

# SOLAR CAR



SOLAR MODULE



## SOLAR CAR | 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.

### 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!

### Using the power of the sun

#### YOU WILL NEED

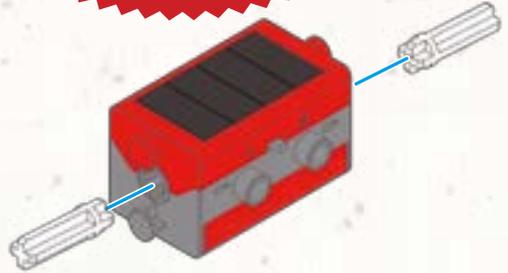
- > Solar module
- > 2 motor shafts
- > Sunlight

#### HERE'S HOW

1. Insert the motor shafts into the solar 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 rotation speed change?
3. Cover part of the solar cell with your hand. Does that have an effect on the shafts?

#### WANT TO LEARN MORE?

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



#### WHAT'S HAPPENING?

The solar cell converts light energy into electrical current, which in turn drives the module's motor. 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.

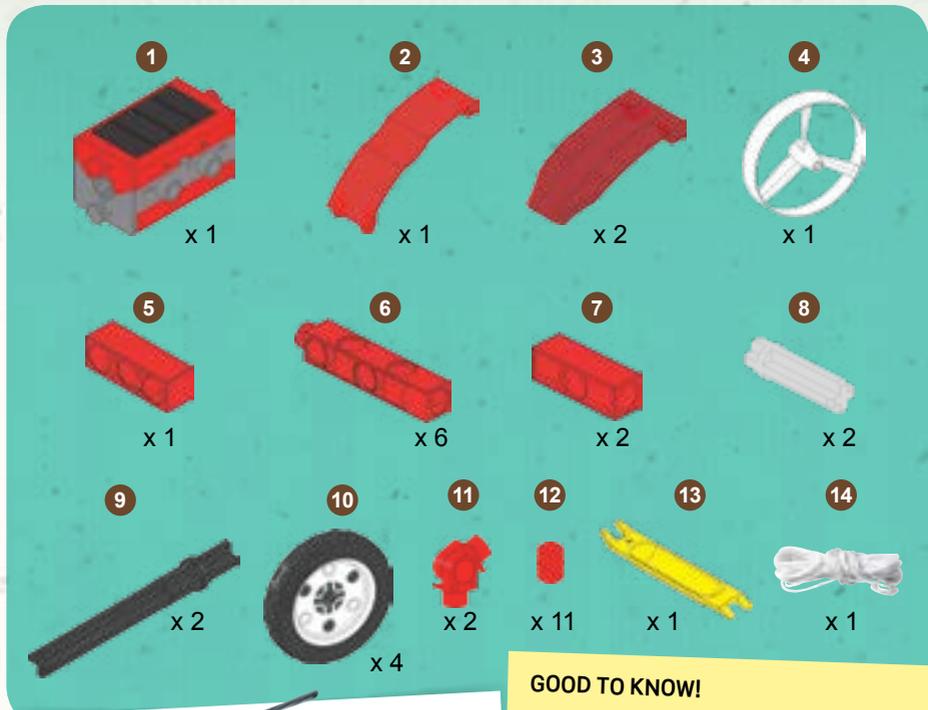
#### DID YOU KNOW ...

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 cars.





## SOLAR CAR | 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, 42W), ruler, sheet of white letter-sized paper, pencil, scissors, paper clip, chair

### 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	714002	8	MOTOR SHAFT	2	702801
2	BODY PANEL, large	1	714003	9	MEDIUM AXLE	2	703238
3	BODY PANEL, small	2	714004	10	WHEEL	4	714006
4	PROPELLER	1	714005	11	JOINT	2	714123
5	3-HOLE ROD	1	714120	12	ANCHOR PIN	11	714124
6	5-HOLE DUAL-ROD	6	714121	13	ANCHOR PIN LEVER	1	702590
7	3-HOLE DUAL-ROD	2	714122	14	STRING	1	714240
Total						37	



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### MODELS AND EXPERIMENTS

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**Experiment 2:** Whup whup whup... With the help of the solar cell, your helicopter is ready for liftoff.

Wind Maker ..... 13

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Solar Jet ..... 17

**Experiment 4:** Ready to take off? Your solar jet is sure to get some attention.

Gyrocopter ..... 21

**Experiment 5:** Whirr... What is a gyrocopter, and what does it have in common with maple seeds?

Copyright page ..... inside back cover

**TIP!**

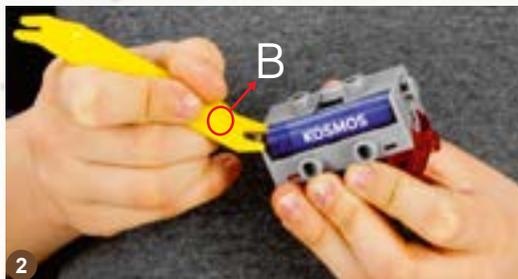
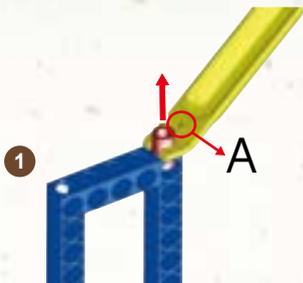
You will find additional information here: "Check It Out"  
**Pages 25, 26, 27, and 28**



