529118
11	Drinking straws	3	701375
12	Pipette	1	232134
13	Parachute material	1	706535
14	Yellow balloon	1	706536
15	Red balloon	1	706537
16	Balloon clip	1	706538
17	Thumbtack	1	706642
18	Wooden beads	2	702756
19	Paper clips	4	263132
20	Small rubber bands	2	706641
21	Large rubber bands	4	706640

No.	Description	Quantity	Part No.
22	Paddle wheel	1	706540
23	Axle	1	706803
24	Anchor pin lever	1	702590
25	Small frame	1	703232
26	Long rods	2	703235
27	Five-hole rods	2	704063
28	Three-hole rods	2	706531
29	Medium gear wheels	2	702505
30	Medium pulleys	2	702518
31	Small pulleys	2	702519
32	O-rings for medium pulleys	2	703251
33	Long shafts	2	703234
34	Medium shaft	1	703238
35	Short shaft	1	703236
36	Crane hook	1	706533
37	String spool	1	702513
38	Connection bridge	1	703231
39	Anchor pins	14	702527
40	Shaft plug	1	702525
41	Joint pin	1	702524
42	Gray rivets	4	704062
43	Axle locks	2	702813

The right to technical alterations is reserved.

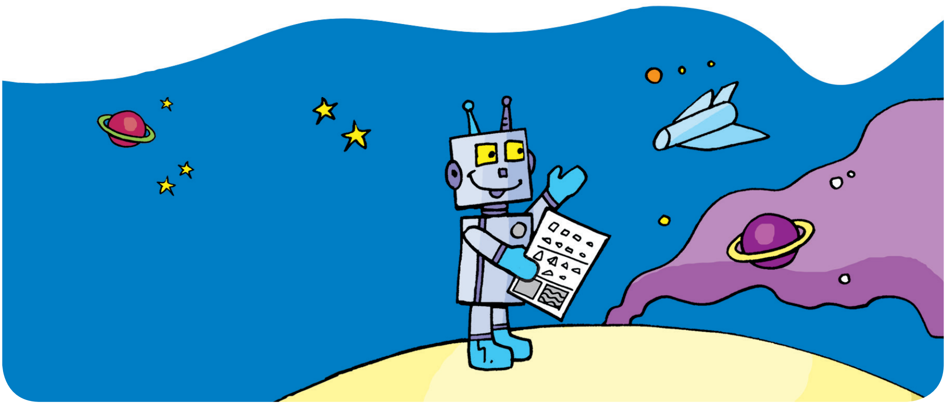


What Is Engineering?

Engineering is the use of scientific knowledge for designing and building things. A person who studies or practices engineering is called an engineer. Engineers plan and build everything from machines to specific materials, from giant structures to microscopic devices, from manufacturing systems to software programs on computers.

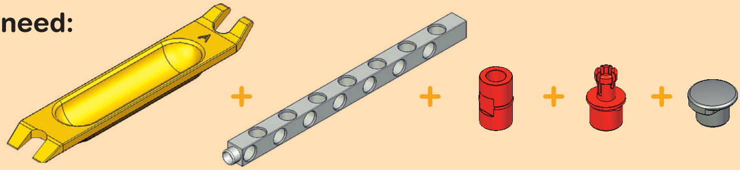
There are six main branches of engineering. Mechanical engineers work on physical systems and machines, like engines and buildings. Civil engineers work on large infrastructure projects, like highways and bridges. Chemical engineers work with all sorts of materials and substances. Aerospace engineers design airplanes and spacecraft. Electrical engineers work on devices that use electricity, like computers. Software engineers write computer programs.

In this kit, we have divided the projects into sections based on location: projects on land, in the air, in the water, and at home. There is also one experiment on engineering in the future, just for fun.



level

You will need:



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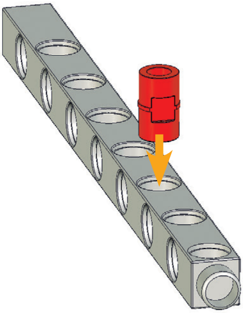

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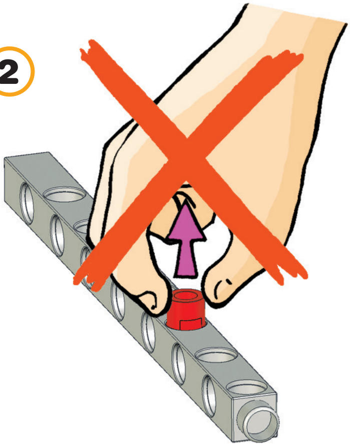

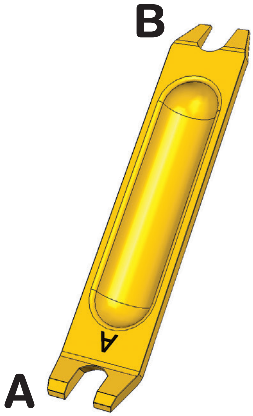

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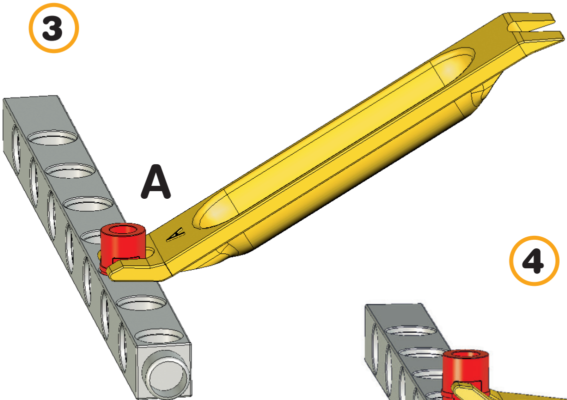
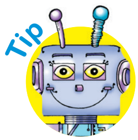
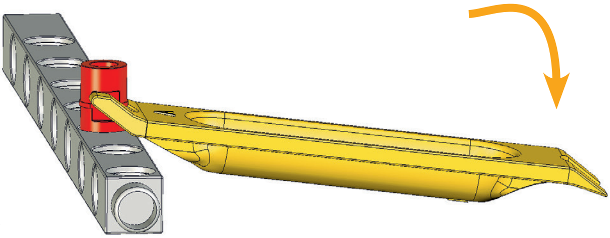




Side A = Narrow
Side B = Wide

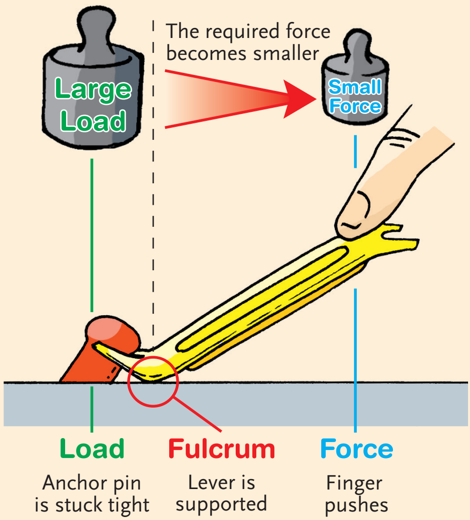
4



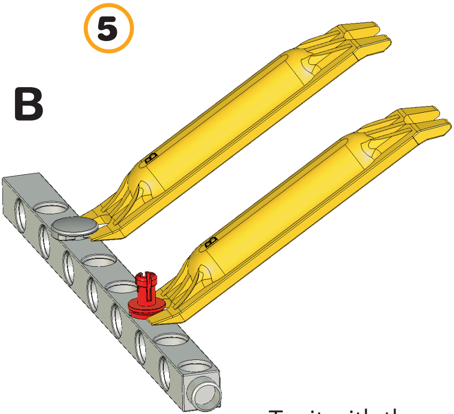
The lever helps you
pull the red pin out.

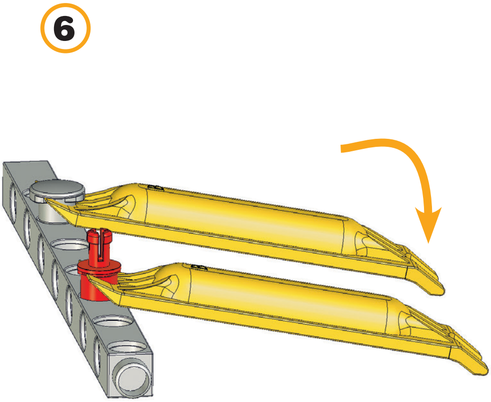
how it works!

It's easier with a lever! You can use a lever to move a load that would otherwise be too heavy for your strength. The farther away from the fulcrum you push, the easier it is. So a long lever can lift a heavier load than a short one.



A lever is a **simple machine** — because it alters a force such that useful work can be done with it. Levers often form parts of larger and more complicated machines. The arm of an earth-digging excavator, for example, is a lever.

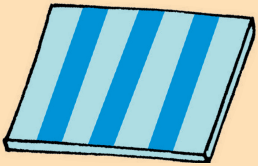




Try it with the gray rivet and the shaft plug.

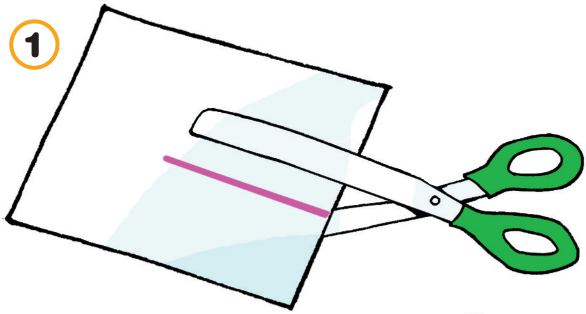
scissors

you will need:



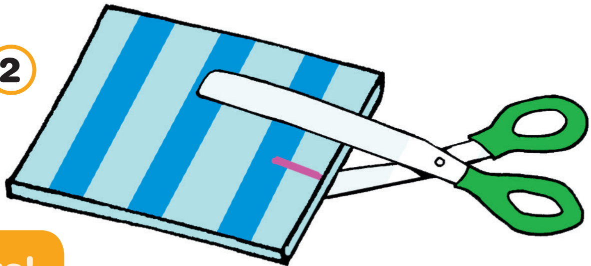
+ *Scissor*, *Paper*

1



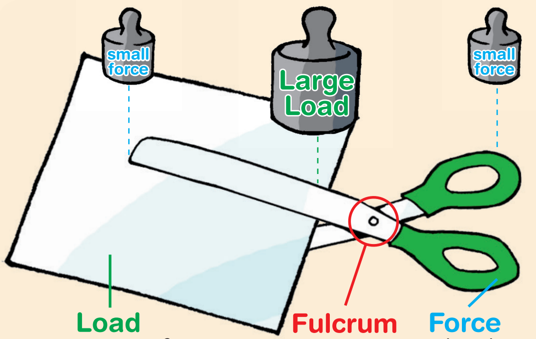
How much force do you need? What is easy to cut? What is hard to cut?

2



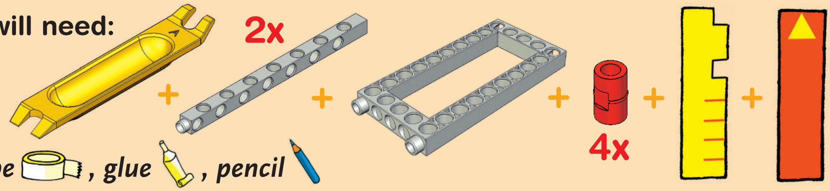
how it works!

A pair of scissors is a lever too! Scissors can come in handy: The scissors increase the force of your fingers. Near the fulcrum, the scissors cut with the greatest force — there, you can even cut thick cardboard easily. Try it several times and make a bunch of small cuts!

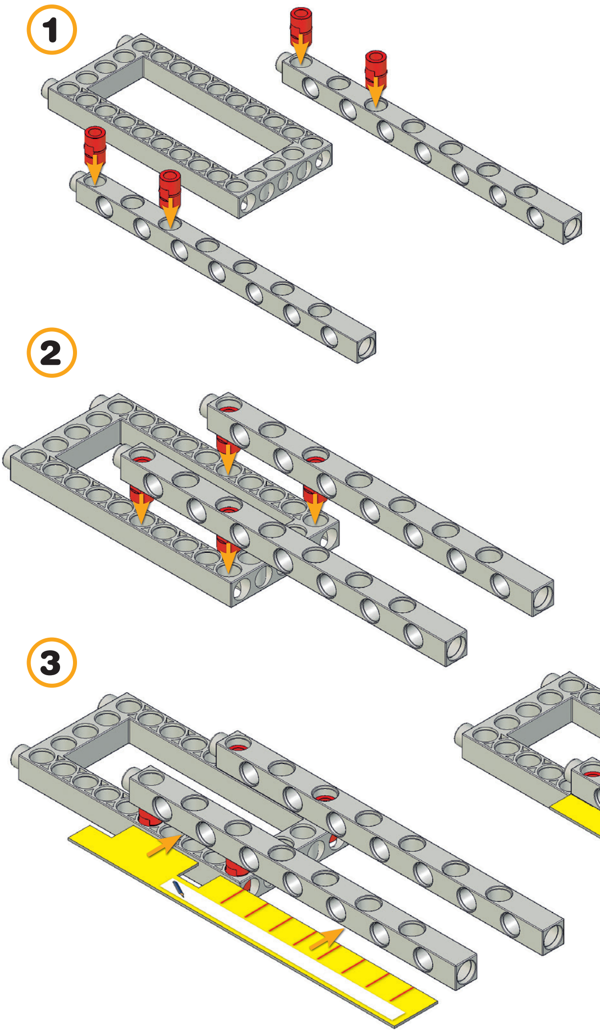


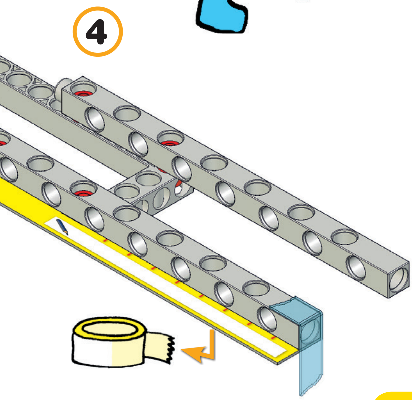
tipping scale

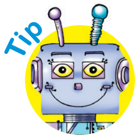
you will need:



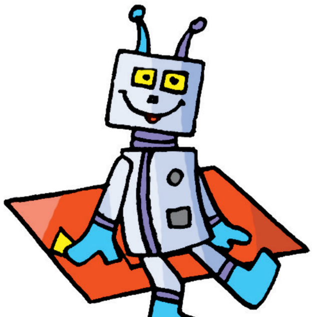
+ *Tape* , *glue* , *pencil*



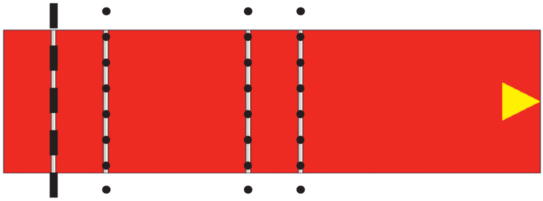




Note! The rods with holes have two different ends, and the sides are not the same either. Pay close attention to the pictures during assembly.



