

# 6-IN-1 MODEL KIT **SOLAR BOAT**



**SOLAR MODULE**



## SOLAR BOAT | SAFETY INFORMATION

**WARNING!** Not suitable for children under 3 years of age. There is a risk of choking due to small parts that may be swallowed or inhaled. Keep the experiment materials and finished models out of the reach of small children. There is a risk of strangulation if long cords are wrapped around the neck.

**WARNING!** Only for use by children 8 years and older. Instructions are included for parents or other supervising individuals. Please follow them!

Save the packaging and instructions. They contain important information.

The models are not intended for long-term operation, and should not be left to operate unattended. In particular, the solar module should not be operated too long with a light bulb, which emits heat. The parts may get damaged.

For models with propellers: Keep rotating propellers away from the face and long hair, and do not reach into or hold onto them. Also, do not let other materials (such as strings, cords, or paper) get into the propellers.

For models used in water:

**WARNING!** Only operate models in water if they are recommended for such use and are properly assembled according to the instructions. Only use these models in the bathtub or shallow containers and under adult supervision.

After completing the experiment, dry all parts and return them to the box for storage.

### Notes on experimenting with batteries

- »» Do not perform any experiments using the household current supply! The high voltage can be deadly dangerous.
- »» To operate the solar cell, you will need a 1.5-volt, type AAA/LR03 battery or a 1.2-volt, min. 800 mAh/type AAA rechargeable battery, which is not included in the kit due to its limited shelf life.
- »» It is not possible to charge a rechargeable battery through the solar cell.
- »» Avoid short-circuiting the batteries. A short-circuit could lead to overheating of circuits and battery explosions.
- »» Always insert batteries in the right polarity orientation, pressing them gently into the battery compartment.
- »» Do not recharge non-rechargeable batteries. They could explode!
- »» Rechargeable batteries are to be removed from the toy before being recharged. Rechargeable batteries are only to be charged under adult supervision.
- »» Exhausted batteries are to be removed from the toy.
- »» Dispose of used batteries in accordance with environmental provisions.
- »» Be sure not to bring batteries into contact with coins, key chains, or other metal objects.
- »» Avoid deforming the batteries.
- »» Do not mix old and new batteries.
- »» Do not mix alkaline, standard (carbon-zinc), or rechargeable (nickel-cadmium) batteries.

With all of the experiments that use batteries, have an adult check the model to make sure you have assembled it properly.

After you are done experimenting, remove the battery from the battery compartment. Note the safety information accompanying the individual experiments!

### Notes on disposal of electrical and electronic components

The electronic components of this product are recyclable. For the sake of the environment, do not throw them into the household trash at the end of their lifespan. They must be delivered to a collection location for electronic waste, as indicated by the following symbol:

Please contact your local authorities for the appropriate disposal location.



### DEAR PARENTS!

Before starting the experiments, read through the instruction manual along with your child and discuss the safety information. Check to make sure the models have been assembled correctly, and assist your child with the experiments.

We wish you and your child a lot of fun with the experiments!

# An experiment to help you hit the ground running

Can you really get electricity from sunshine?  
Try it, and prepare to be surprised!

## SOLAR BOAT



### WANT TO LEARN MORE?

Then come along into the sunny world of solar energy...

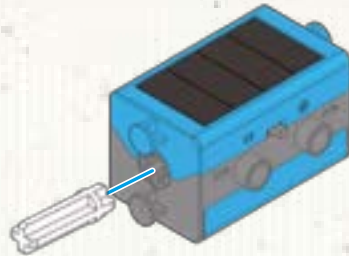
## Using the power of the sun

### YOU WILL NEED

- › Solar module
- › Motor shaft
- › Sunlight

### HERE'S HOW

1. Insert the motor shaft into the module short end first, and slide the module switch to the "sun" symbol. Hold the solar cell in the sunlight or a few inches away from a light bulb. What happens?
2. Move the module farther and farther away from the light source (if you are outside, move it into the shade). Does the shaft's rotation speed change?
3. Cover part of the solar cell with your hand. Does that have an influence on the shaft?



### WHAT'S HAPPENING?

The solar cell converts light energy into electrical current, which in turn drives the module's motor. Several gear wheels transfer this movement to the shaft. It makes a big difference how bright the light source is — the motor becomes slower as you move it away from the light — and how large the solar cell is.

Solar energy is a very good type of energy, because it is "renewable."

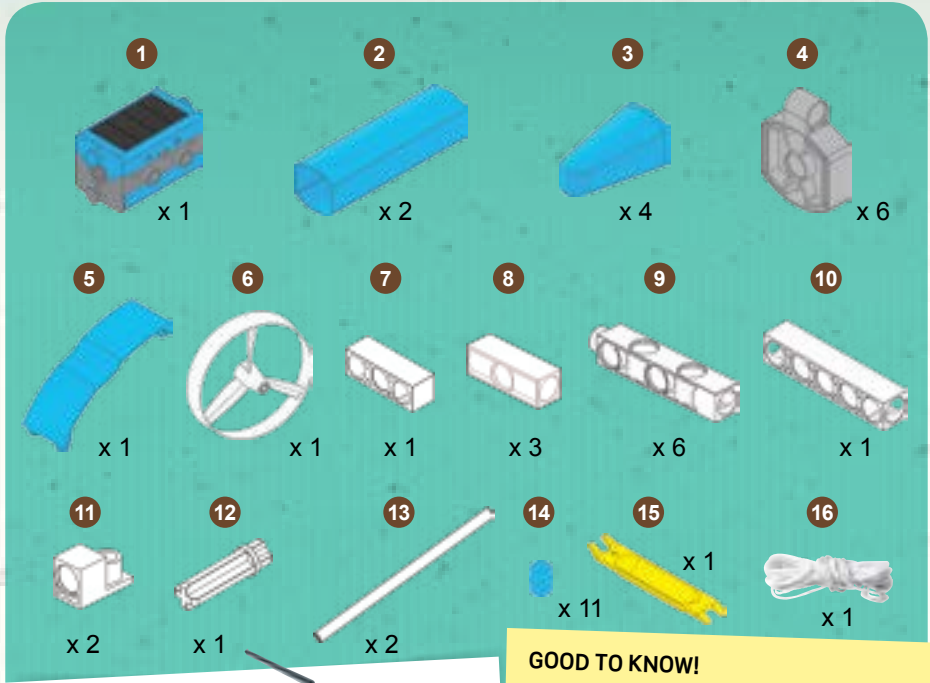
### DID YOU KNOW ...

The production of electricity from sunlight is becoming more and more common. If you keep an eye out for dark blue solar cells, you will start seeing them on the roofs of lots of houses, and sometimes even on boats.





# SOLAR BOAT | The parts in your kit



### You will also need:

Source of energy (sunlight, 1 x 1.5-volt battery, type AAA/LR03, or 1 x 1.2-volt rechargeable battery, min. 800 mAh/type AAA, light bulb (only halogen energy-saving bulb, 42 W or above)), bathtub or wading pool, hair dryer, sheet of letter-sized paper, pencil, scissors, ruler, 2 chairs, weight, tape

### GOOD TO KNOW!

If you are missing any parts, please contact Thames & Kosmos customer service.