## THE ANCHOR PIN LEVER

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

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

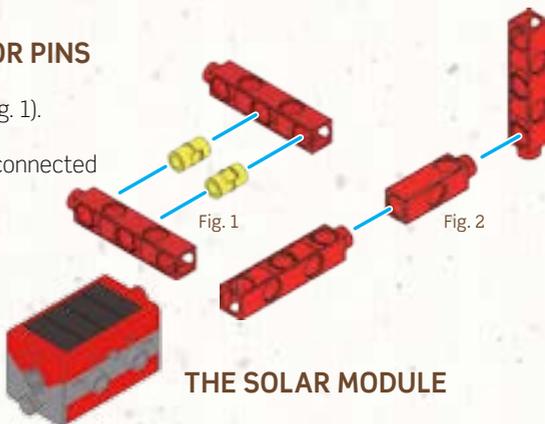


2. Use the “B” end to remove the battery from the solar module.

## MOUNTING BARS AND ANCHOR PINS

Use the anchor pins to connect rods (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 Car

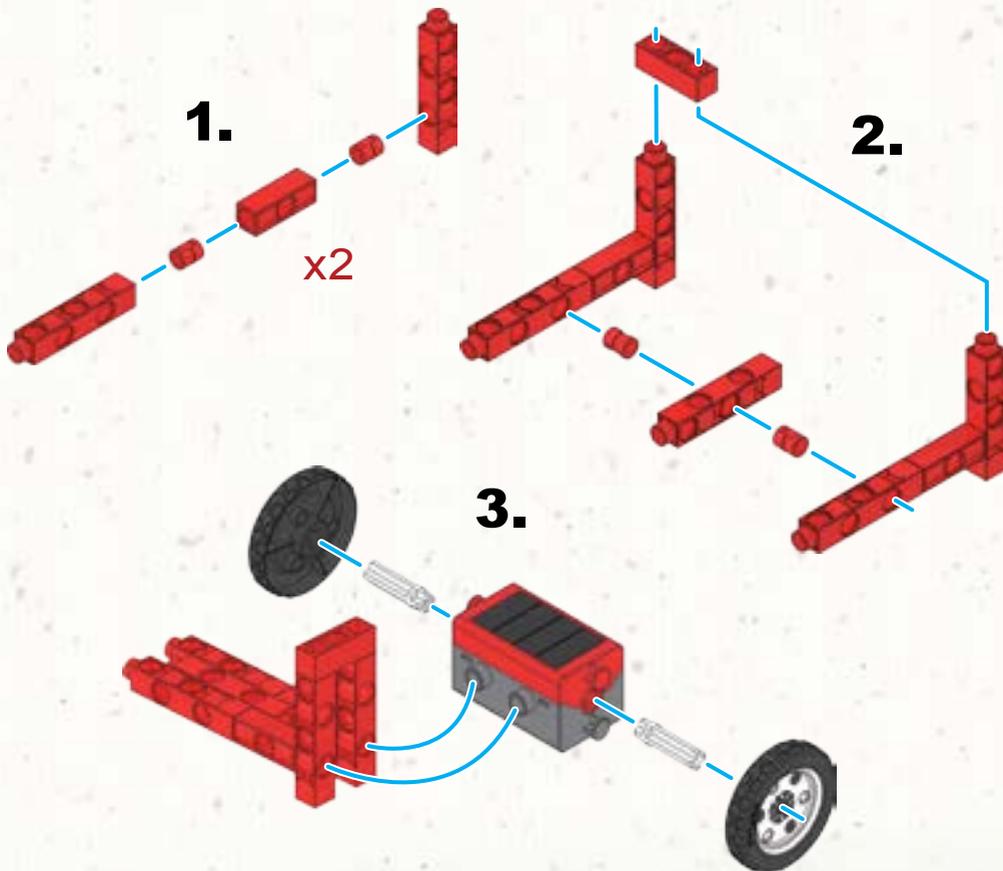
Can a real car run on solar energy? Sure it can! Of course, the car has to be very light and it has to have a large portion of its surface area covered with solar cells. You can use the components in the kit to build your own car powered with energy from the solar cell.