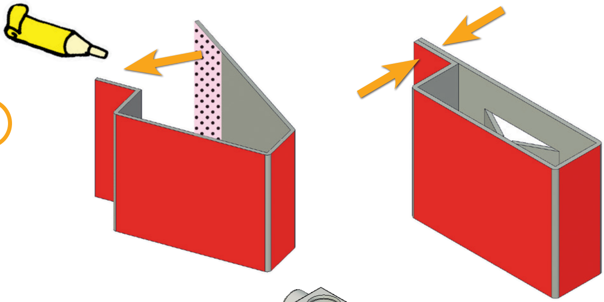
tipping scale



Tip

Dotted lines •••••• remain visible from the outside after folding, while dashed lines ------ disappear on the inside when folded.

5



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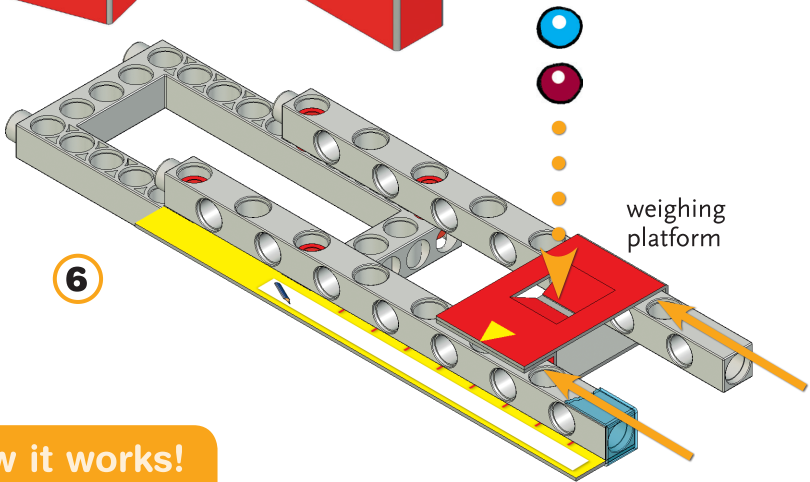


how it works!

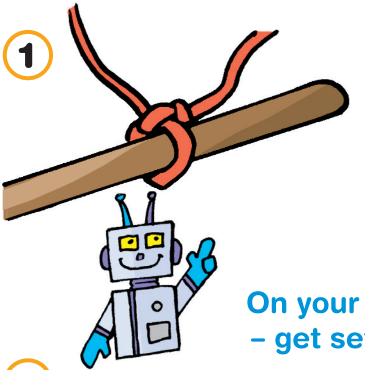
Push the red weighing platform to the middle of the scale and fill it with small weights, like candies. Does the scale lean a little? In that case, you need something lighter to weigh. Once you have a light enough weight, push the weighing platform slowly outward, until you reach the point where the scale tips. You can determine your results by looking at the dial: What weight does the scale show for one die cube? What about two dice? Record the weights by putting a mark at the spot on the yellow strip where the arrow points. A lever is at work in this scale.

muscle man

you will need: + *2 broomsticks, 4 friends*

rope (about 4 meters long and smooth, e.g. towing rope from the car)

1



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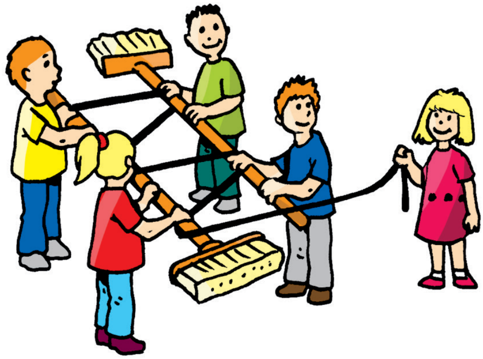
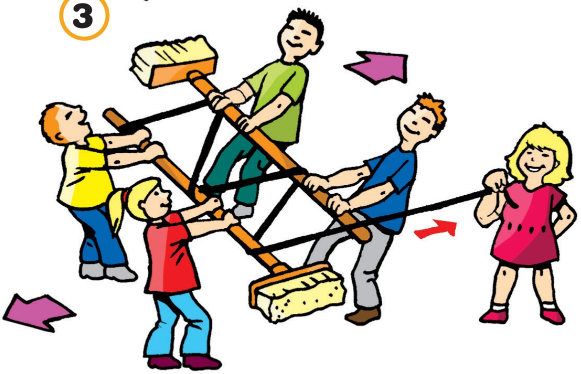


On your marks – get set – go!

3



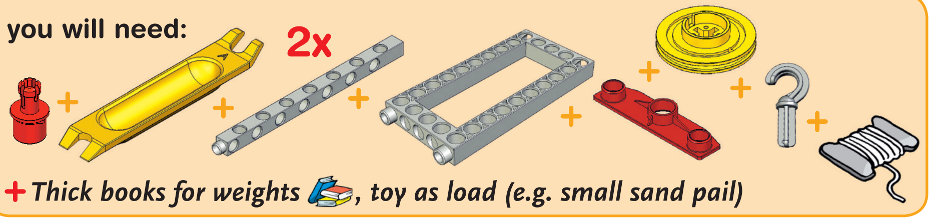
Hold the rope taut and ask your assistants to pull back on the broomsticks with all their might — it will be hard! Then tug strongly on the rope. Even though everyone tries to prevent it, you can pull the broomsticks closer together all by yourself.

how it works!

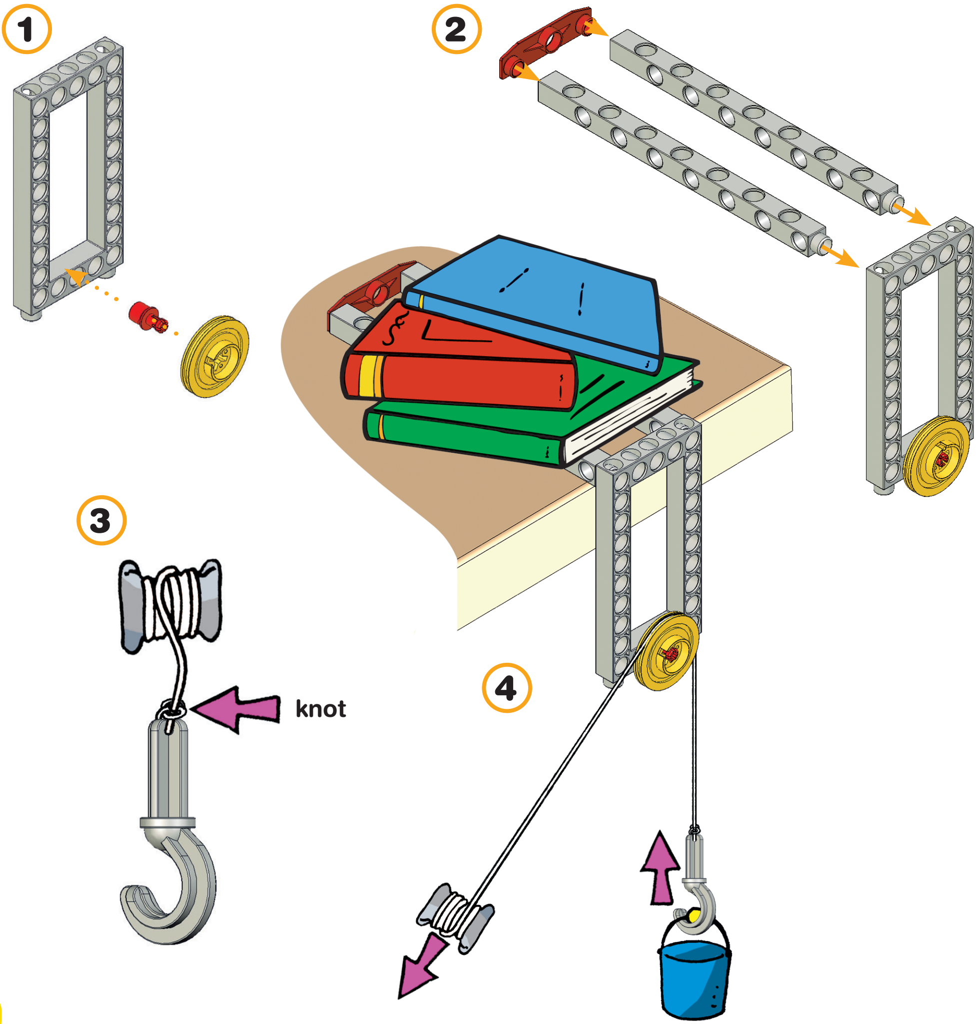
Magic powers? No — engineering tricks! An important basic principle in engineering is that you can reduce the amount of force required if you use a longer distance to apply it. You are taking advantage of that principle here, by wrapping the rope several times back and forth around the broomsticks and then holding tight to the rope's end. For your friends, it is very difficult to pull the broomsticks apart. For you, on the other hand, it's easy: In order to move the broomsticks one step farther apart, sure, you have to pull on the rope while moving several steps away — but on the other hand, you need to exert a lot less force than your friends do as they try to resist you!

fixed pulley

you will need:



+ Thick books for weights, toy as load (e.g. small sand pail)

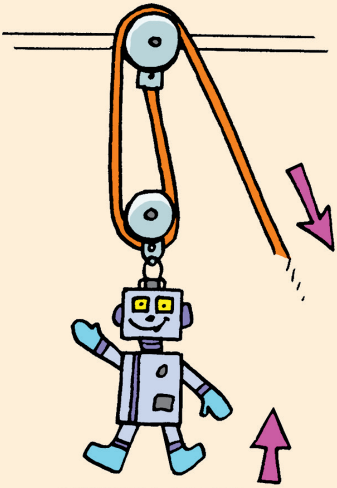


how it works!

If you want to lift the blue bucket onto the table, all you have to do is pull down on the string, and the bucket will be hauled up. The pulley and the string changed the direction of the force. Normally, you have to pull upward to lift something up. The strength of the force remains the same, but the pulley can still be a helpful tool. For example, it can help a painter's assistant quickly get a new bucket of paint up to him when he's working on the scaffolding of a building.

did you know?

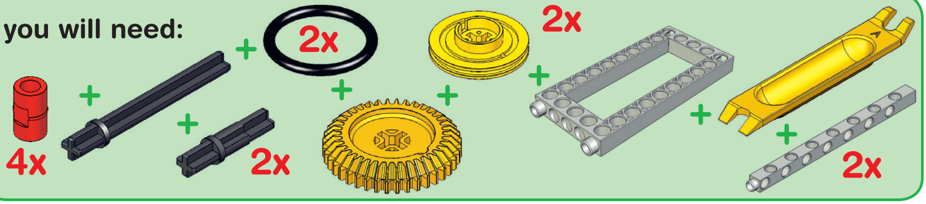
You can save effort by working with several pulleys. That is exactly what happens with a block and tackle pulley. The rope runs back and forth between the pulleys. That means you need a longer rope and you have to pull farther, but on the other hand you need to use less force.

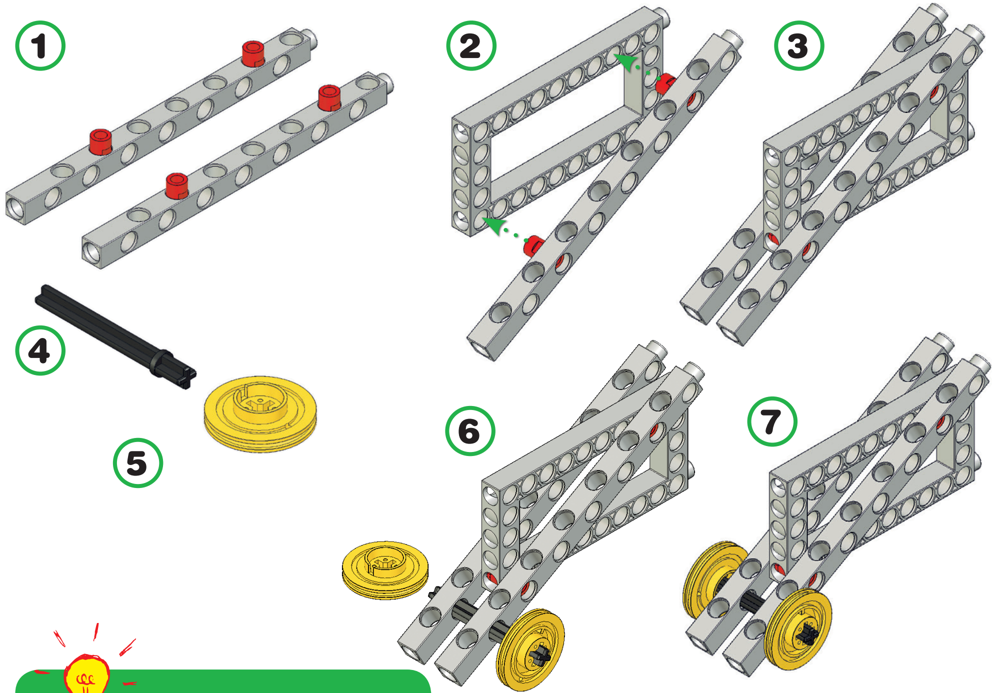


Block and tackle pulleys are used, for example, on sailing ships and construction cranes.

speedy racer

you will need:

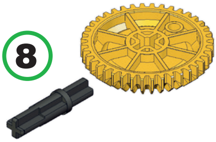




how it works!

Without wheels, a car wouldn't go very far when you gave it a push. Rolling on wheels is a lot easier, and the car goes a lot farther with the same push.