Any materials not included in the kit are indicated in *italic script* under the "You will need" heading.

No.	Description	Qty.	Item No.	No.	Description	Qty.	Item No.
1	SOLAR MODULE with Motor	1	714009	9	5-HOLE DUAL-ROD	6	714126
2	FLOAT	2	714010	10	5-HOLE ROD	1	714179
3	FLOAT COVER	4	714011	11	90-DEGREE CONVERTER - R	2	714128
4	BASE	6	714012	12	MOTOR SHAFT	1	702801
5	BODY PANEL, large	1	714013	13	TUBE	2	714014
6	PROPELLER	1	714005	14	ANCHOR PIN	11	714129
7	3-HOLE ROD	1	714125	15	ANCHOR PIN LEVER	1	702590
8	3-HOLE DUAL-ROD	3	714127	16	STRING	1	714130
						Total	44



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Copyright page ..... inside back cover



**TIP!**

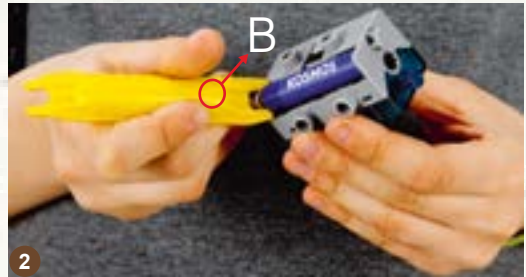
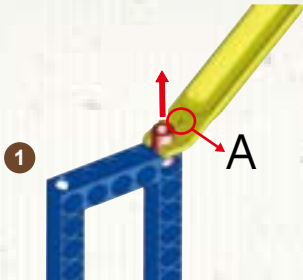
You will find additional information here: "Check It Out" Pages 29, 30, 31, and 32



## THE ANCHOR PIN LEVER

Take a look inside the kit box and find a little yellow tool — the anchor pin lever.

1. The “A” end of the lever lets you remove anchor pins easily.

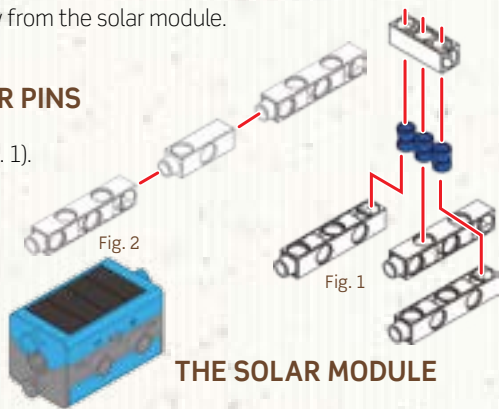


2. Use the “B” end to remove the battery from the solar module.

## MOUNTING BARS AND ANCHOR PINS

Use the anchor pins to connect bars (Fig. 1).

Some of the components can also be connected without anchor pins (Fig. 2).



### TIP!

If the sun isn't shining brightly enough, you can use a halogen energy-saving light bulb or insert a battery into the module.

## THE SOLAR MODULE

Take a look at the solar module. It has two energy sources — the dark solar cell area and a battery compartment. You can switch back and forth between these two sources by using the switch (with one symbol for the sun and another for the battery). Set the switch to the middle position to turn off the motor. Always use the solar cell when you can.

### TIP!

When assembling the solar module, always make sure you are doing it as indicated in the drawings. Otherwise, your experiments won't work.





# Solar Boat















Your quick and agile airboat can zip across swamps, marshes, and shallow bodies of water. An airboat is made with one or more shallow hulls and a large propeller driven by a powerful motor.

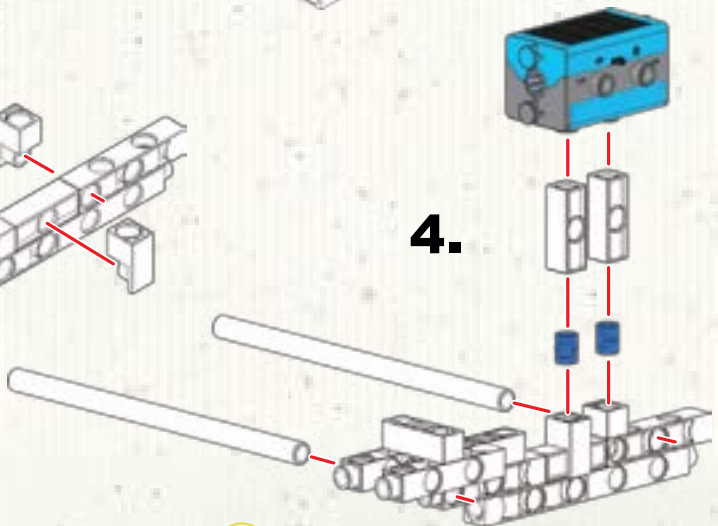
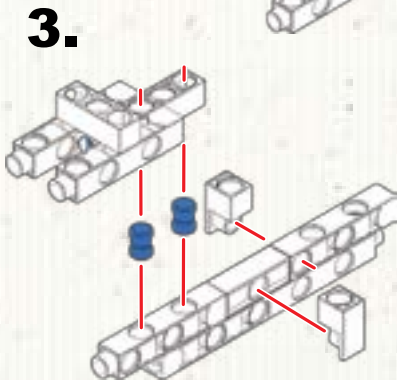
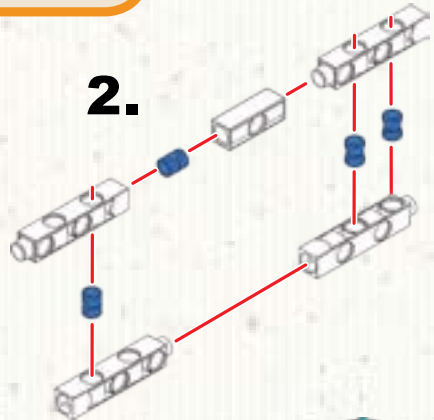
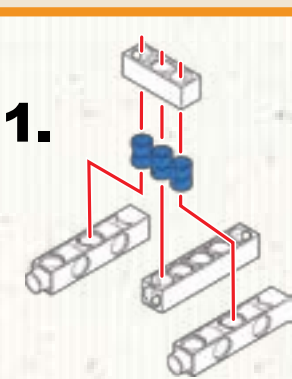
You can use the solar module to build your very own environmentally friendly airboat!