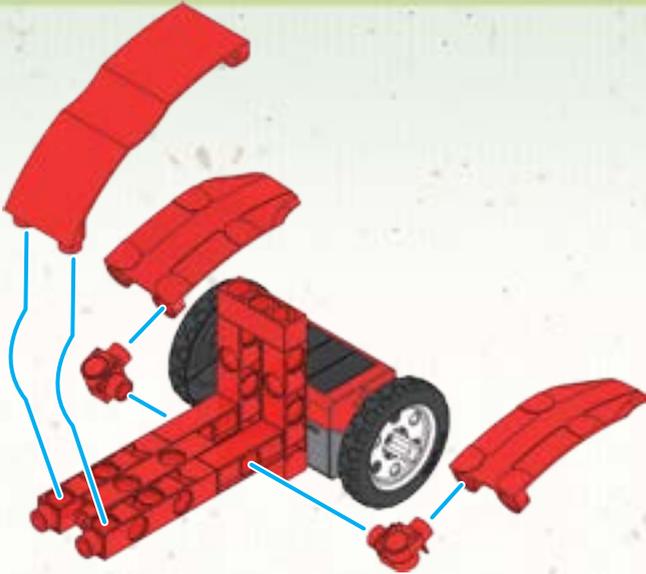
Required Parts

 x1	 x1	 x2	 x1	 x5	
 x2	 x2	 x1	 x4	 x2	 x6

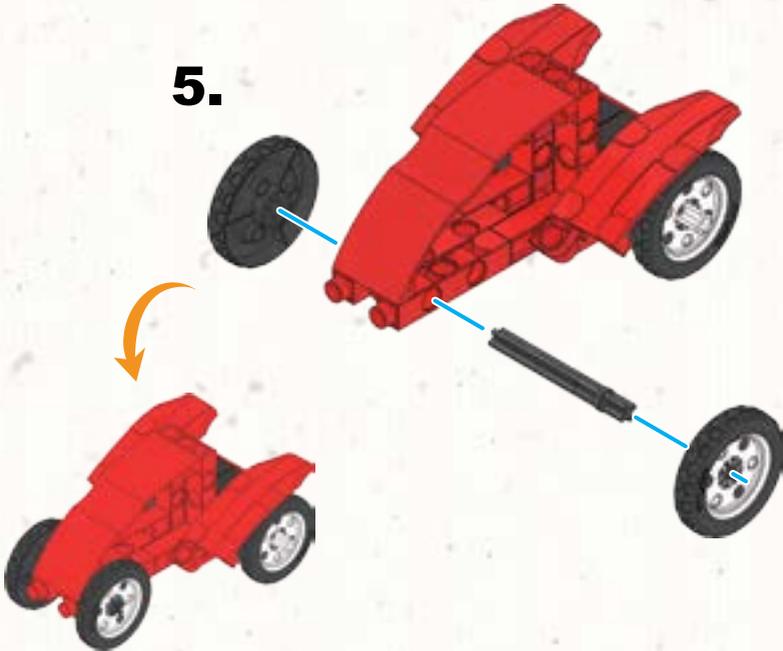




4.



5.



Completed



### EXPERIMENT 1

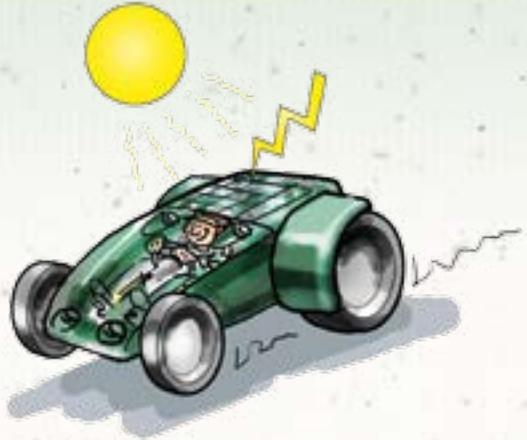
## Can your car drive forward and backward?

### YOU WILL NEED

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

### HERE'S HOW

1. Run the car with the solar cell or the battery, sliding the switch to the appropriate setting.
2. In what direction does your car move?
3. Now remove the solar module from the model along with the tires, and re-mount it after rotating it 180 degrees.
4. Let the car run again. What happens now?



### WHAT'S HAPPENING?

The current from the solar cell or the battery powers the motor inside the module. Several gears transfer this movement to the axles, and hence to the wheels. The wheels start to turn and your car drives forward. If you turn the solar module around, the axles turn in the opposite direction and your car races in reverse.

### TIP!

Try driving your car on different surfaces, such as a hard, smooth floor and a carpet. If you're testing your car outside, you might try running it on a garden path, balcony, or terrace. On what kind of surface does the car drive best?

### DID YOU KNOW ...

This yellow racer, which was built at Bochum University in Germany, is called "SolarWorld No. 1." At a race held in Australia in 2007, it got a prize for being the best-looking solar car in the world!





# Solar Helicopter

Lift off and fly! Helicopters are highly maneuverable and can be deployed in many terrains for many different jobs — as rescue helicopters, for monitoring traffic, and for police operations. They can easily get to impassable areas, and they can carry large loads. See how your own helicopter's rotor can be powered by the solar cell.