8



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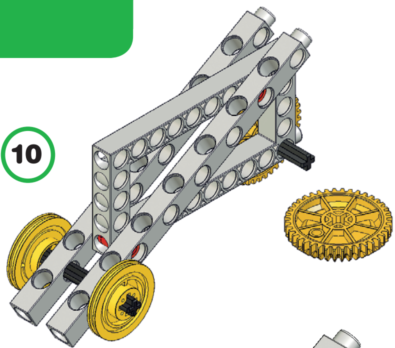

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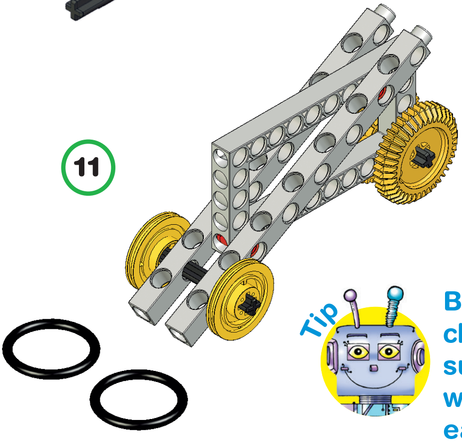
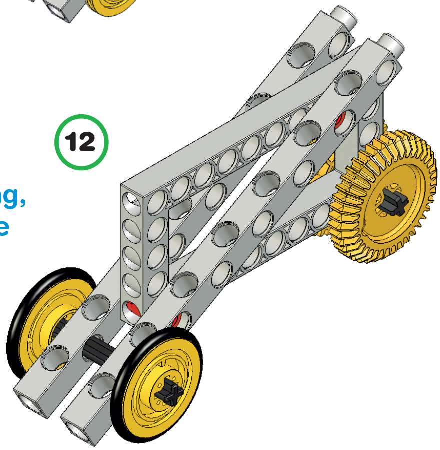


Tip

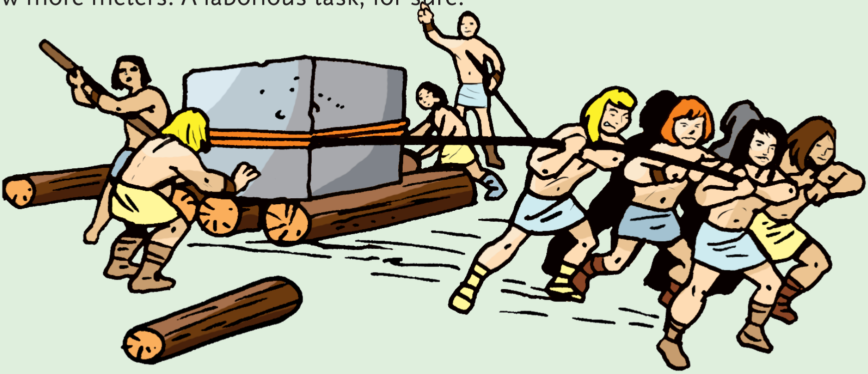
Before starting, check to make sure all the wheels turn easily.

12



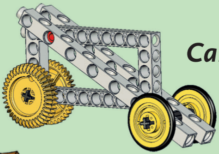
did you know?

Did you know that the invention of the wheel was a revolutionary development in human history? Wheels allow heavy loads to be transported with ease from one location to another. Before wheels existed, people did things like laying logs on the ground, placing the load on them, and pulling it forward with ropes. The logs had to be continually moved from the rear to the front in order to pull the load a few more meters. A laborious task, for sure!



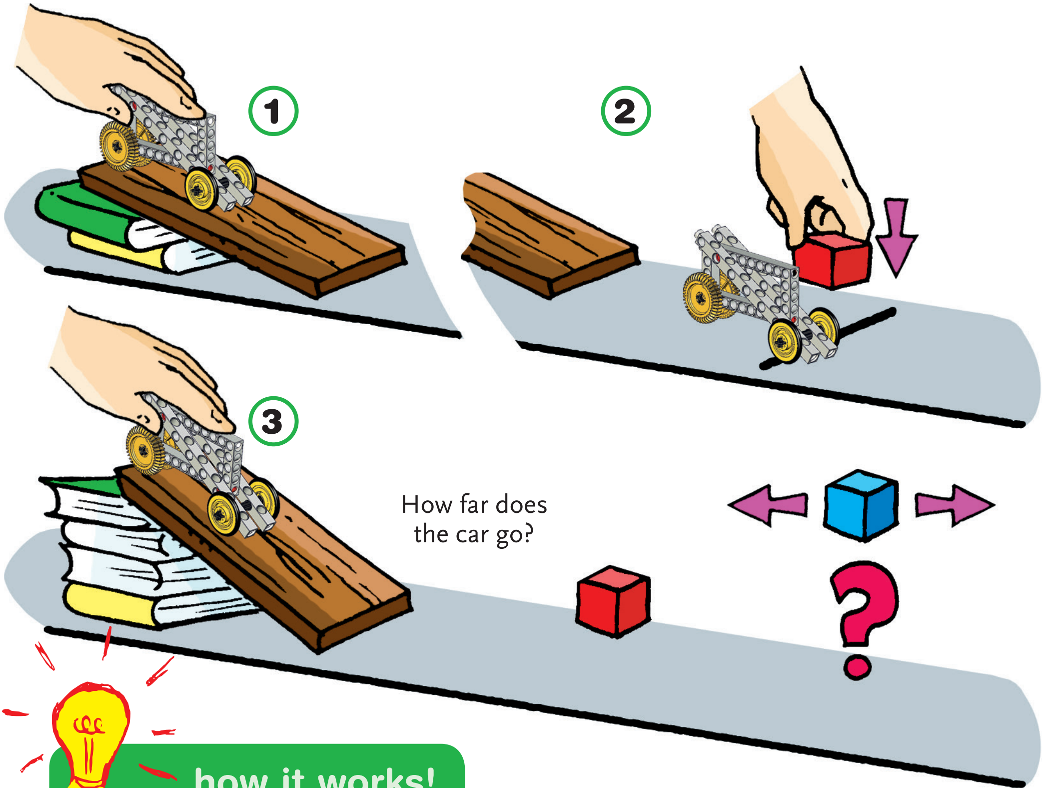
ramp racing

you will need:

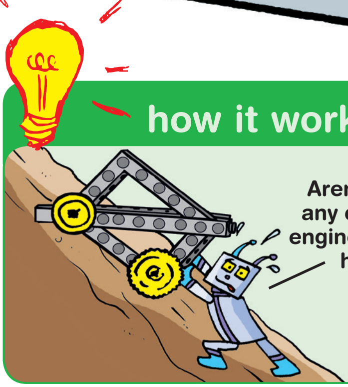


Car from the last experiment

+ *wooden board* *, several books* *, wooden blocks for marking distance*



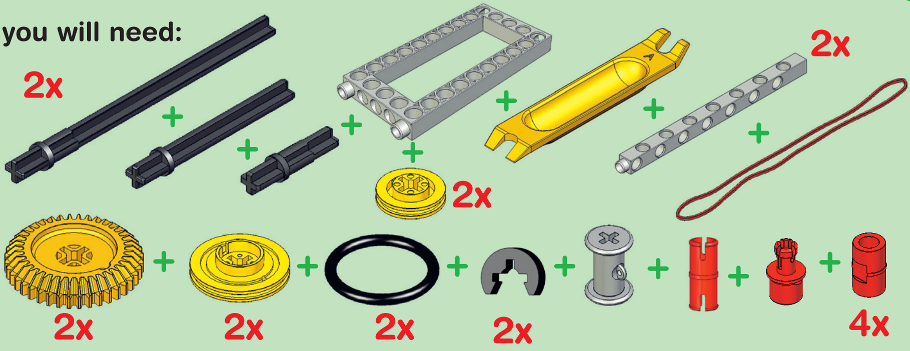
how it works!



This car lacks a built-in propulsion system. To make it go, you either have to give it a push or let it roll downhill. The steeper the ramp, the more speed it will have.

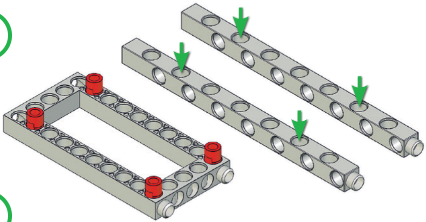
wind-up car

you will need:



+ *Scissors*

1



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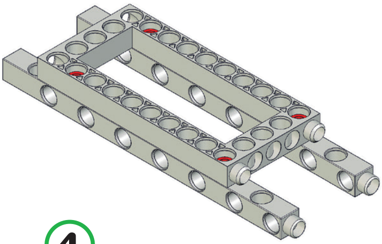

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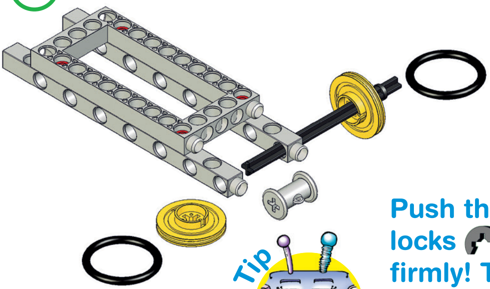

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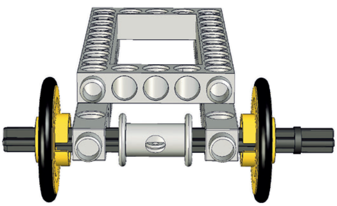
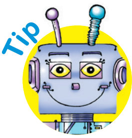
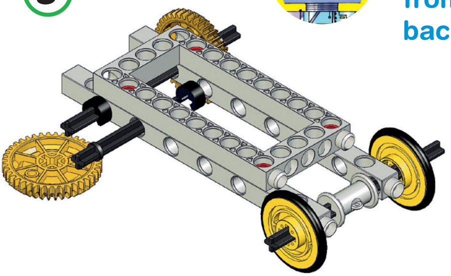




Push the axle locks on firmly! They keep the axles from slipping back and forth.

5



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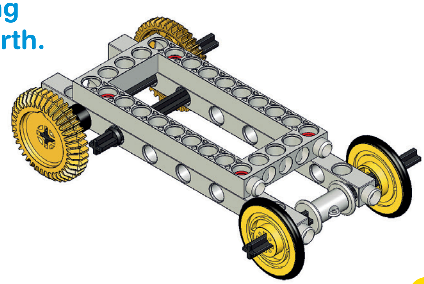

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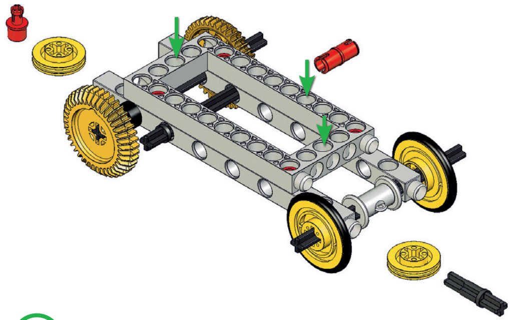

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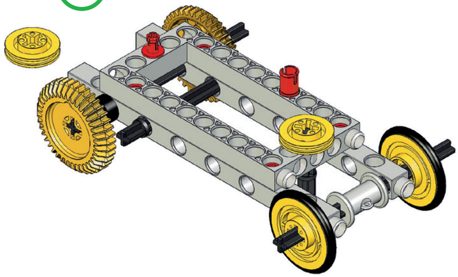

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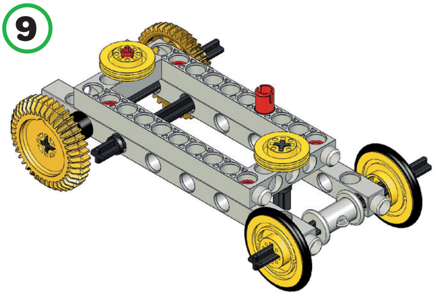

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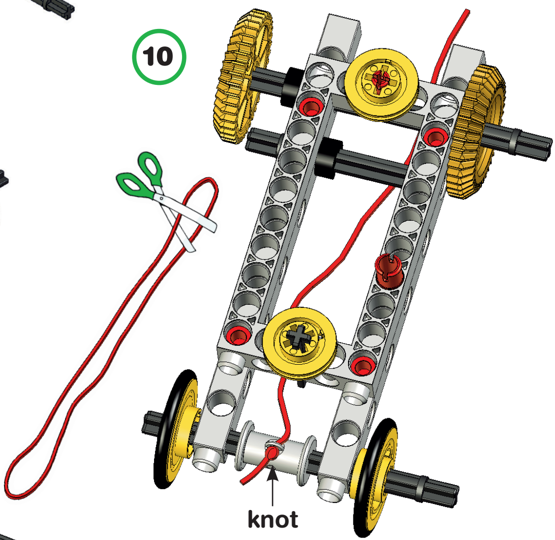

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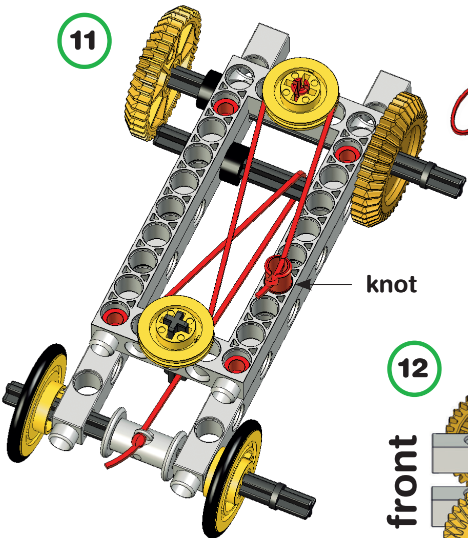
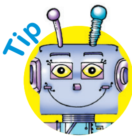
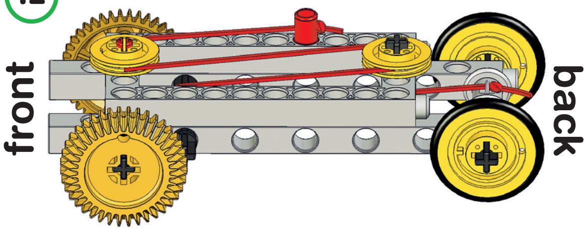




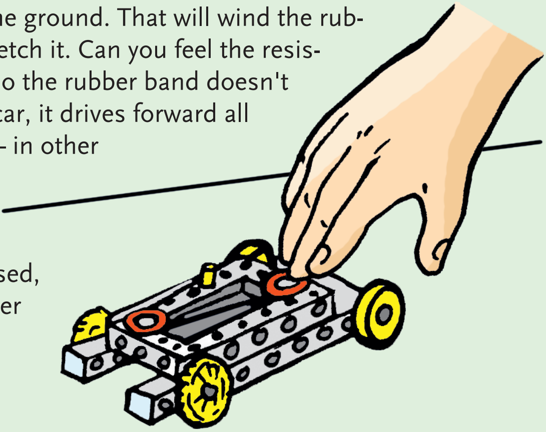
Check to be sure all the wheels turn easily!