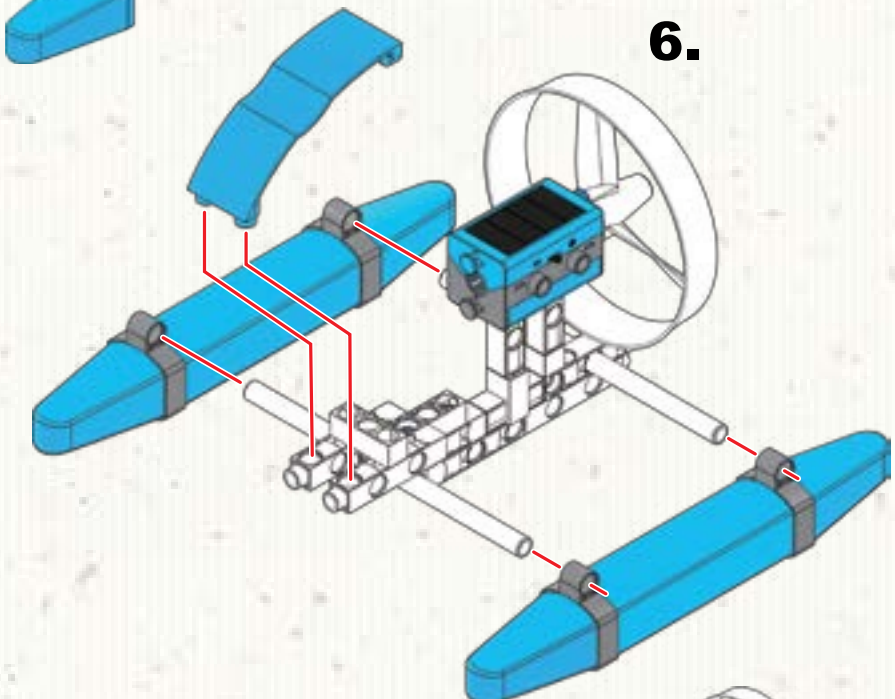
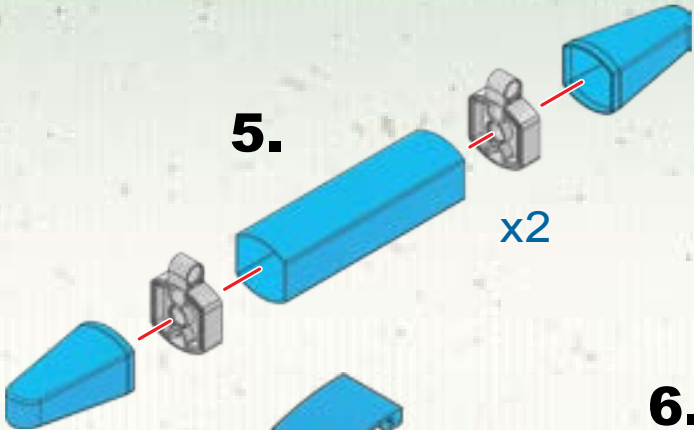


## Required Parts

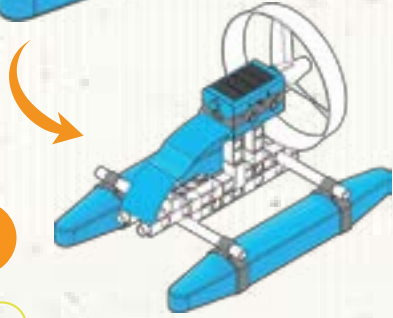
 1 x1	 2 x2	 3 x4	 4 x4	 5 x1	 6 x1		
 7 x1	 8 x3	 9 x6	 10 x1	 11 x2	 12 x1	 13 x2	 14 x11







**Completed**





## EXPERIMENT 1

### When does your solar boat run?

#### YOU WILL NEED

- › The assembled solar boat
- › Energy source (battery)
- › Bathtub



#### HERE'S HOW

1. Set your boat in a dry tub. Push the switch to the battery power setting to turn on the motor.
2. Gradually fill the tub with cold water. How high does the water level have to get for the boat to float? When that happens, does it start moving right away?

#### WHAT'S HAPPENING?

The two floats help the solar boat float on the water. The motor powers the propeller or fan, which creates a strong push of air behind the boat, moving the boat forward. Unlike in an ordinary boat, this propeller is positioned above the water rather than sticking down into it. That means that the boat can even move through shallow water.

#### WARNING!

Never place an electric lamp anywhere near water or near a bathtub! Use only the battery power or sunlight when operating in water.

#### TIP!

If you want to use the boat outside, set it in a shallow basin or wading pool. Dry off all the pieces after use!

#### DID YOU KNOW ...

Airboats (also known as fanboats) have no brakes, and they can't drive in reverse. So the person piloting an airboat has to steer carefully in order to get it to the right destination. Along with rubber rafts, airboats are often used in flooded areas.





## Solar Windmill

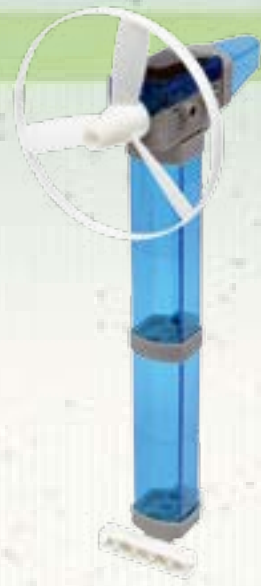
Windmills use their giant rotors to convert wind energy into electricity. These days, you will sometimes see lots of wind turbines collected together in a single large wind farm. This way, a lot of electricity can be produced at once. An average-sized windmill can be as tall as an apartment building, with rotor blades as long as a passenger plane.



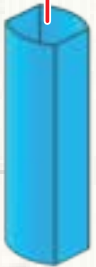


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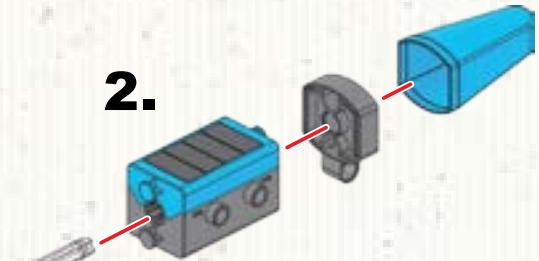
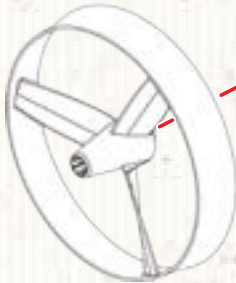
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|    |    |    |    |    |
| x1 | x1 | x1 | x1 | x1 |



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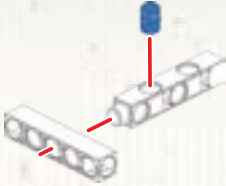