Required Parts

1



x1

2



x1

3



x2

4



x1

5



x1

6



x6

7



x2

8



x1

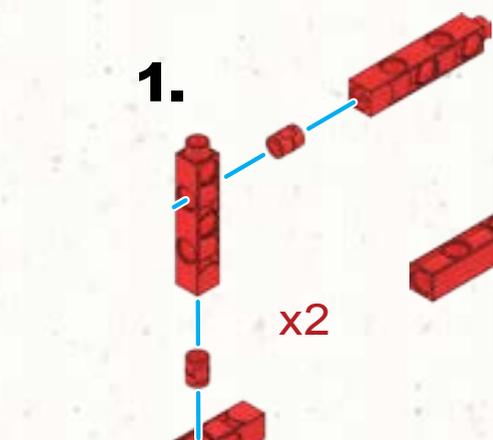
12



x10

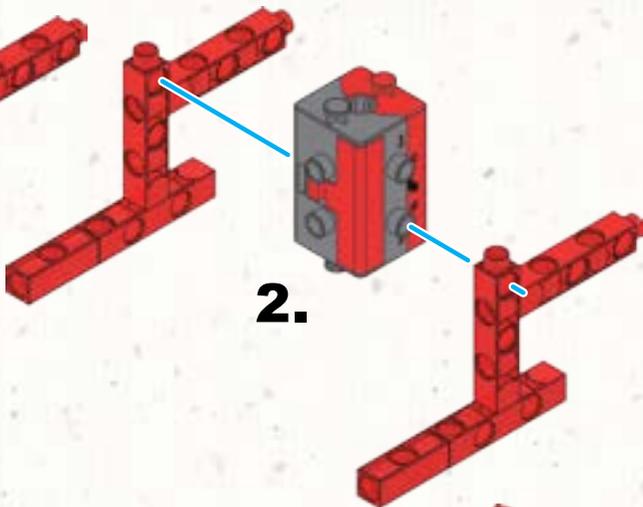


1.

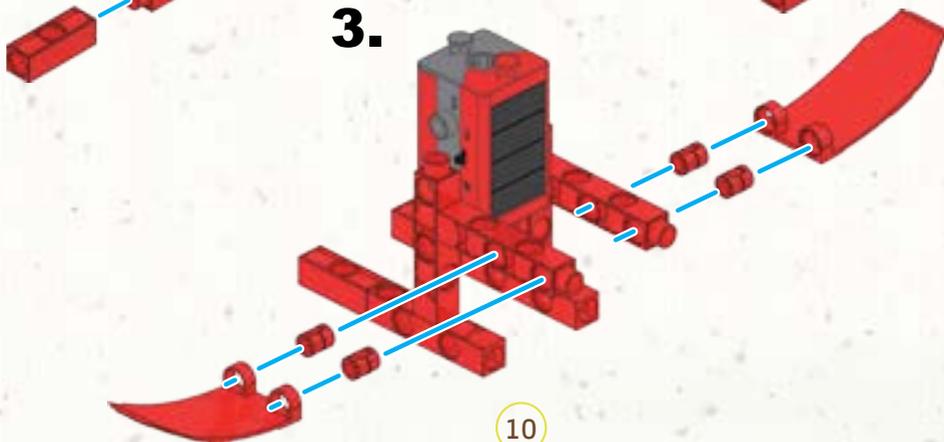


x2

2.

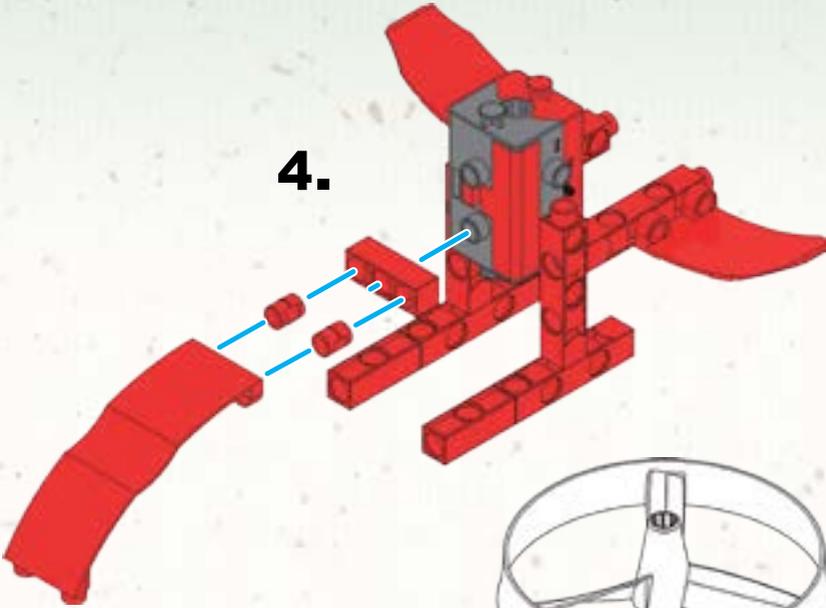


3.