12

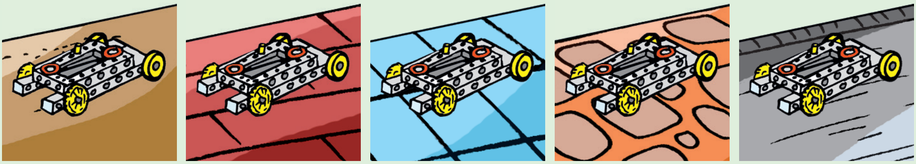


how it works!

Pull your car backwards along the ground. That will wind the rubber band onto the spool and stretch it. Can you feel the resistance get stronger? Then stop, so the rubber band doesn't break. Now, if you let go of the car, it drives forward all by itself! When you wind it up — in other words, when you stretch the rubber band — you accumulate energy in the car. When you let it go, this energy is released, and the car drives until the rubber band is slack again.



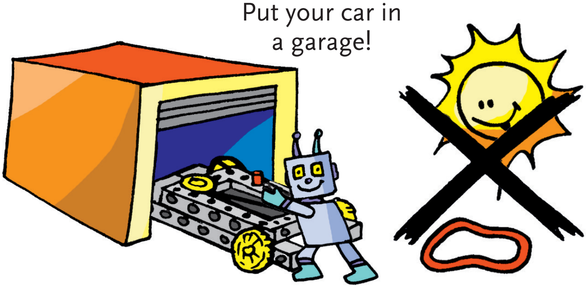
Where does your car drive best? Try out different surfaces!



Tip

If the wheels slip, check these things: Did you install the black rubber tires on the rear wheels? Is the rubber band winding up correctly around the spool or is it slipping?
When starting, give the car a little push to get it going. Before you wind up the car, the rubber band should sit quite loosely. If necessary, you can move the joint pin to another hole.

Put your car in a garage!

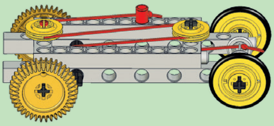


Tip

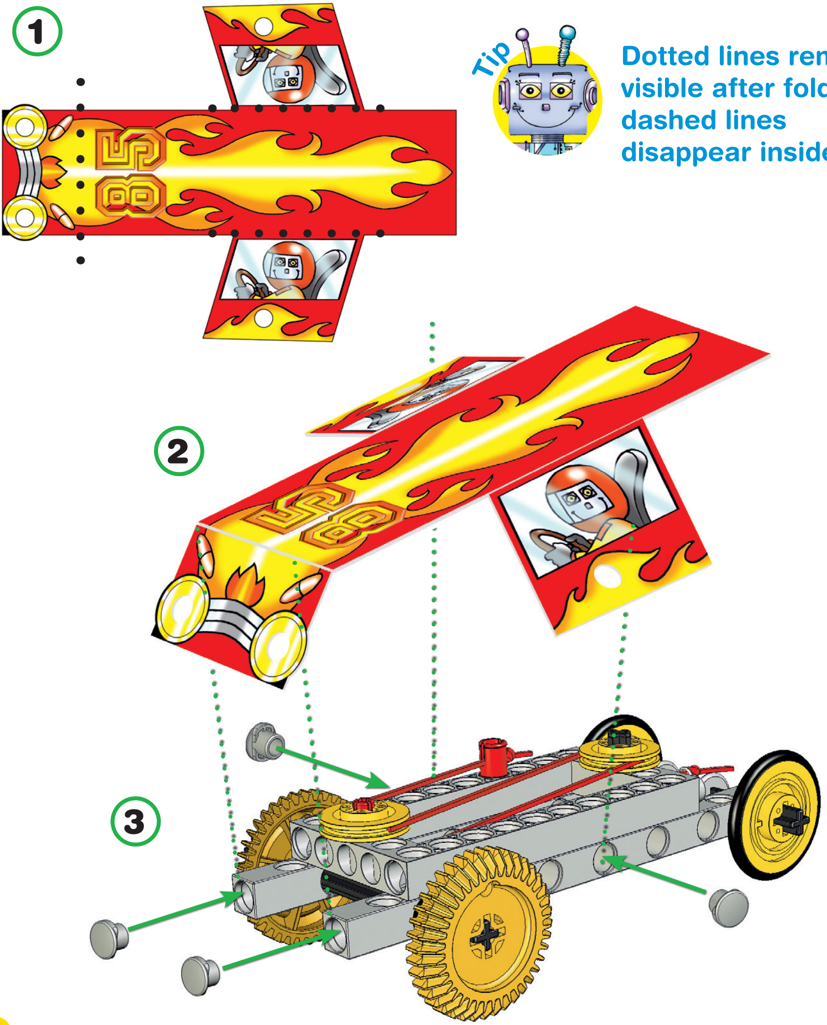
Rubber bands can change and become brittle when exposed to light!

auto body

you will need:



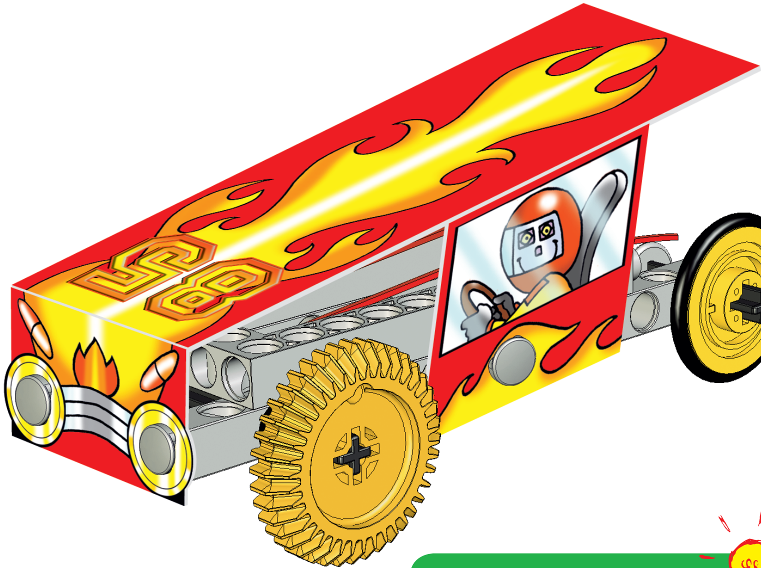
Car from the last experiment



Tip

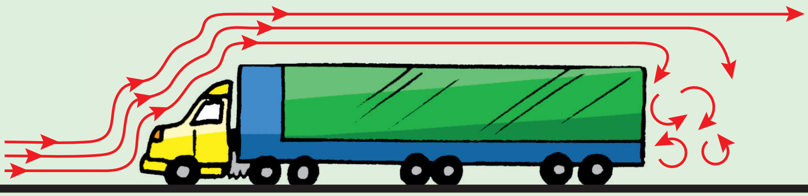
Dotted lines remain visible after folding, dashed lines disappear inside!

4

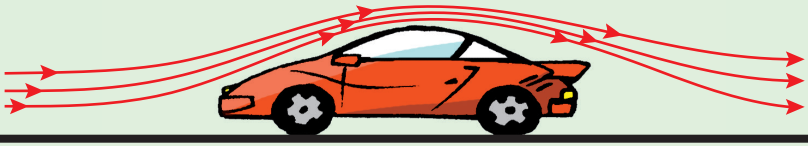


how it works!

The size and shape of a vehicle's body determine its air resistance. A tall truck with lots of corners and edges has more resistance. Racing cars, on the other hand, are low to the ground and expose only a small surface area to the wind, so the air glides easily around their streamlined shapes. That is one reason they can go so fast.



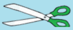
No Streamlined Shape

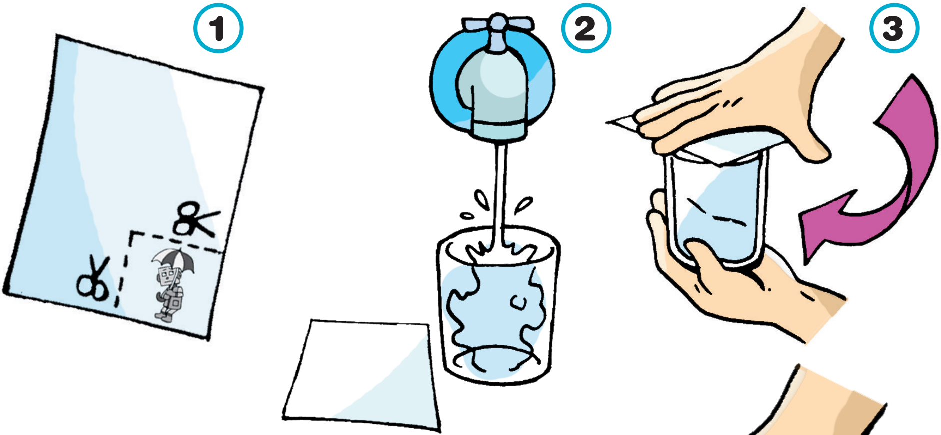


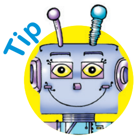
Streamlined Shape

water glass trick

you will need:

+ *Scissors* , *Glass* , *Water*





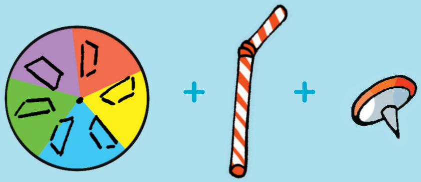
The paper has to cover the glass well all the way around and extend a little beyond the glass's edge.

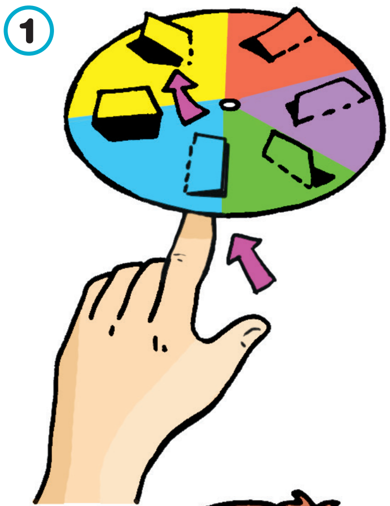
how it works!

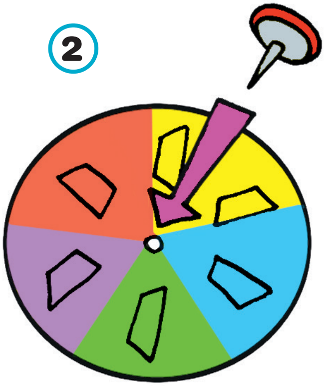
Air is strong! You can't see it, but it's there — and it pushes against the paper from below. Even though you have pulled your hand away, the paper won't fall down, and the water stays in the glass.

puff-powered carousel

you will need:





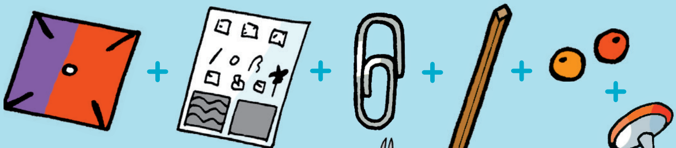


how it works!

You won't need to turn this wheel with your fingers — it is propelled by air! If you hold the straw so that you are blowing directly beneath the flaps, the wheel will start turning. The stronger you blow, the faster it turns.

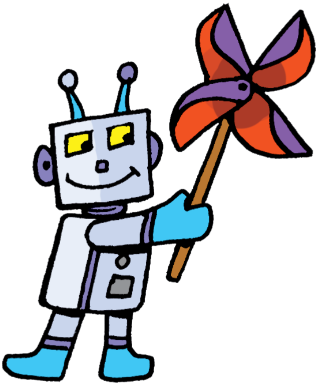
pinwheel

you will need:



+ *Scissors* , *Pliers with round, narrow tip*

1 This is how the completed pinwheel will look! You will find the assembly instructions on a separate sheet.



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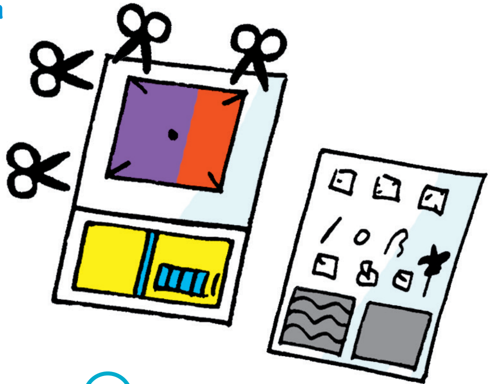


3

You can either blow on the pinwheel yourself…

4

…or let the wind do the work.

how it works!

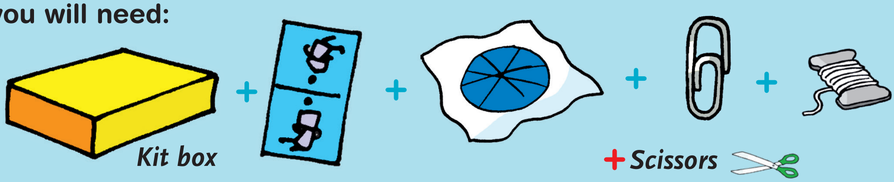
The pinwheel is propelled by wind too! Blow into the open blades of the pinwheel. If the stream of air is strong enough, the pinwheel will start to turn.

did you know?