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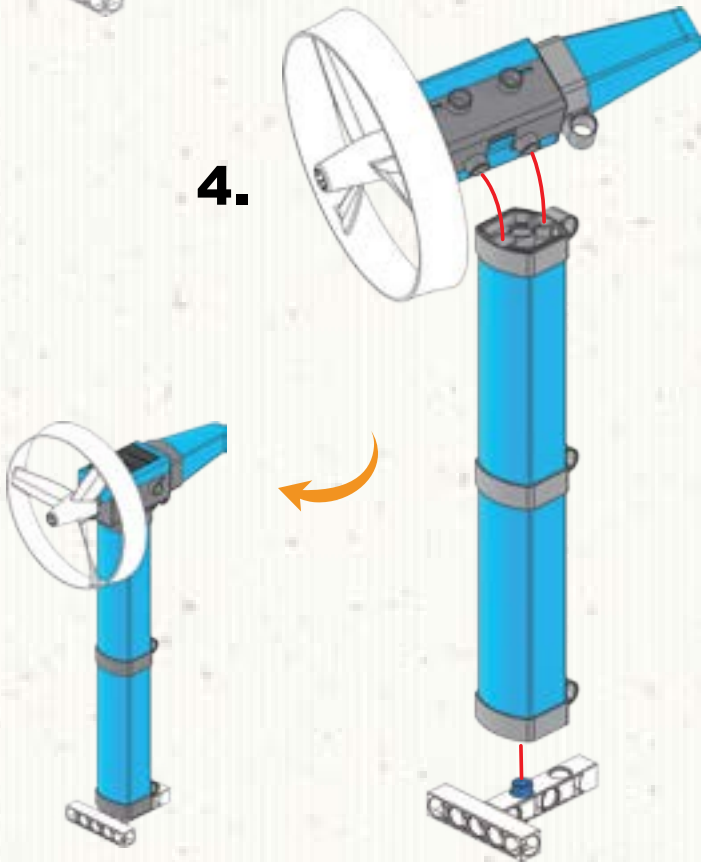




3.



4.



Completed



## TIP!

If you operate the windmill with the solar cell or the battery, it will turn into a fan!

### EXPERIMENT 2

## When does your windmill turn?

### YOU WILL NEED

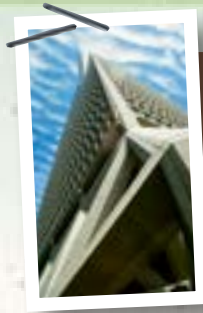
- > The assembled windmill
- > Hair dryer

### HERE'S HOW

1. Do not insert a battery. Hold your windmill firmly by the base, so it doesn't tip over.
2. Set the module switch to the center position and aim the hair dryer at the rotor from the front. Watch what happens.
3. Shift the hair dryer's position up, down, and to the sides. Try the different blowing settings of the hair dryer. When do the blades turn faster, and when do they turn slower?

### DID YOU KNOW ...

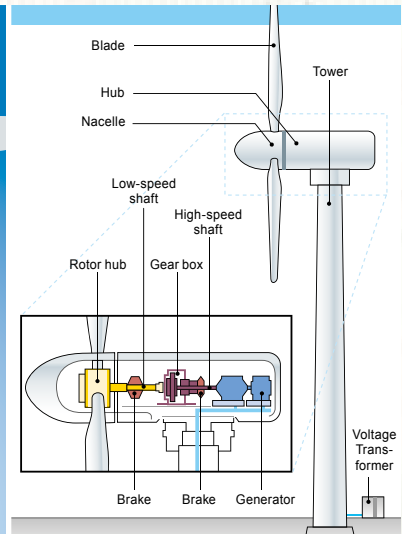
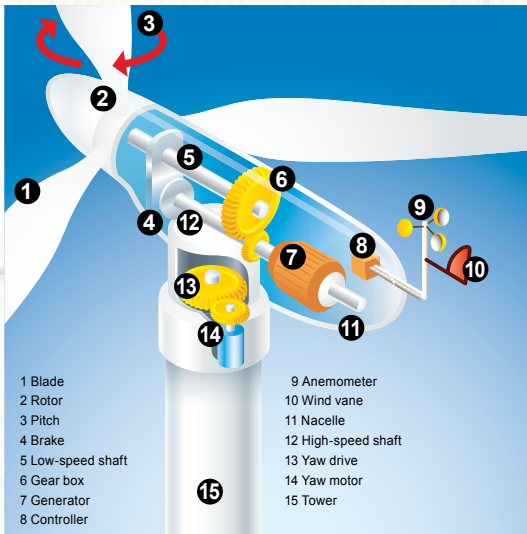
The largest electricity-producing windmill in the world is in Brandenburg, Germany. With a height of 205 meters, it is as tall as a 75-story building!



4. Only operate the windmill for a brief period of time with the hair dryer, and turn the hair dryer off after use.

### WHAT'S HAPPENING?

When the wind hits the rotor blades at the right angle, they start to turn, since they are mounted at a slight slant. In an actual wind turbine, this rotation is turned into electrical energy by a generator. Large iron coils and magnets are needed for that. Wind energy is a form of renewable energy, because nothing is combusted or consumed.





## Solar Plane

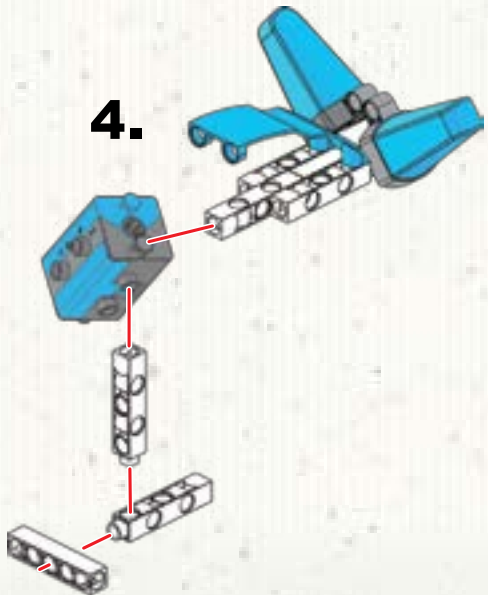
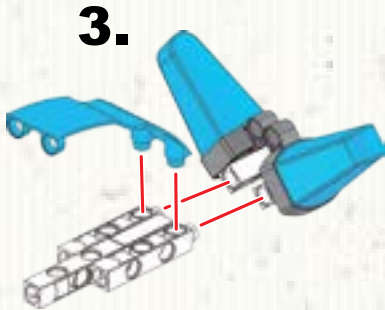
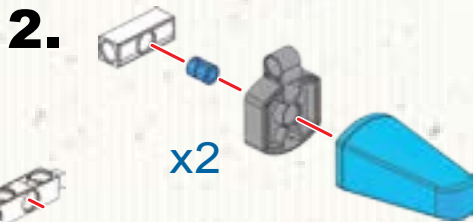
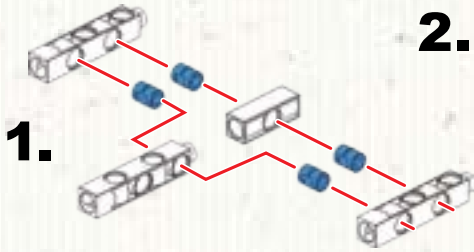
It's hard to believe - motor-powered airplanes have only been in use for about a hundred years. In large airplanes, extremely powerful turbines take the place of motors. Planes that fly using electricity produced by solar cells are a recent innovation. You can use your solar module to build your very own solar plane.