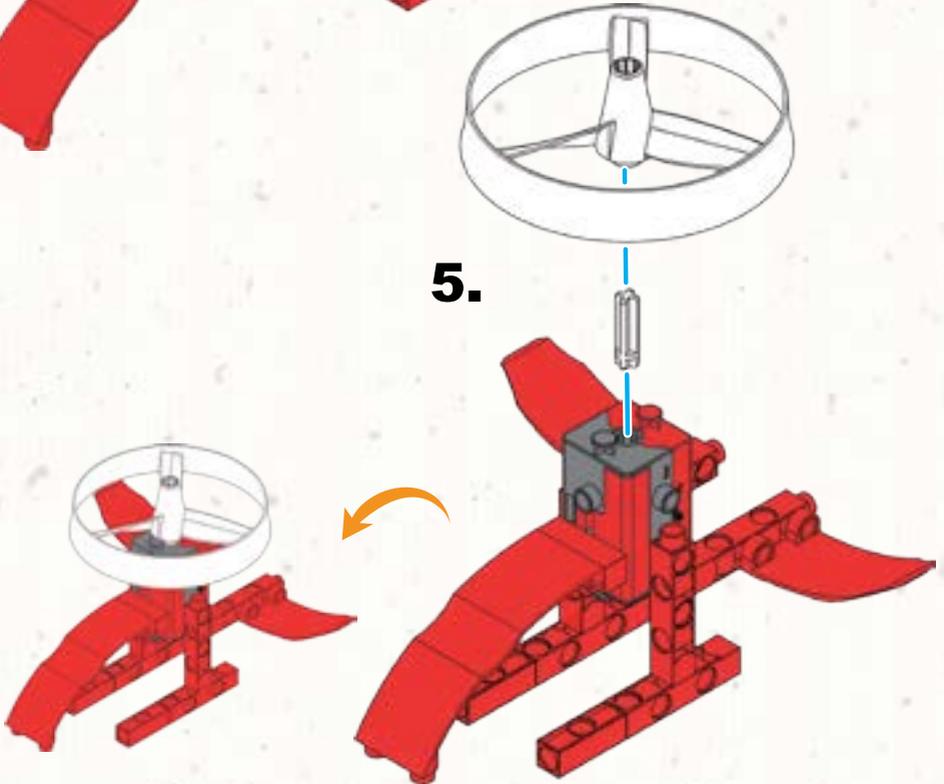




4.



5.



Completed



### EXPERIMENT 2

## What makes a helicopter take off?

### YOU WILL NEED

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

### HERE'S HOW

1. Run the helicopter with the solar cell or the battery, sliding the switch to the appropriate setting.
2. Hold your hand over the rotor blades as they turn. Do you feel a draft of air?
3. Now hold your hand beneath the blades. Do you feel something here?



### WHAT'S HAPPENING?

Beneath the rotor, you will feel a stream of air due to the fact that the rotor blades are mounted at a certain angle. That makes them push a stream of air downward, which will create enough force to make a real helicopter lift off the ground if the rotor turns fast enough.

That is how a helicopter can take off and land straight up and down, which can come in handy if there's no room for a runway.



### DID YOU KNOW ...

Helicopters can land on all kinds of surfaces, even on snow or in a meadow. That makes them useful for many different operations. You can actually see the downward flow of air created by the rotor blades when the snow beneath them is kicked up or tall grass is pressed flat.





# Wind Machine

It doesn't just look like a fan, it is one. Wind machines like this are often used on film sets. Instead of cooling things, their job is to create wind on demand, causing the actors' hair to blow and their clothes to flutter. They can be used inside or outside on a calm day. Now it's time for you to build a wind machine of your very own!





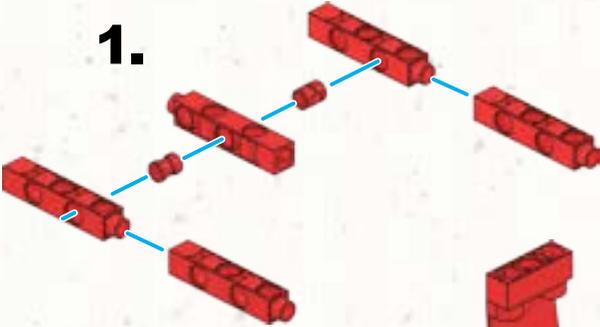
# SOLAR CAR | Wind Machine

## Required Parts

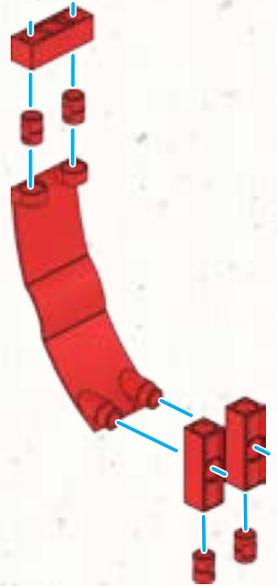
 x1	 x1	 x2	 x1	 x1	 x5
 x2	 x1	 x2	 x4	 x2	 x6



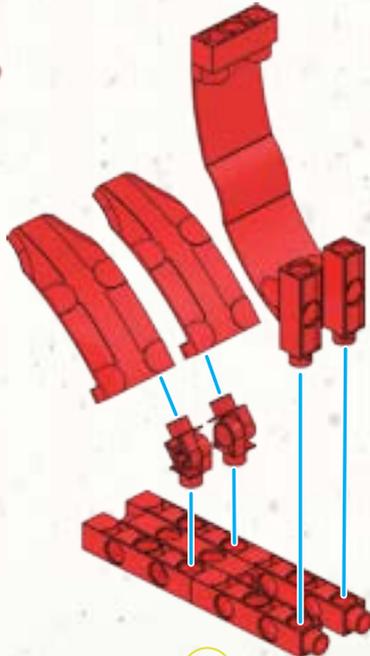
1.