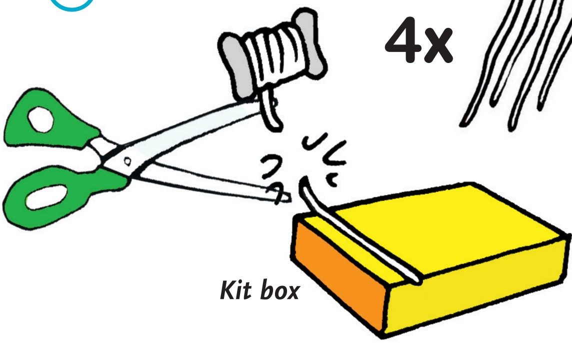
Did you know that people use wind to generate electricity? In wind farms, the wind is used to drive giant wind turbines. The kinetic energy of these windmills is converted into electrical energy. So in the beginning, there's wind — and at the end, you get electricity coming out of the wall socket!

parachute

you will need:



1



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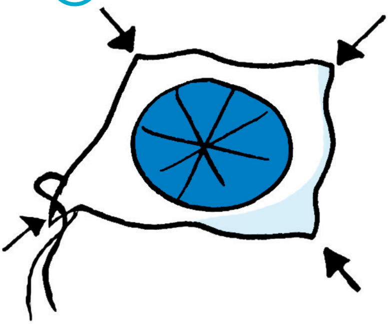

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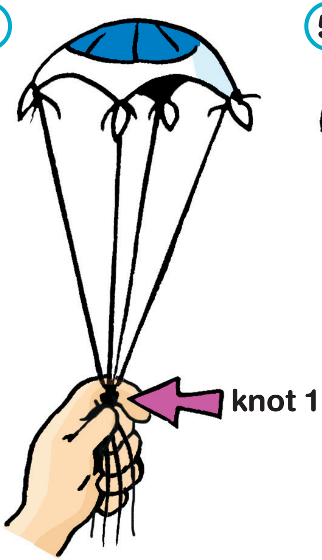

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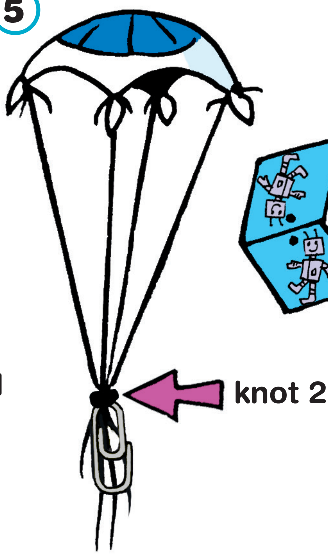

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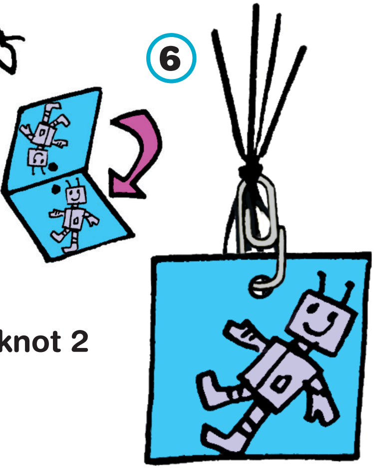
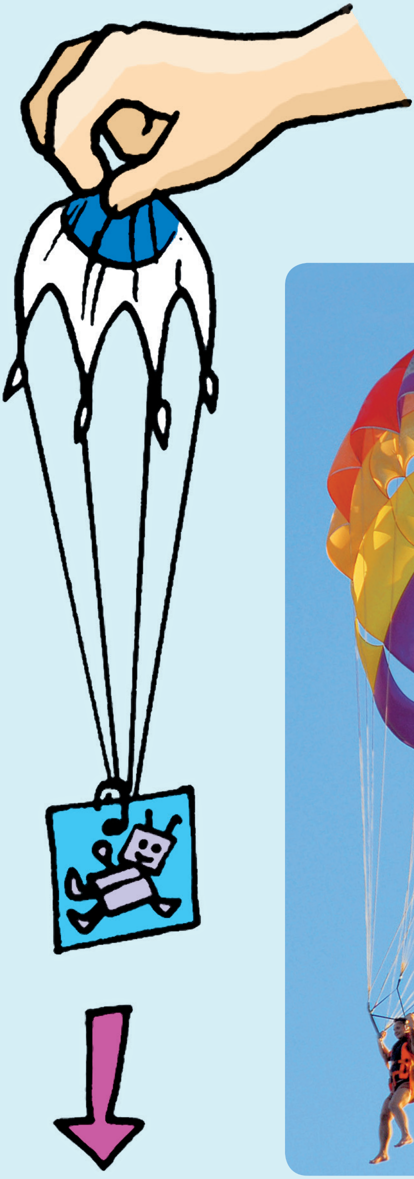


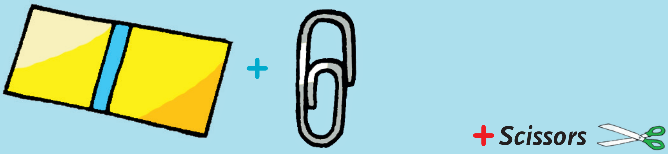
how it works!

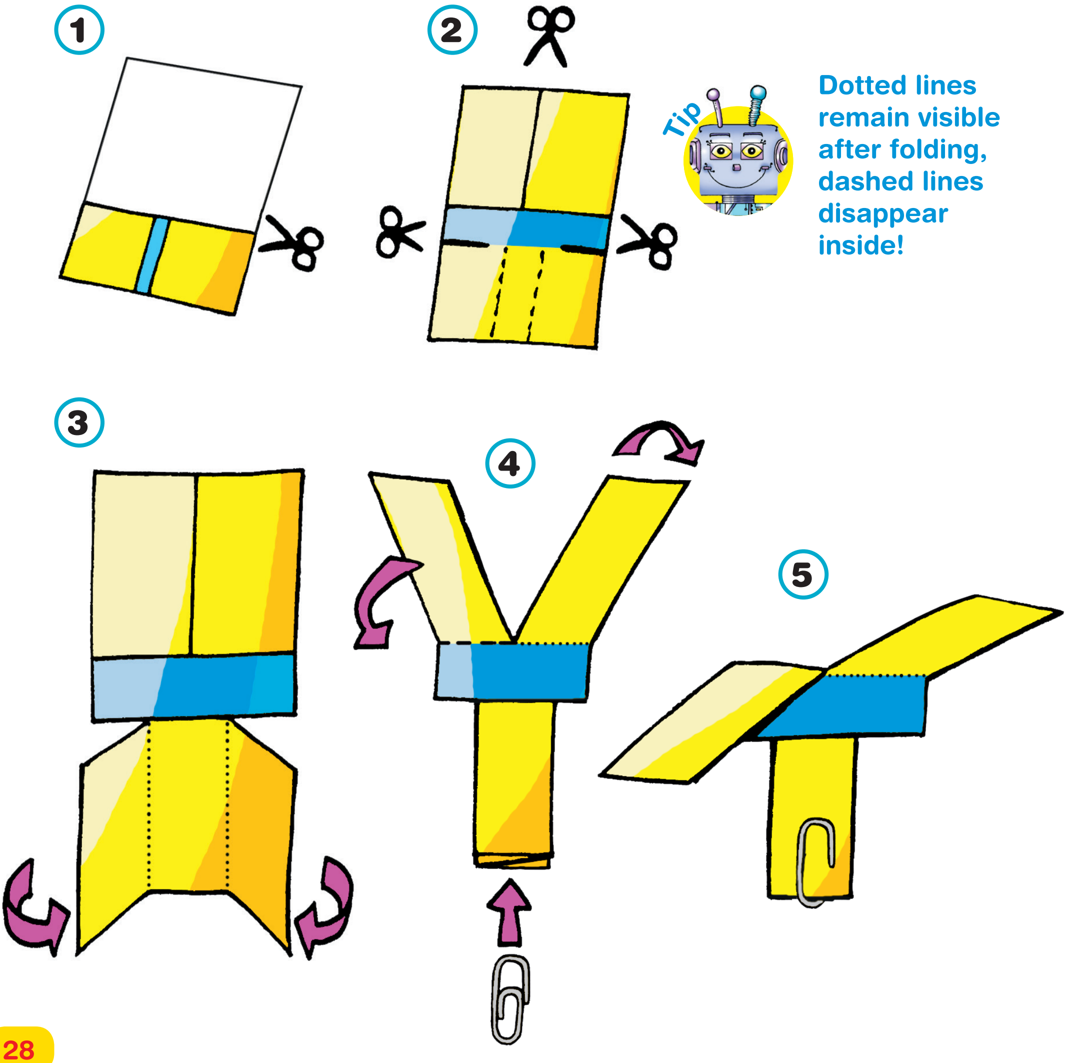


Hold the parachute by the center of the top and let it go. The parachute will spread out and the skydiver will glide softly to Earth, with the air beneath the chute acting as a brake. Without the parachute, he would fall to the ground like a stone.

helicopter

you will need:

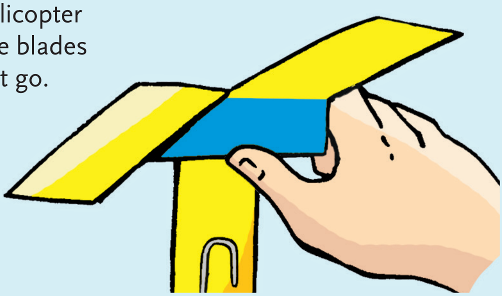




Dotted lines remain visible after folding, dashed lines disappear inside!

how it works!

Hold your helicopter just under the blades and then let it go.



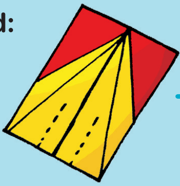
It will start to rotate, and will then glide slowly to the ground.

did you know?

Did you know that helicopters can fly sideways and backward, in addition to up and down? They can even stand still in the air! In addition, a helicopter does not need a runway when taking off or landing, since it can move straight up and down. Because it is so agile, it is often deployed in difficult terrains: to transport the injured after an accident, for mountain rescues, and to save people at sea.

glider

you will need:



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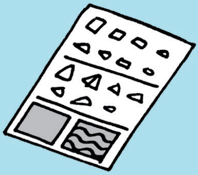
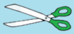


+ *Scissors*



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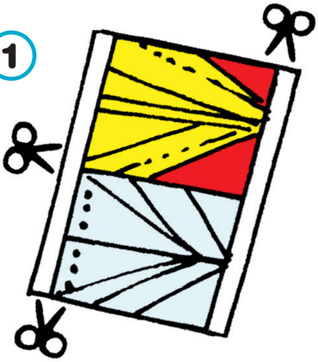

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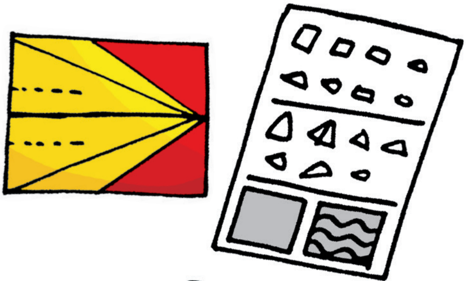

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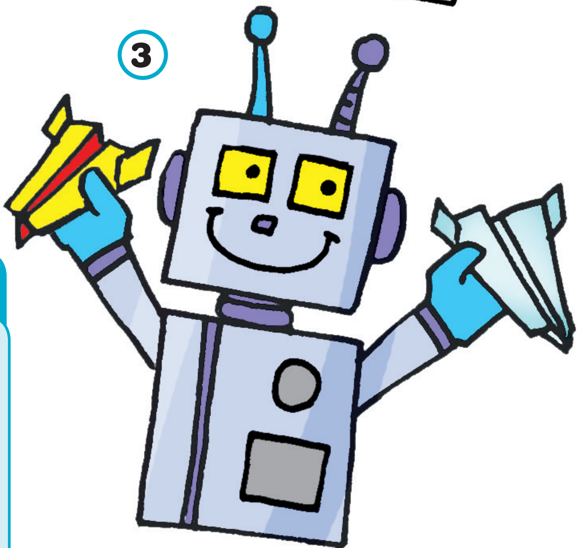


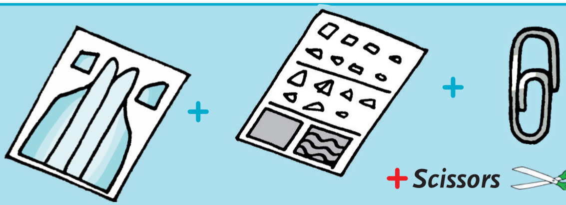
how it works!

Hold your glider tightly by the bottom and let it go!

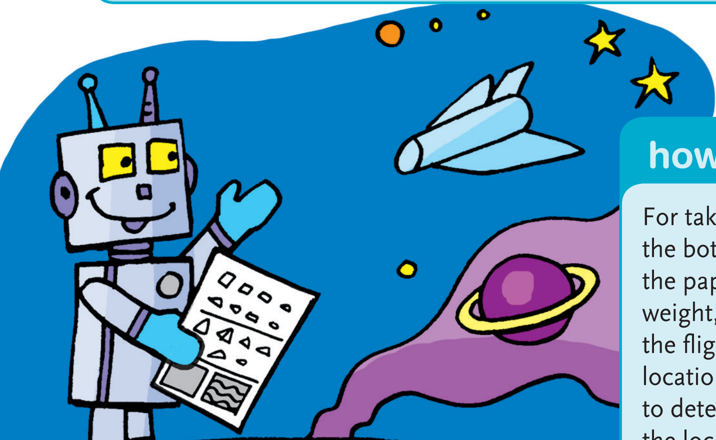
This is how the completed gliders look. You will find the assembly instructions on a separate sheet.

shuttle

you will need:



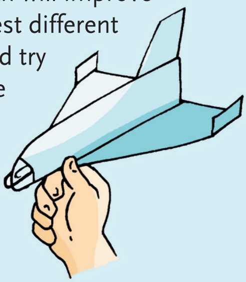
+ *Scissors, Tape*



Here comes the shuttle! The assembly instructions are on a separate sheet.

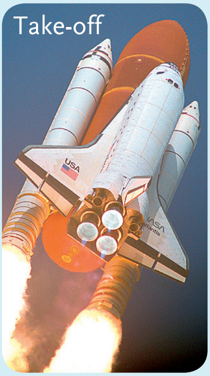
how it works!

For takeoff, hold your shuttle at the bottom near the front. Attach the paper clip to the nose as a weight, which will improve the flight. Test different locations and try to determine the location that makes it flies best.



did you know?

Did you know hat a shuttle takes off like a rocket but returns to Earth like a plane? That's how a shuttle can fly so many times into space. At the beginning of space travel, that was not possible. A rocket could take off into space, but after its first use it couldn't be used again.



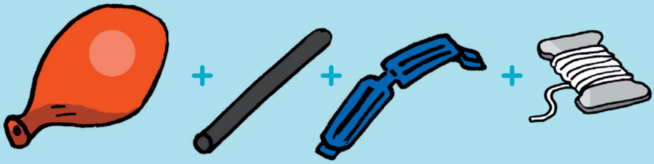
Take-off

Landing

At takeoff, the shuttle is attached to a tank and two rockets, which are ejected later on at a high altitude.