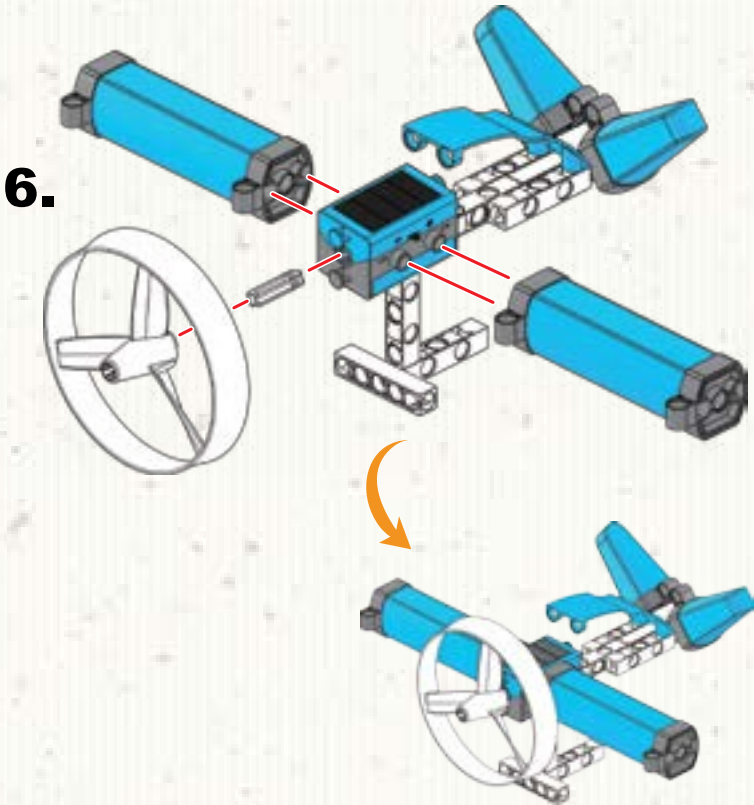
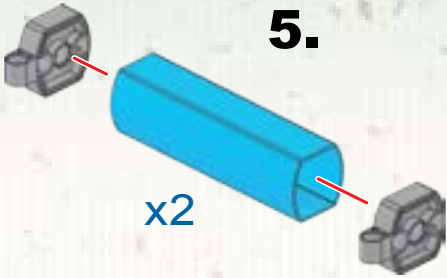


Required Parts

- |    |    |    |    |    |    |
|----|----|----|----|----|----|
|    |    |    |    |    |    |
| x1 | x2 | x2 | x6 | x1 |    |
|    |    |    |    |    |    |
| x1 | x3 | x5 | x1 | x1 | x6 |









### EXPERIMENT 3

## When does an airplane fly?

### YOU WILL NEED

- › The assembled solar plane
- › Energy source (sunlight, halogen energy-saving bulb, battery)
- › Strip of paper, about 2 x 10 cm



### HERE'S HOW

1. Power the propeller with the solar cell or the battery by moving the switch to the appropriate setting.
2. Use your hand to check whether the stream of air flows forward or backward from the propeller.
3. Hold the strip of paper by one end and move it toward the propeller from the nose of the airplane. What happens?
4. Take the paper strip and hold it on the other side of the propeller. Watch the movement of the strip.

### TIP!

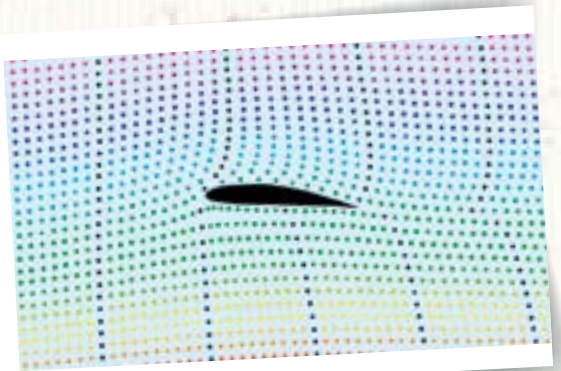
It works best if you watch the paper strip from the side.

### WHAT'S HAPPENING?

When you hold the paper strip behind the propeller, it shows you how the stream of air is flowing. As the air from the propeller strikes the strip, it rises up like a miniature wing! The stream of air from the propeller has to be pointed backward in order for the plane to move forward.

### KEYWORD WING

All propeller planes also have wings. They work by a principle known as "dynamic lift," which pushes the wings upward. The reason that happens is that the air has to flow faster over the curved upper edge of the wing than over the flatter lower edge, which creates an area of low pressure above it.





## Solar Fan

This fan will be particularly handy in the summer. It keeps the air moving so you can keep cool. Fans come in all sizes. Assemble your very own solar fan here!





Required Parts

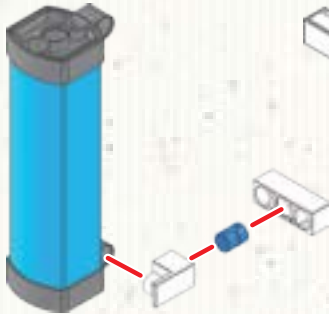
x1	x1	x2	x1	x1	
x2	x4	x1	x2	x1	x7



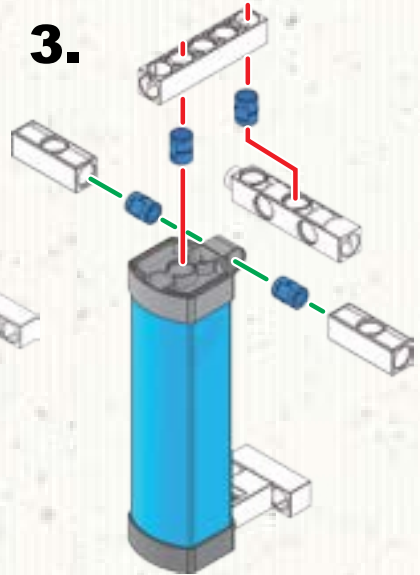
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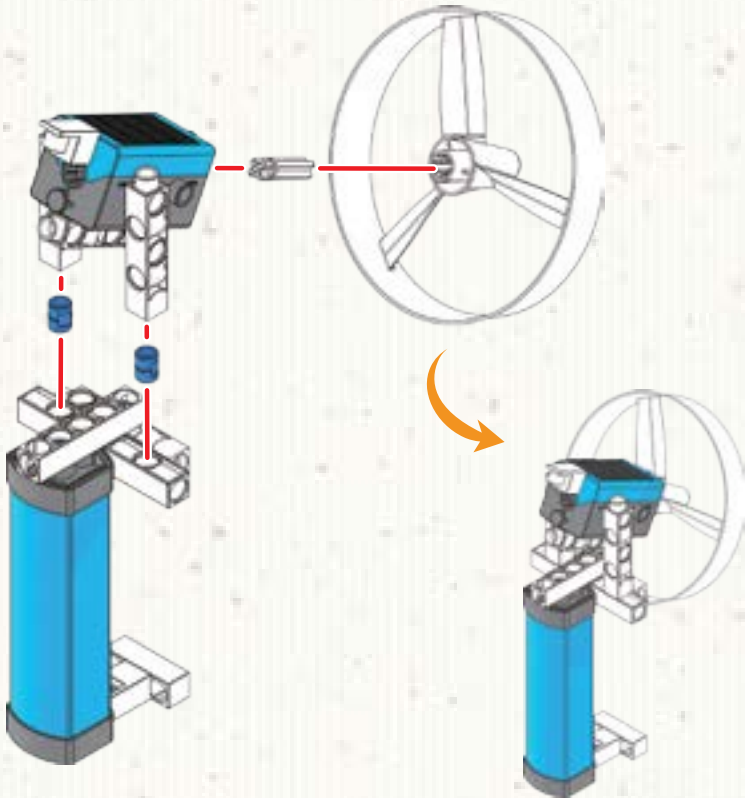
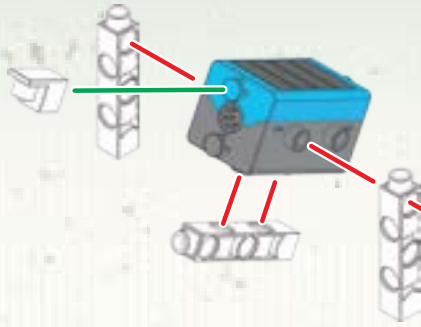