2.

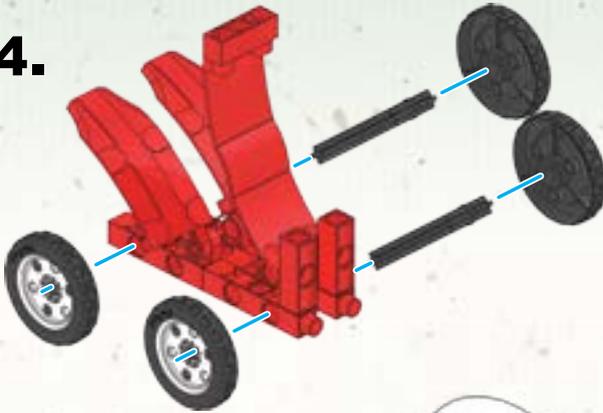


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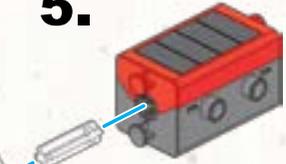




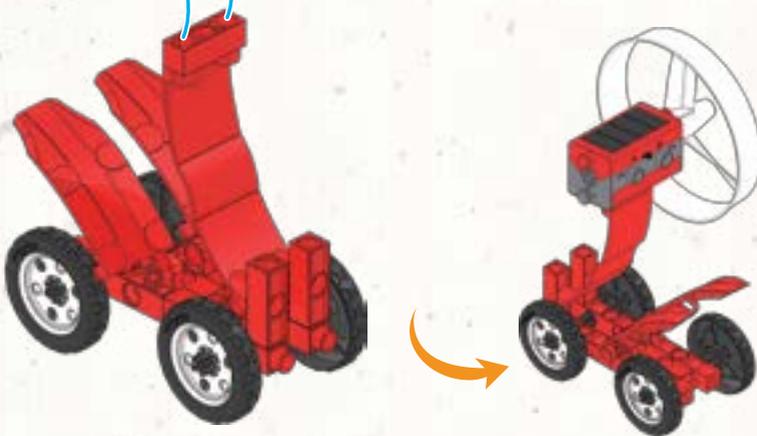
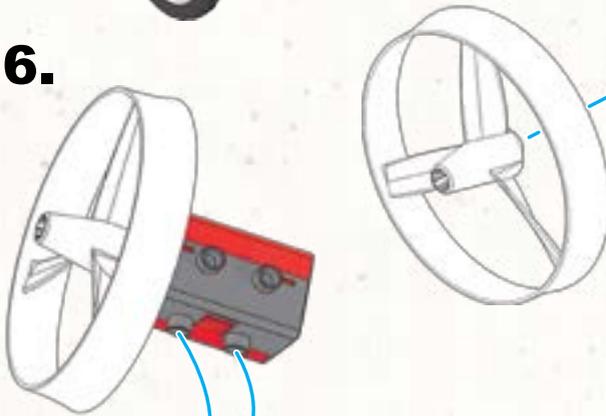
4.



5.



6.



Completed



### EXPERIMENT 3

# How does a wind machine work?

## YOU WILL NEED

- › The assembled wind machine
- › String (10 cm)
- › Ruler
- › Scissors
- › Energy source (sunlight, halogen energy-saving bulb, battery)

## HERE'S HOW

1. Power the wind machine with the solar cell or the battery by moving the switch to the appropriate setting.
2. Hold the string right in front of the rotor blades. What does it do in the wind?
3. Increase the distance between your hand holding the string and the blades. What happens to the string?
4. Measure the distance between the wind machine and the string at the point at which the string is no longer affected by the wind.

## KEYWORD WIND TURBINE

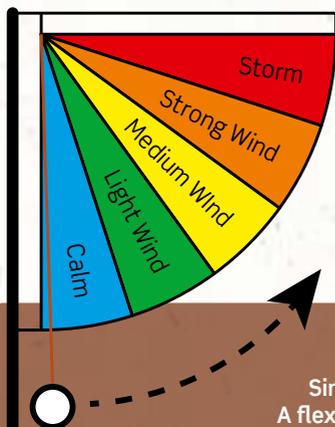
A wind turbine is also a kind of wind machine, except it works in the opposite way. With a wind turbine, it's the wind that moves the rotor blades rather than the other way around. This rotation is then converted into electrical energy by a generator.



## WHAT'S HAPPENING?

The rotor blades create a wind that blows against the string. The wind is strongest close to the blades, where the string will be held almost horizontally in the air. The farther away from the rotor you move the string, the weaker the wind becomes and the more the string will drop.

So if a strong wind is needed on a film set, the machine will be moved close to the action — but never so close that the artificial wind producer would be visible in the scene.