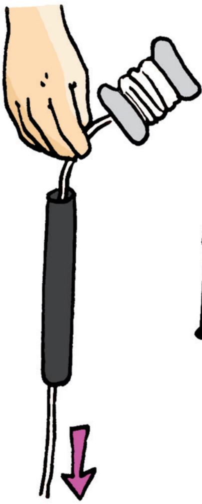
balloon rocket

you will need:



+ *Tape* 

1



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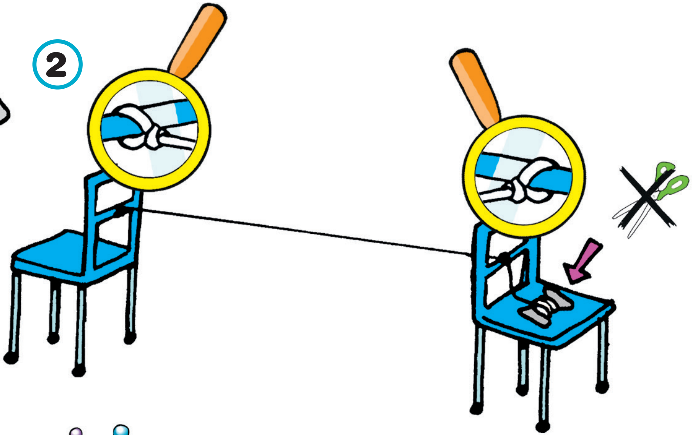
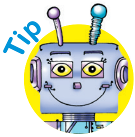
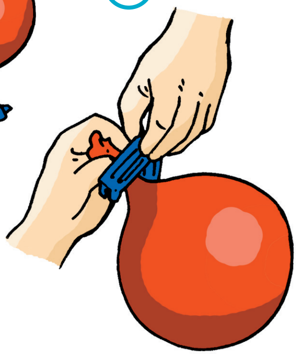




Do not cut the string! You will need the long piece of string later on when you make the string telephone.

3

4



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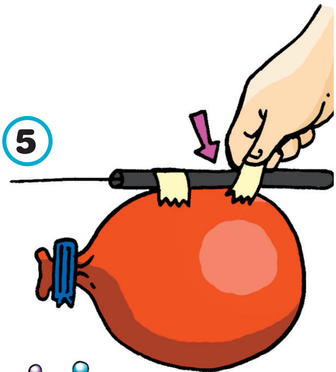
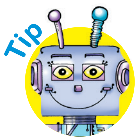
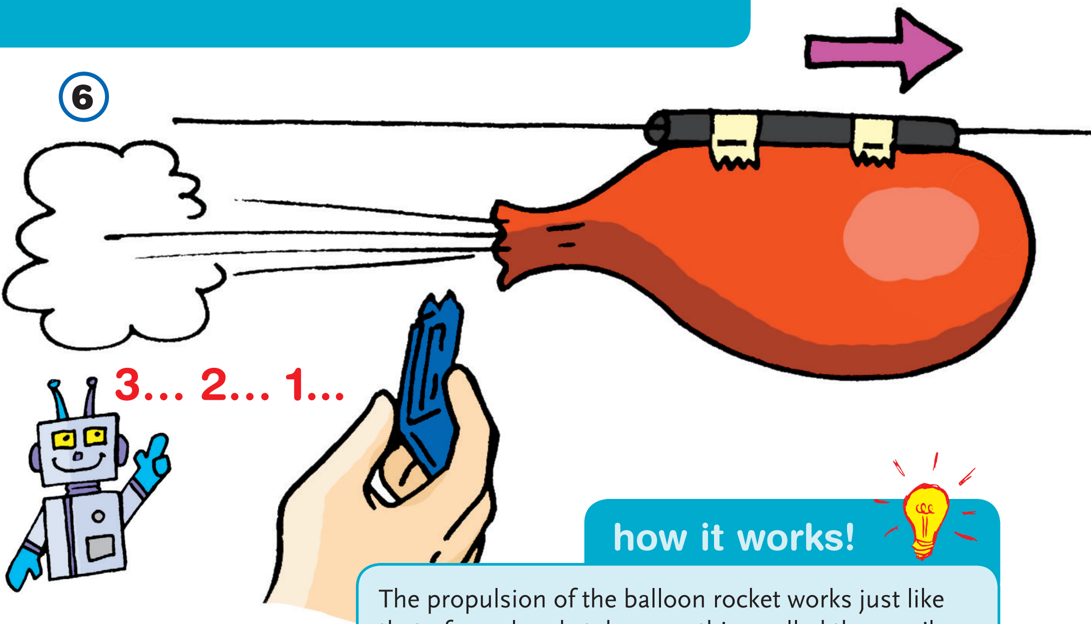




The string has to be stretched tight.

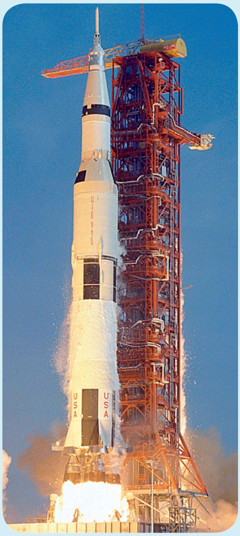
6



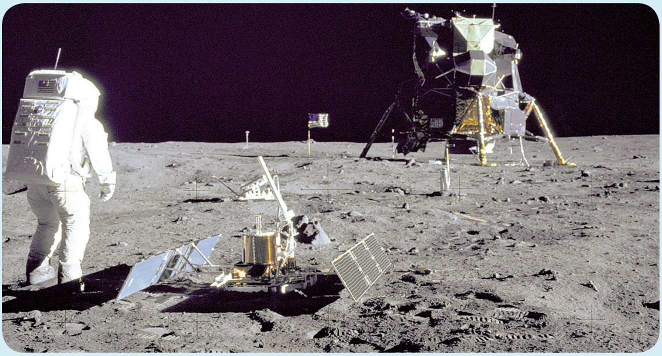
how it works!

The propulsion of the balloon rocket works just like that of a real rocket, by something called the recoil or reaction principle. When gases are expelled out the rear under great pressure, the rocket moves forward.

did you know?



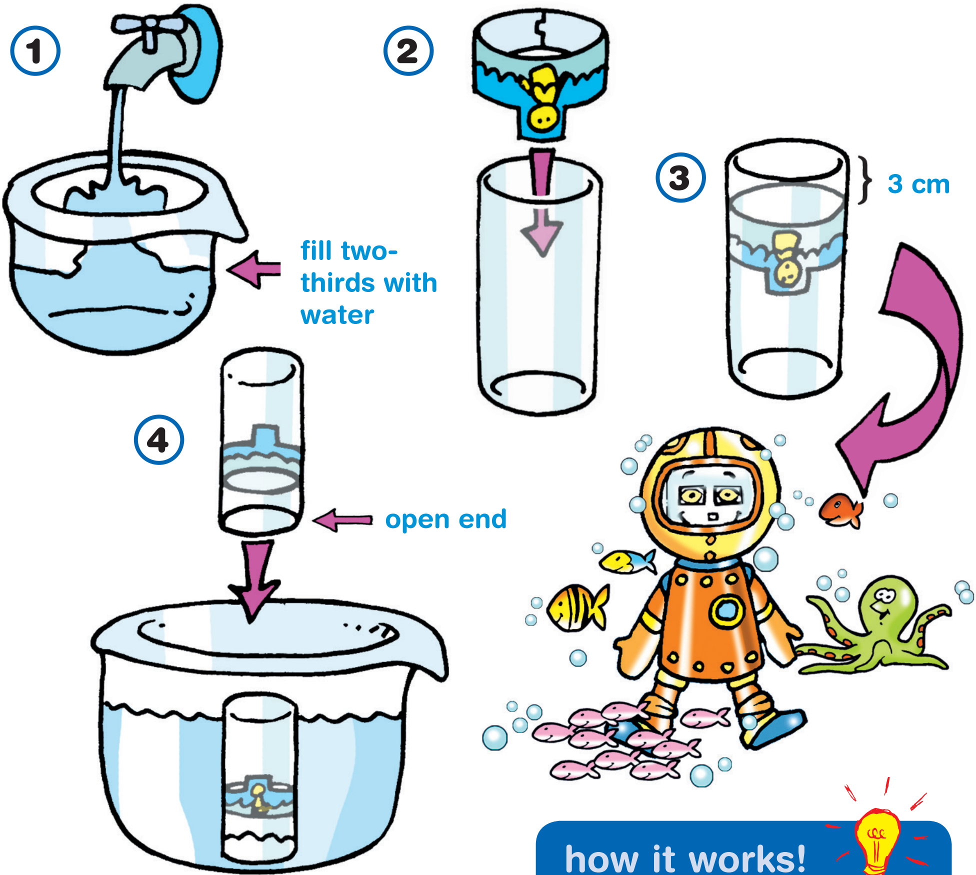
Did you know that the American Neil Armstrong was the first man on the moon? In 1969, he landed there with his rocket and, as he set foot on the moon's surface, said the famous words: "That's one small step for [a] man, one giant leap for mankind."



diving bell

you will need:

+ *glass with straight sides* *, mixing bowl (plastic)* *, water* 

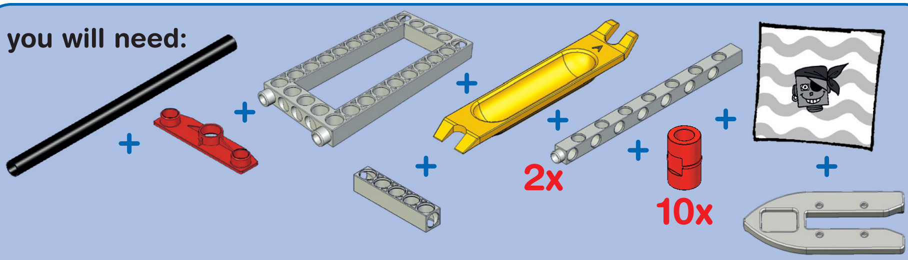


how it works!

It's true that your glass looks empty, but it is actually full — of air! If you hold the open end of the glass straight down, the air can't get out of the glass. It is merely compressed. The diver stays dry!

sailboat

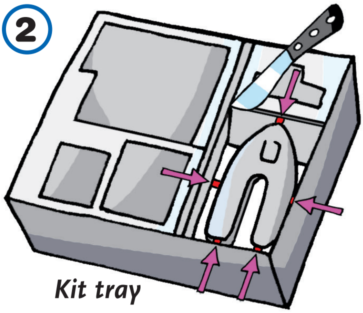
you will need:



+ *Scissors, knife, tape, sink, water, captain*

1

2



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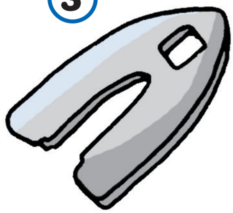

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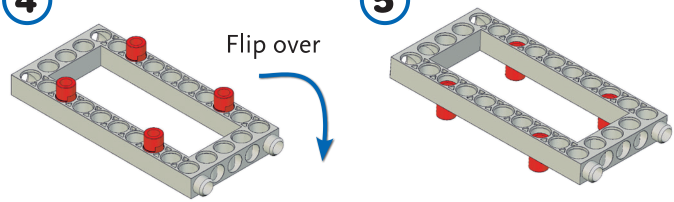
5



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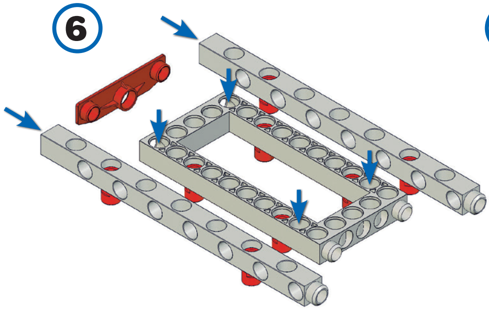

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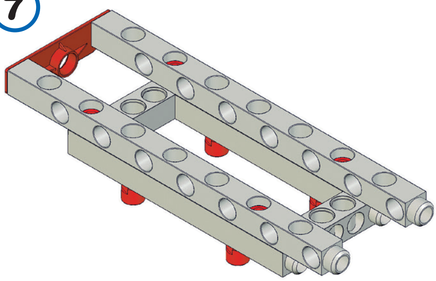

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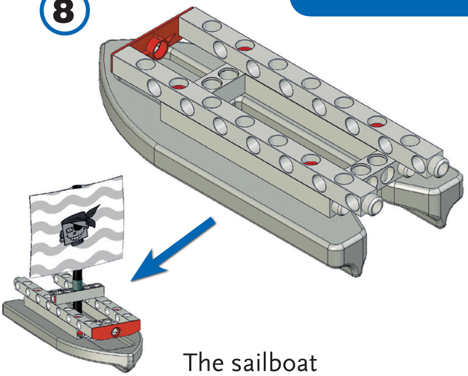
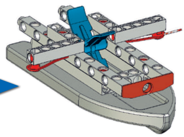
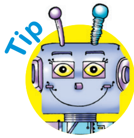


To make the boat into a paddle-wheel boat, skip to the next experiment!

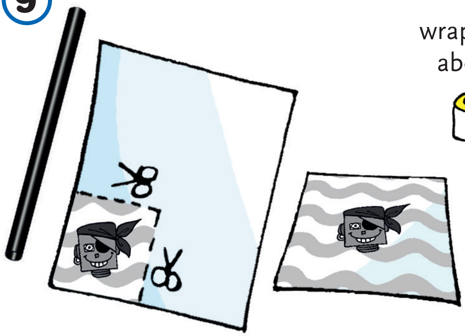




Tip The paddle-wheel boat in the next experiment starts exactly the same as the sailboat.

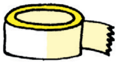
The sailboat continues here!

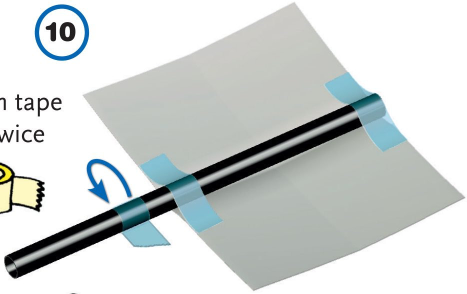
9

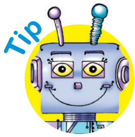


10

wrap with tape about twice

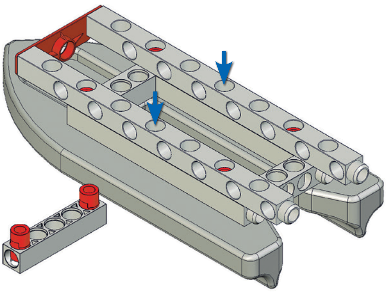






Tip If you wind tape around the bottom of the mast, it will sit snugly without slipping.