3.





4.



Completed



## EXPERIMENT 4

### Where does your fan blow?

#### YOU WILL NEED

- › The assembled fan
- › Energy source (sunlight, halogen energy-saving bulb, battery)

#### HERE'S HOW

1. Power the fan with the solar cell or the battery by moving the switch to the appropriate setting.
2. Use your hand to check whether the fan pushes the stream of air forward or backward.
3. What happens when you install the solar module rotated 180 degrees?



#### WHAT'S HAPPENING?

The fan creates a stream of air. But it only works because the fan blades are mounted at an angle. If you look at the tip of the fan, you will see that it blows the air across the solar module when its blades rotate in a clockwise direction. If you turn the solar module around, the fan rotates in a counterclockwise direction and the air blows in your direction. The angle of the blades and their rotation speed control the strength of the air stream.

#### KEYWORD HELICOPTER

If you hold the fan so that the air blows toward the ground, it will demonstrate the principle by which a helicopter works. The long rotor blades create a stream of air flowing downward. If they rotate fast enough, there's enough power to lift the helicopter off the ground.





## Solar Rocket

In order to lift off into space, there's one thing a rocket needs most of all: a lot of thrust. The thrust, or propulsion, is created by powerful engines and turbines. All space rockets consist mostly of fuel tanks! You might not be able to take off into space with your rocket, but you will be able to zip around closer to home.



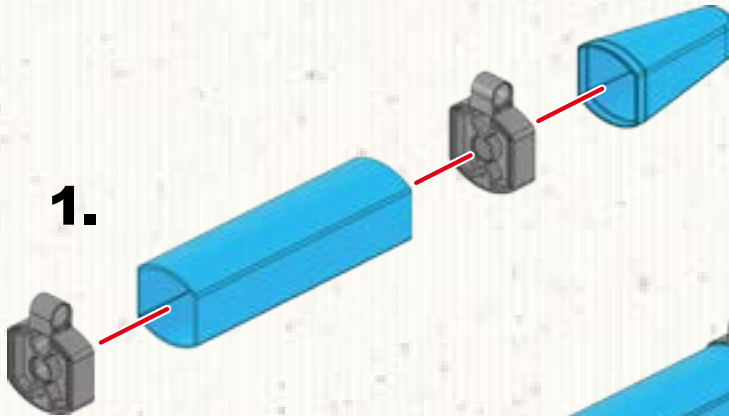


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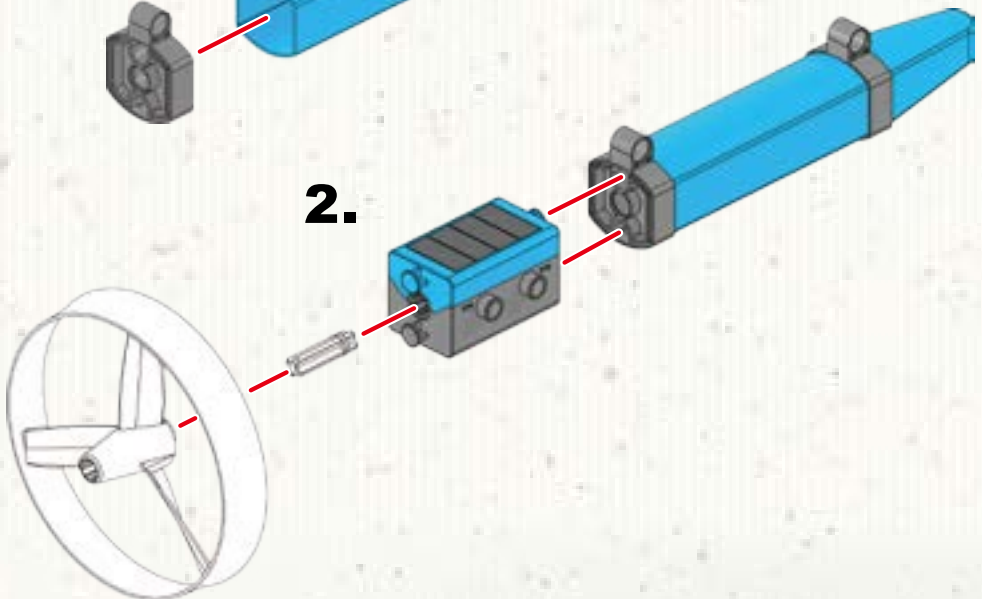
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x2	x1	x1		



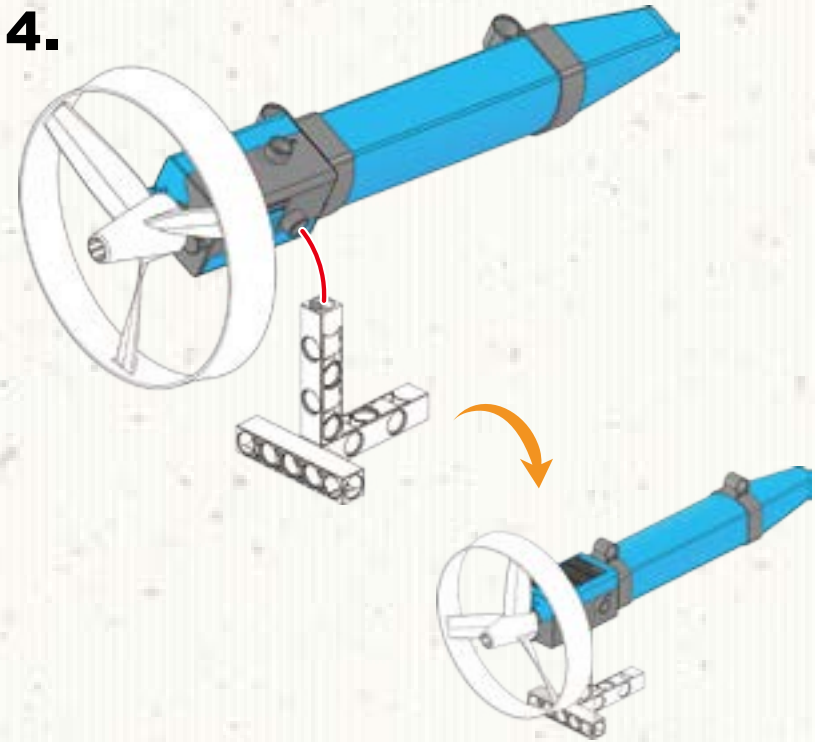
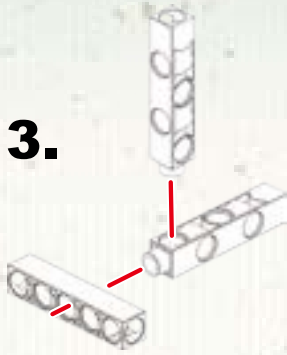
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**Completed**