## DID YOU KNOW ...

Simple wind meters work by this same principle, too. A flexibly mounted, suspended string indicates wind strength depending on how far it is pushed by the wind.



## Solar Jet

There are, in fact, airplanes capable of flying with solar energy. They are extremely light (weighing about the same as a car) and powered by electric motors. The motors are supplied with energy converted by thousands of solar cells mounted on the wings. Their wingspan is very large, about as large as that of a big jet plane. The wings of your solar jet are not quite that large, but it can still fly (with a little help from a string.)





### Required Parts

1



x1

2



x1

3



x2

4



x1

5



x1

6



x6

7



x2

8



x1

11



x1

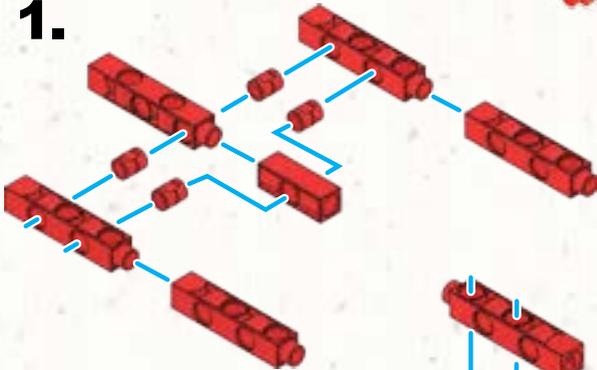
12



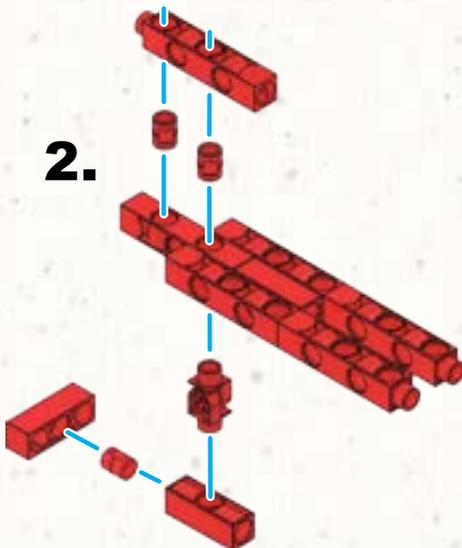
x11



1.

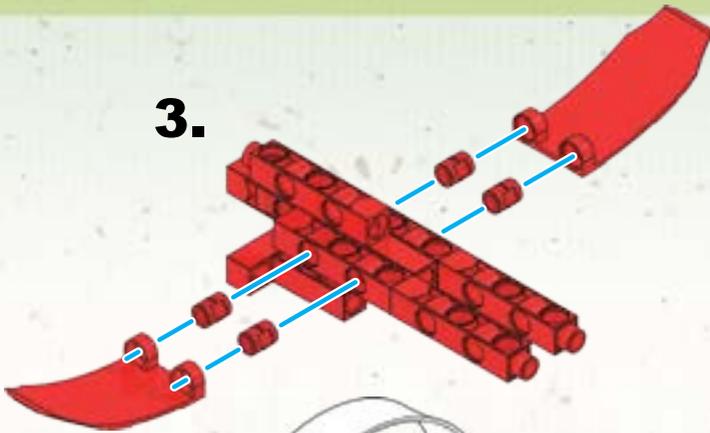


2.