11



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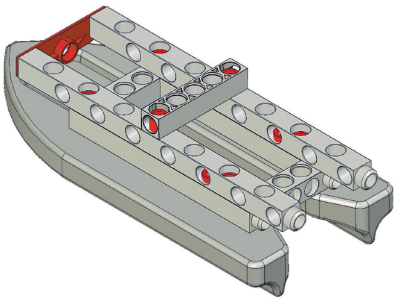

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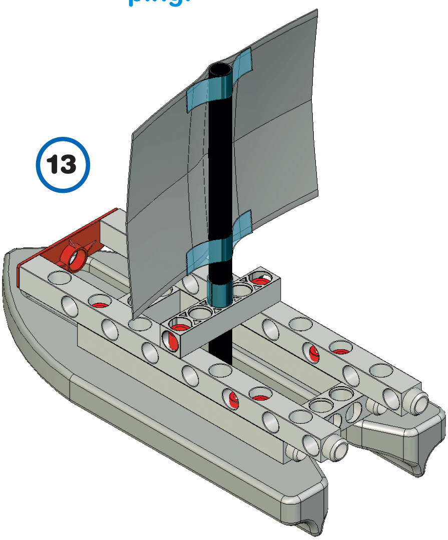

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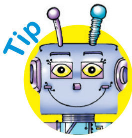
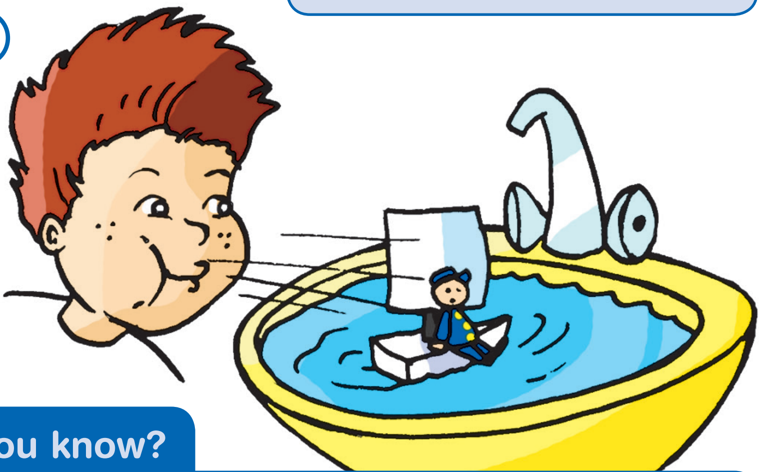


Do you have a captain for your sailboat?

how it works!

If you blow into the sail from the rear, the sailboat will float forward.

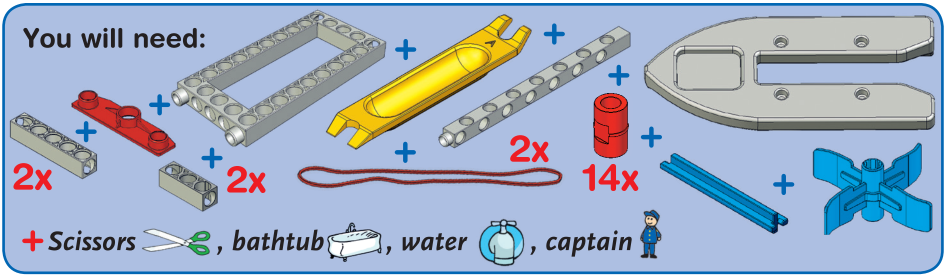
15

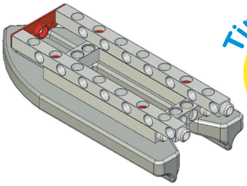


did you know?

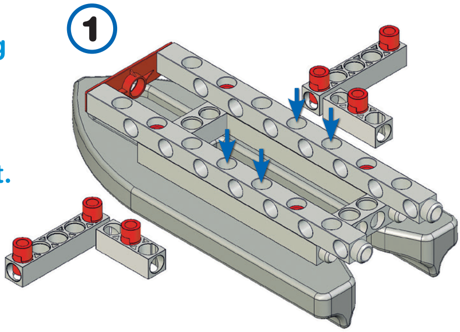
Did you know that a sailboat can make its way back to harbor even against a headwind? By maneuvering cleverly with the sail adjusted at an angle to the wind, the boat can zigzag its way to its destination.

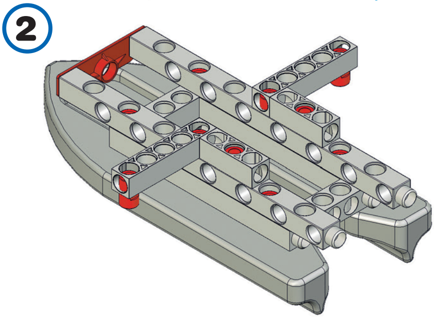
paddle-wheel boat

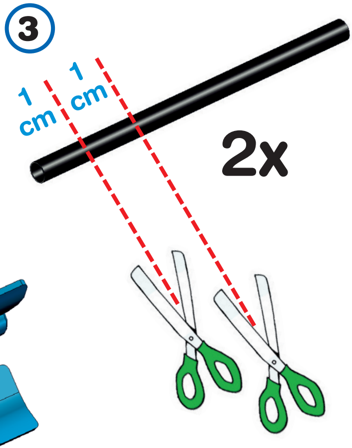


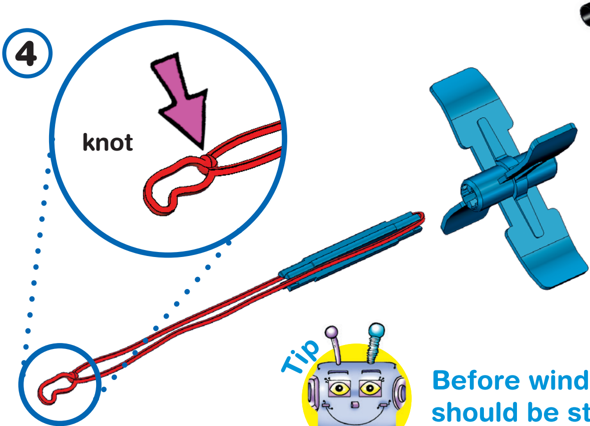


Tip: Start assembling the boat exactly as in the last experiment.



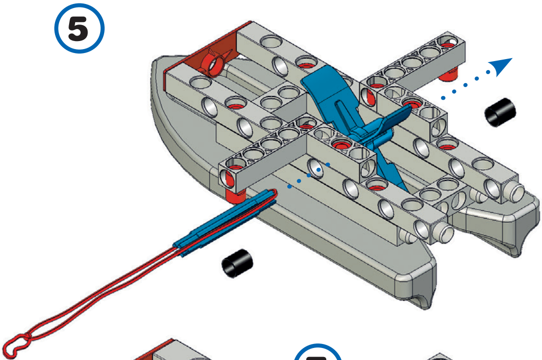






Tip: Before winding it up, the rubber band should be stretched tight. Use the knot to shorten it to the proper length.

5



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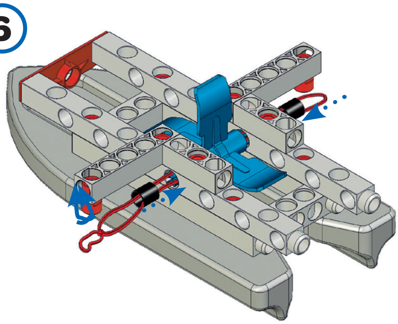

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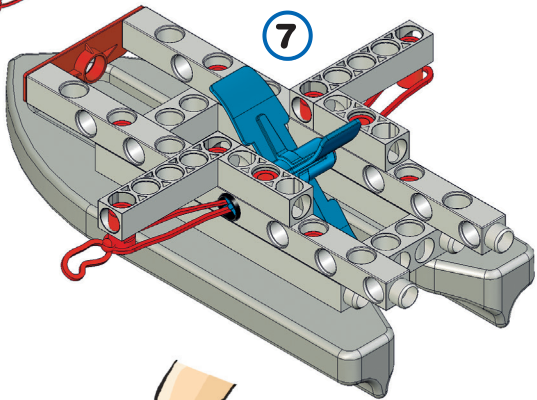

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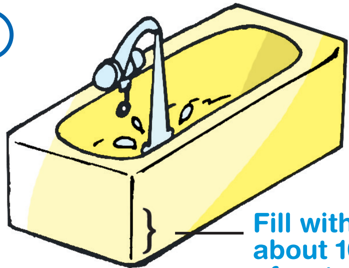

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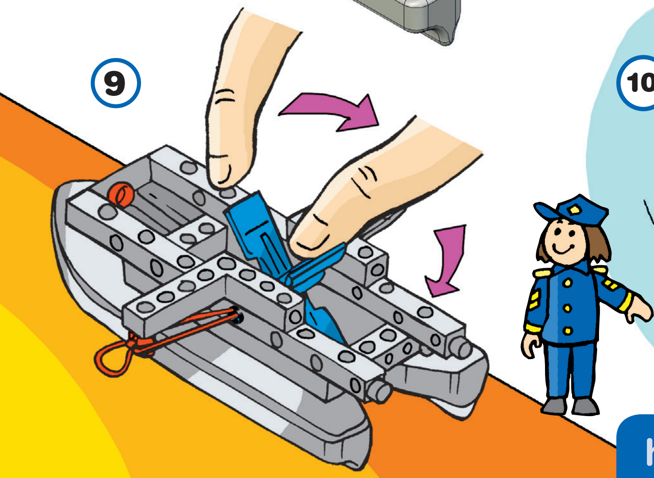


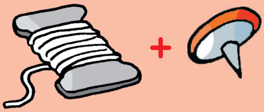
10

how it works!

There's energy stored in the wound-up rubber band — you know that from the wind-up car. When you let go of the paddle wheel, it starts to turn. The blades of the paddle wheel push the water away at the rear and drive the boat forward.

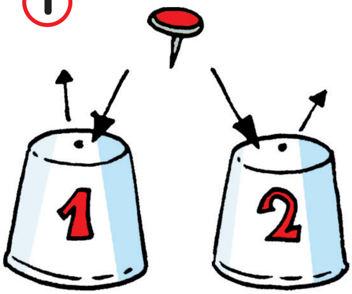
string telephone

You will need:



+ *Two empty small yogurt containers* 

1



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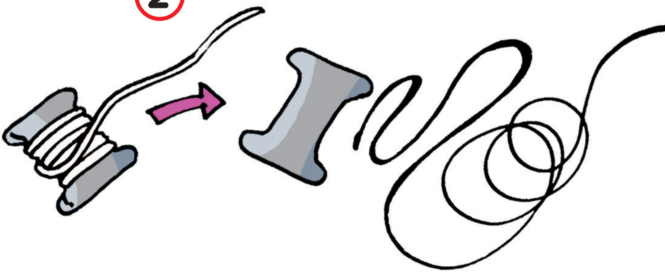

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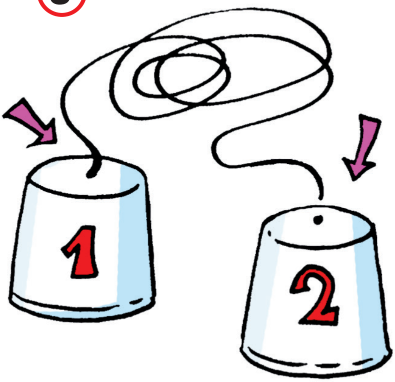

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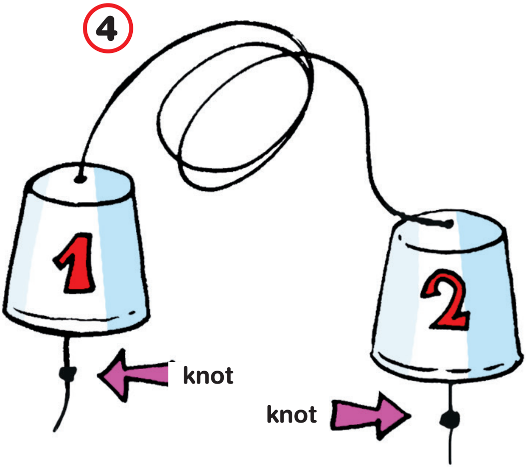

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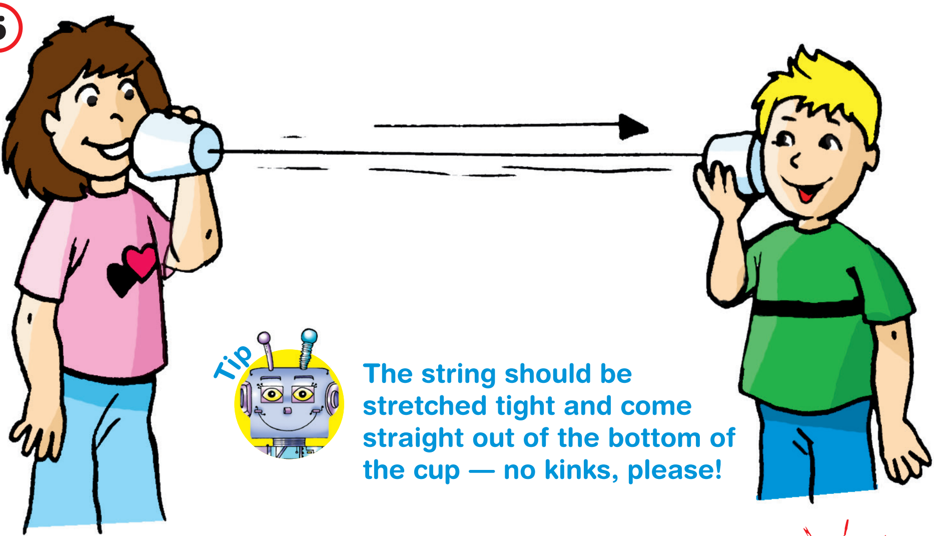


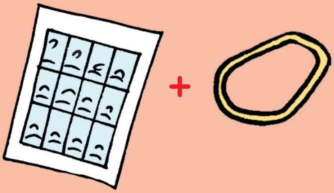
Tip The string should be stretched tight and come straight out of the bottom of the cup — no kinks, please!

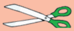
how it works!