### EXPERIMENT 5

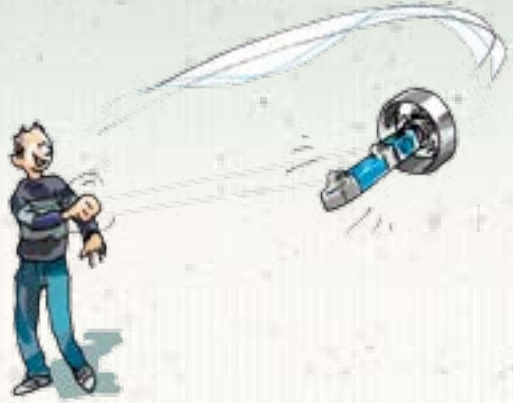
## How does your rocket fly?

### YOU WILL NEED

- › The assembled rocket
- › String (1.4 m)
- › Energy source (sunlight, halogen energy-saving bulb, battery)

### HERE'S HOW

1. For this experiment, it's best to start by running the rocket on battery power. Remove the display stand. Insert the battery and slide the switch to the "battery" setting.
2. Hold your hand behind the propeller. Do you feel a draft of air? Switch off the motor.
3. Next, tie one end of the string to the front of the rocket and the other end to the rear.
4. Now you will have to be sure that nobody and nothing is in the way! Set the switch to "battery" mode again and hold the string by the middle of the loop.
5. Pull the string tight and start turning in a circle while holding the rocket.
6. Keep your eye on the rocket and try to make it rise or drop by pulling on the string.
7. Can your rocket fly outside too? Take it into the sunshine and find out!



### WHAT'S HAPPENING?

Your rocket can fly in a circle! The propeller provides the recoil it needs to move forward. That means that the rocket is moved forward with the same force with which the propeller pushes the air to the rear. Your turning movement assists the recoil.

You can see this same recoil principle at work in the large rockets that shoot off into space.





# Solar Spaceship

Spaceships glide through space seemingly weightless and friction-free. The spaceship Apollo 11 carried humans to the Moon for the first time. A lot of spaceships are equipped with solar modules for their energy needs.



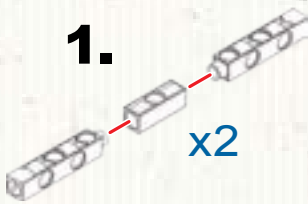


Required Parts

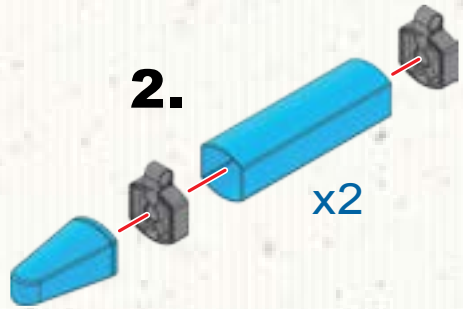
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x1	x1	x3	x5	x1	x1	x7



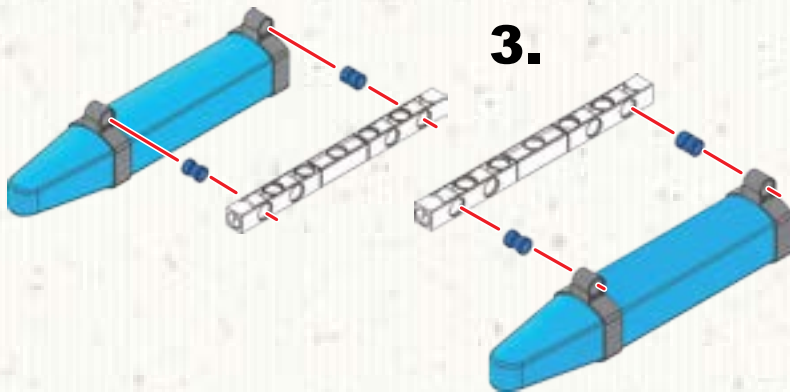
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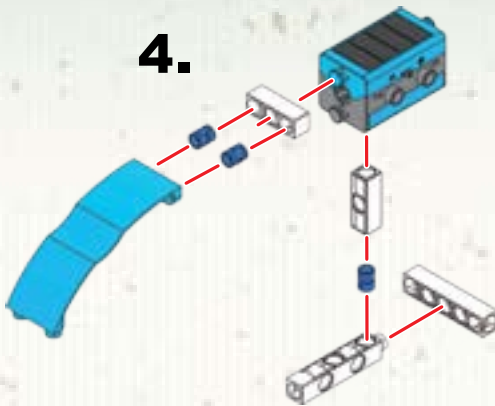


3.

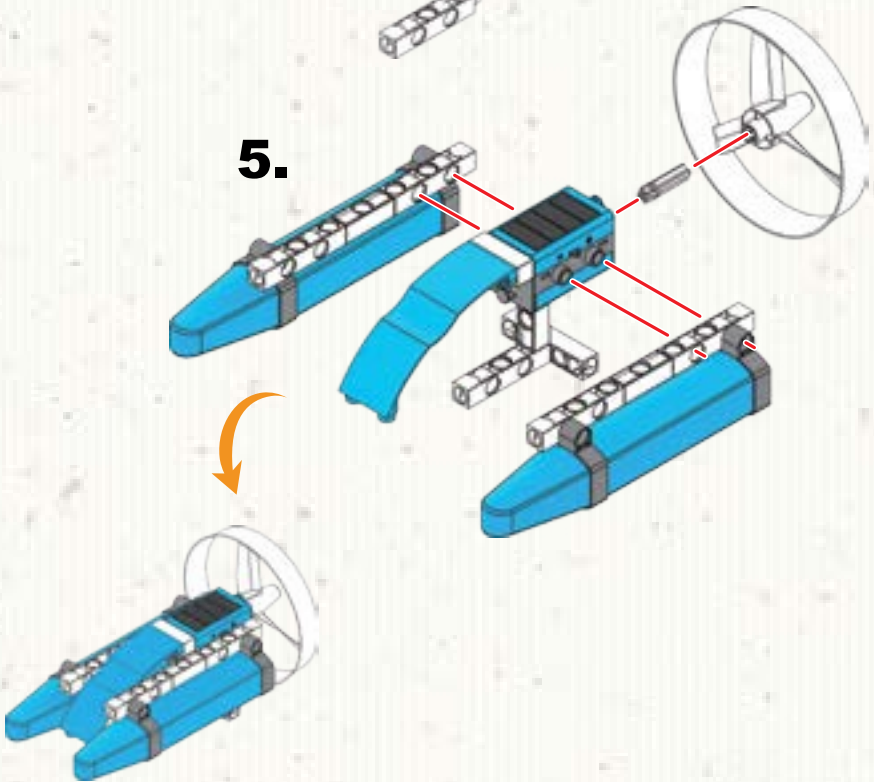




4.



5.



Completed



## EXPERIMENT 6

### How does your spaceship fly?

#### YOU WILL NEED

- › The assembled spaceship
- › String (2.6 m)
- › Tube
- › Energy source (sunlight, halogen energy-saving bulb, battery)
- › 2 chairs
- › Tape
- › Weight

#### TIP!

Outside, you could tie the string to a garden fence, for example, or a railing. Have an adult help you.



#### HERE'S HOW

1. Remove the display stand.
2. Take 30 cm of the string and tie one end to one of the gray holes in the forward base section. To do that, you will briefly need to remove the base section from the bar with the holes. Proceed the same way with a second piece of string and the rear base section holes.
3. Thread the tube onto a 1-meter section of string and insert the tube through the loops of string attached to the model.
4. Tape the tops of the loops to the tube.
5. Stretch out the long section of cord and tie its ends to the backs of 2 chairs, making sure it is tight and horizontal.
6. Now thread a 1-meter-long section of string through the front two free holes of the white bars, and tie a weight to it.
7. Start up the propeller, and your spaceship will zip along the string.

#### WHAT'S HAPPENING?

For your spaceship to travel easily along the string, friction has to be kept to a minimum. If two rough surfaces move against each other, there's a lot of friction. Your tube, though, is very smooth on the inside, so it moves easily along the string. The less friction there is, the faster your spaceship will move.

#### DID YOU KNOW ...

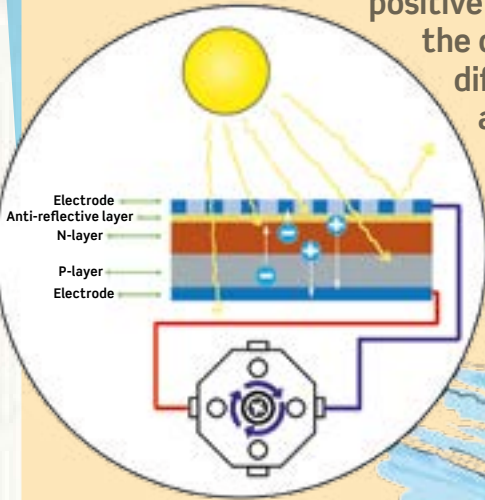
Some modern trains are held aloft by magnets, resulting in a complete absence of friction between train and rails. That lets them travel extremely fast!



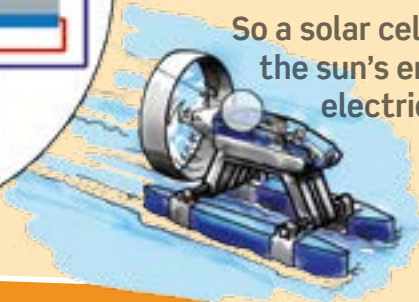


## How does a solar cell work?

When the sun shines on a solar cell, the electrons in the cell start to move. Wherever there are a lot of electrons, a negative pole forms. Wherever there are “electron holes,” a positive pole forms. This difference in the quantity of electrons is called a difference in electrical potential, also known as voltage. If the two poles are connected, the electrons start to flow, resulting in electrical current.



So a solar cell converts the sun's energy into electrical energy.



### RENEWABLE ENERGY — WHAT IS IT?

ENERGY THAT IS OBTAINED FROM SOURCES THAT ARE NEVER USED UP IS CALLED “RENEWABLE ENERGY.” THE SUN IS AN EXAMPLE OF THAT KIND OF SOURCE. SO ARE WIND AND WATER.



### WHAT IS AN ELECTRON?

An electron is a very small negatively charged particle — in other words, it carries a negative electrical charge. Here, researchers have attempted to photograph an electron.





## AIRBOAT

To steer an airboat, air from the fan is guided past large rudders. The captain just has to adjust the direction of these rudders in order to steer. Airboats are especially popular for transporting people and goods in the swampy areas of Florida and other southern U.S. states.



## And if the wind isn't blowing?

One of the biggest problems with renewable forms of energy is how to store them. The wind won't always

be blowing, but you always need a supply of electrical energy. So researchers are looking for ways to store energy when the wind is blowing strongly. Unfortunately, it isn't easy to charge ordinary batteries for this purpose. So new technologies have to be developed.





## FANS EVERYWHERE...

YOU WILL FIND FANS IN A LOT OF EVERYDAY THINGS, SUCH AS CARS, COMPUTERS, AND CLIMATE CONTROL SYSTEMS. IN THE CASE OF MACHINES LIKE THESE, THE FAN ENSURES THAT TOO MUCH HEAT DOESN'T BUILD UP. THERE'S A FAN IN YOUR HAIR DRYER, TOO. IT BLOWS AIR ACROSS ELECTRICALLY HEATED WIRES, SO YOU CAN DRY YOUR HAIR WITH WARM AIR.



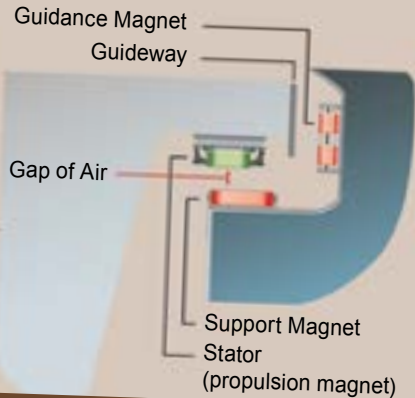
## What do a rocket and an octopus have in common?

The recoil principle! The octopus moves forward with the same force with which it pushes water out of its body to the rear.



## FLOATING TRAINS?

A MAGNETIC LEVITATION (MAGLEV) TRAIN IS A TRAIN THAT IS LIFTED UP AND PROPELLED FORWARD BY THE FORCE OF POWERFUL MAGNETS. IT MOVES ALONG WITHOUT TOUCHING THE TRACKS, SO IT CAN MOVE VERY FAST. IN THE CHINESE CITY OF SHANGHAI, THERE IS A MAGLEV TRAIN THAT CAN REACH SPEEDS OF 430 KILOMETERS PER HOUR!



## SOMEWHAT SLIPPERY...

Have you ever slipped on a patch of ice? When it's "slippery," it means the friction between your shoes and the ground is very low. Some materials, such as oil, have this kind of effect. That's why those materials are used wherever you want to reduce friction — such as in machines. When you oil your bicycle chain, it reduces friction and improves the interplay of the moving parts.





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