When you speak into the plastic cup, the floor of the cup starts to vibrate. The vibration is transferred to the string, which also starts to vibrate. The louder the sound, the stronger the vibration. The higher the sound, the faster the vibration. Then, it passes its vibrations on to the floor of the other cup, where the other person can hear you. Real telephones do not transmit vibrations through a string, but when you speak into a telephone mouthpiece, the sound vibrates a metal plate, which creates electrical signals which are then transmitted through wires.

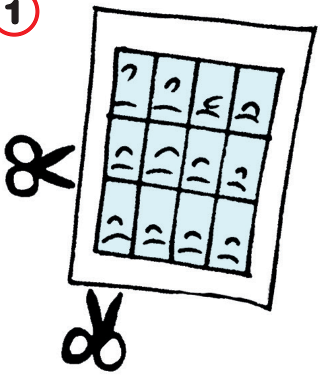
flip book

You will need:



+ *Scissors* 

1



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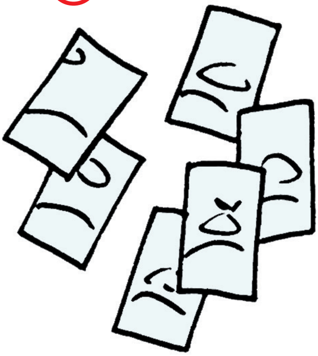

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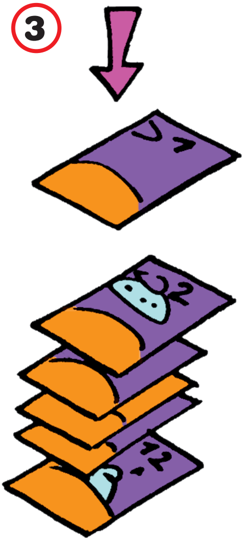

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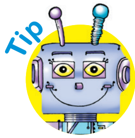
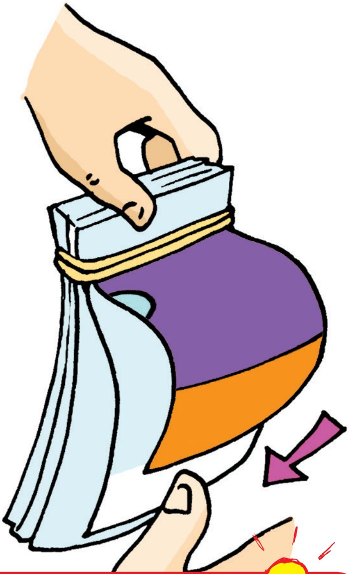


Tap the edge of the stack of cards against a table before you attach the rubber band, so all the cards are evenly lined up.

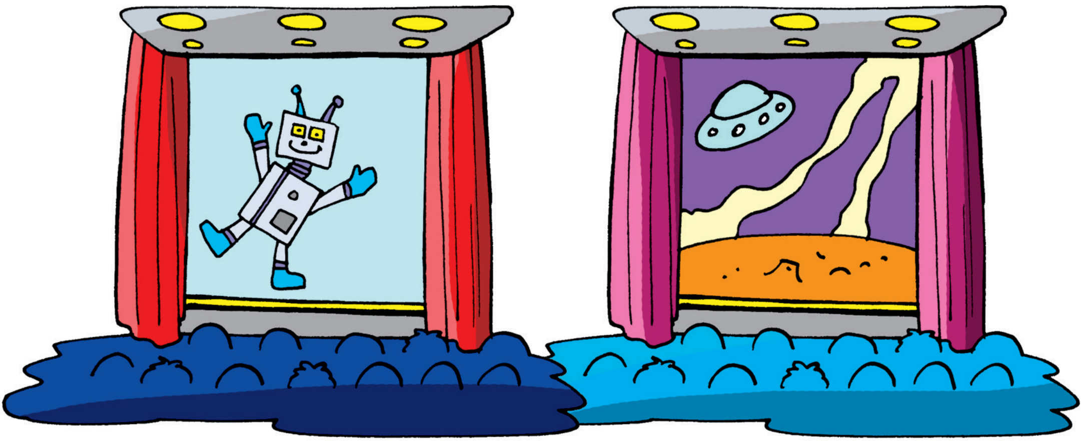
6

7



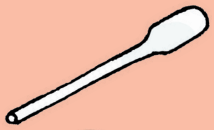
how it works!

Just like a real movie, the flip book displays lots of individual pictures, one after the other. Each picture only changes a little bit from the one before it. When you run your thumb along the edge, you quickly flip through all the pictures in a row. Your eye and brain are too slow to perceive the individual images, so they flow together into one continuous image that appears to move.



mound of water

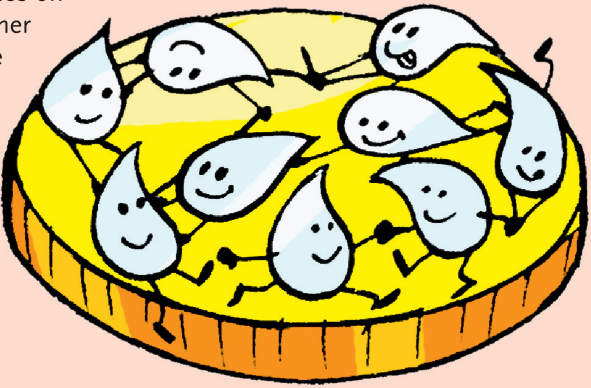
You will need:



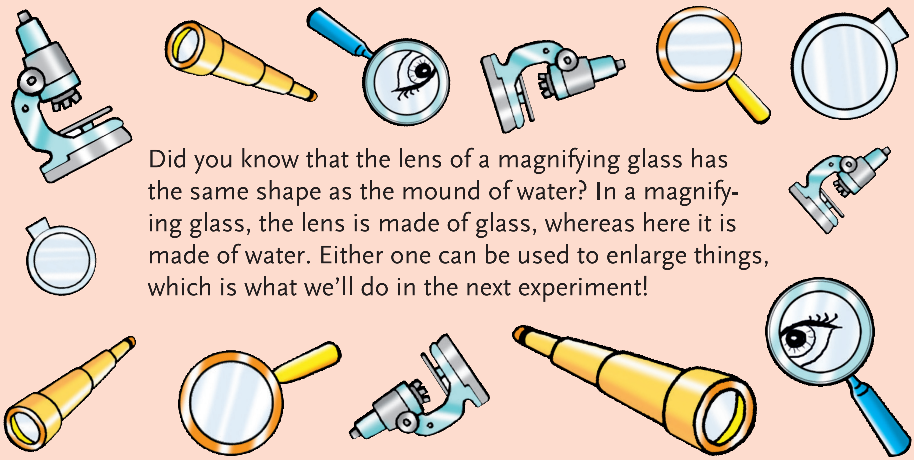
+ *coin, plastic cup, water, paper towel*

how it works!

Water is composed of lots of little particles that you can't see. But they have an interesting property: They attract one another — as if they were all latched together. When you add a water drop to the mound of water, its particles latch onto the other water particles on the coin. They attach together so strongly that the surface of the water bulges up and none of the water flows away until a certain point when there is too much water. This attraction force is referred to as the surface tension of water.



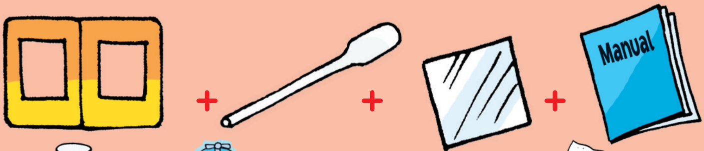
did you know?



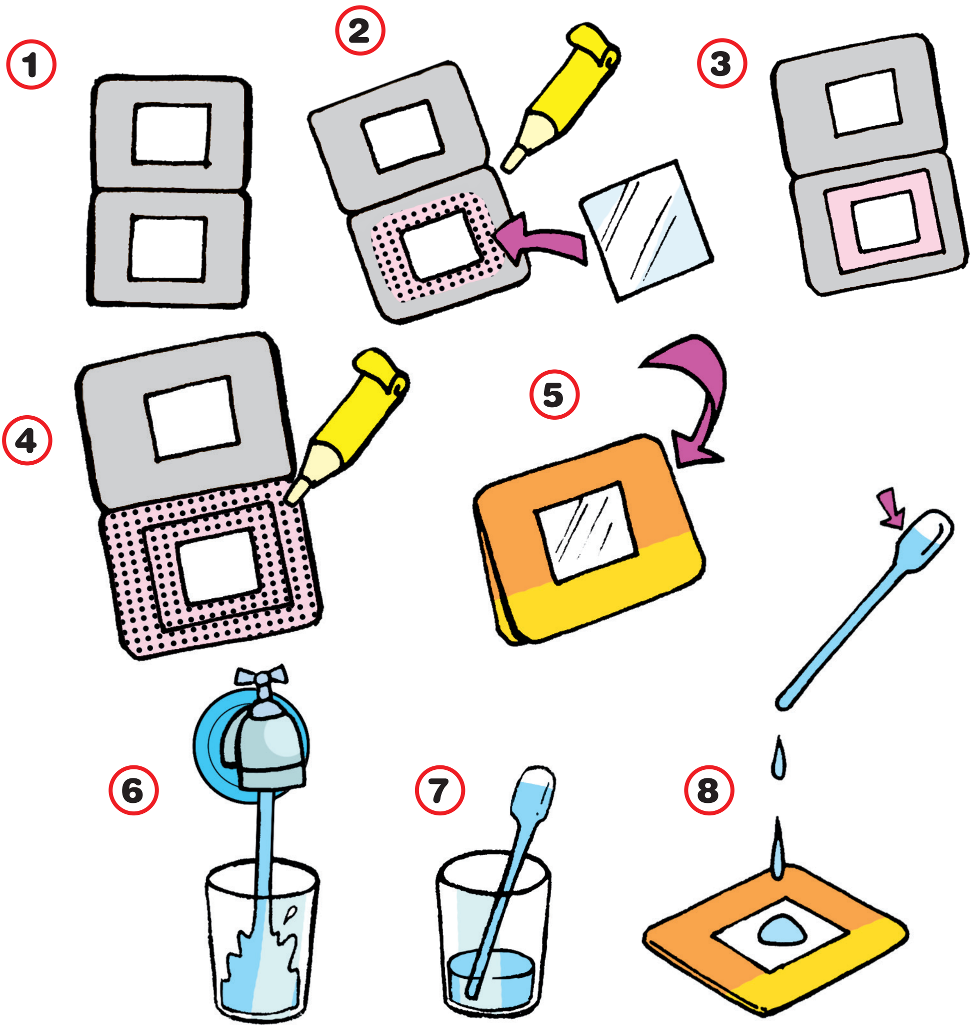
Did you know that the lens of a magnifying glass has the same shape as the mound of water? In a magnifying glass, the lens is made of glass, whereas here it is made of water. Either one can be used to enlarge things, which is what we'll do in the next experiment!

water-drop lens

You will need:



+ *Glue*, *plastic cup*, *Water*, *paper towel for wiping up*



9

how it works!

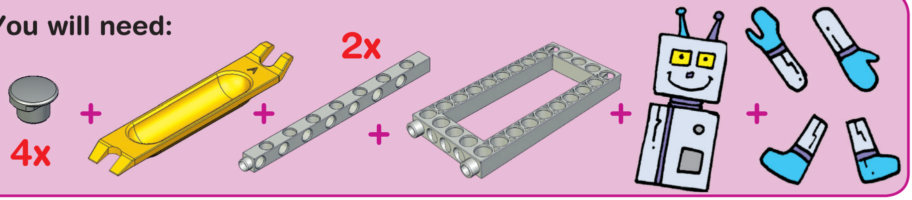
The water drop on the plastic film works like a lens. The curve of the lens causes light refraction, which means that light rays change their direction when they hit the lens. That is why small objects look really big when you look at them through the lens!

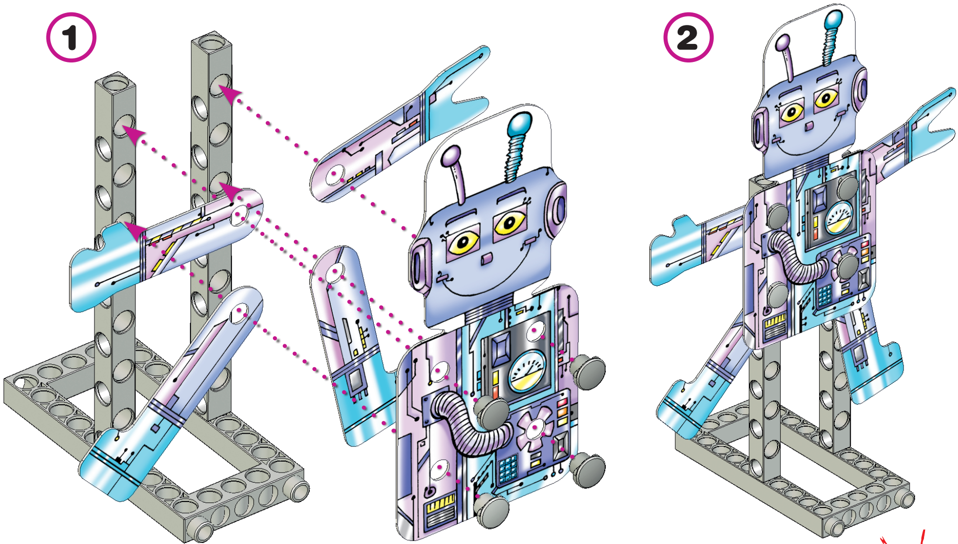
did you know?

Did you know that a microscope is like a really strong magnifying glass? It contains several lenses, so it can attain a much greater magnification. A magnifying lens shows objects 10 to 20 times larger, but a microscope can magnify things by more than 1,000 times! The record is held by the electron microscope, which works with electron beams instead of rays of light. It provides images that are magnified over 1,000,000 times!

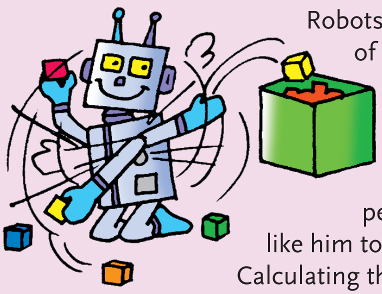
robot

You will need:





how it works!



Robots are machines, and they can do many kinds of work more quickly and more precisely than humans. We are always astounded by the latest developments in robotics. What won't a robot be able to do in the future? This fantasy robot will be happy to be your personal everyday assistant. What would you like him to give you a hand with? Cleaning up your toys? Calculating the number of nights before your next birthday comes? Or maybe he can fetch balls off the roof with his telescopic arm?

little labs