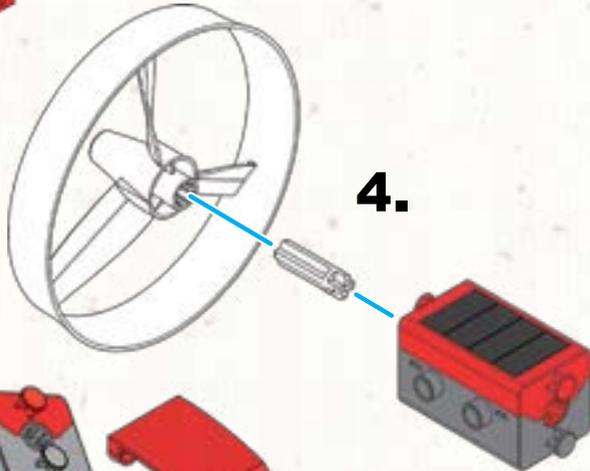




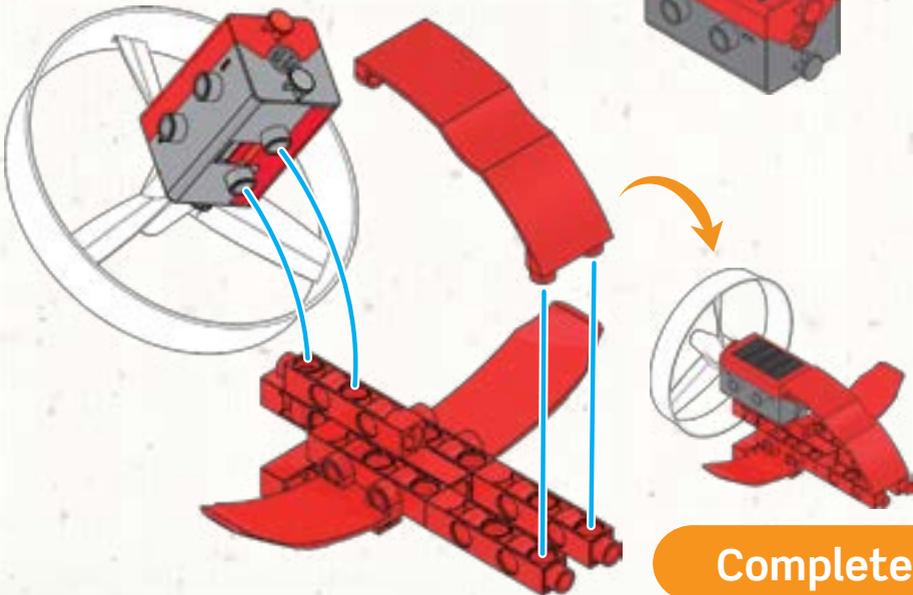
3.



4.



5.



Completed



## EXPERIMENT 4

### What makes your plane fly?

#### YOU WILL NEED

- › The assembled solar jet
- › String (about 1.90 meters)
- › Energy source (sunlight, halogen energy-saving bulb, battery)

#### HERE'S HOW

1. For this experiment, it's best to start by running the plane on battery power. 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? Then switch off the motor.
3. Tie one end of the string to the front of the jet 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.

#### DID YOU KNOW ...

Solar planes can even fly at night. To do that, they rise up very high during the day and then glide lower over a period of four to five hours as dusk arrives. The rest of the night, they fly on the current from their rechargeable battery.

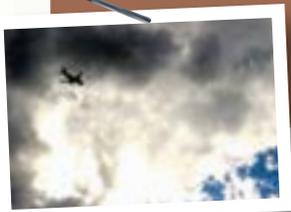


5. Pull the string tight and start turning in a circle while holding the jet.
6. Keep your eye on the jet and try to make it rise or drop by pulling on the string.
7. Can your jet fly outside too? Take it into the sunshine and find out!

#### WHAT'S HAPPENING?

Your solar jet can fly in a circle! The propeller provides the recoil it needs to move forward. That means that the plane is propelled 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.





# Gyrocopter

This neat flying machine is also known as a “rotaplane” or “autogyro.” It is mostly flown by hobby pilots, since it is not as expensive as a helicopter and is also easier to fly. In contrast to helicopters, the gyrocopter needs a runway to get started. This chapter will show you how a gyrocopter works.

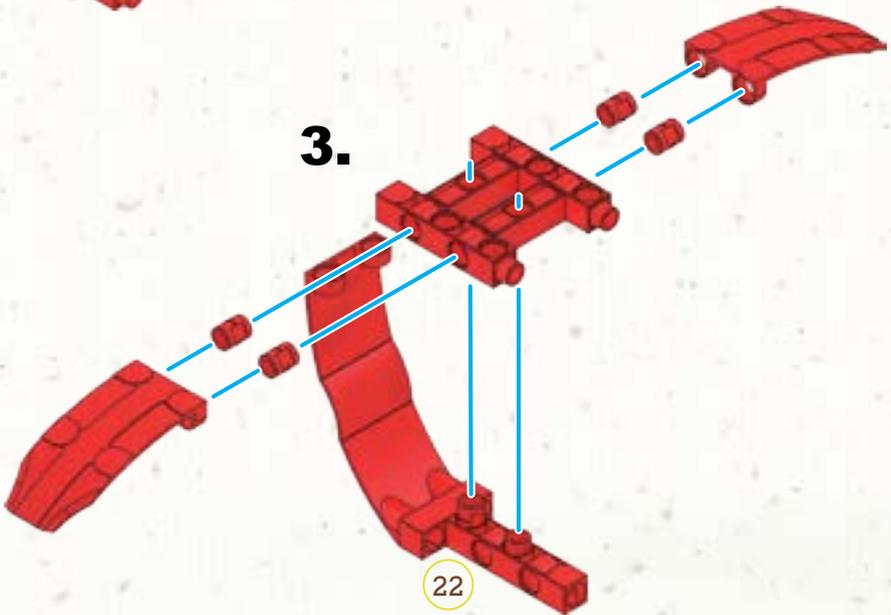
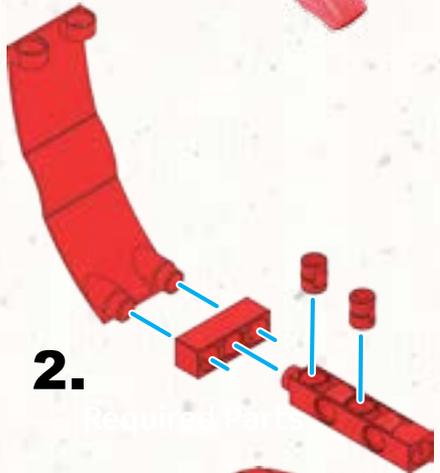
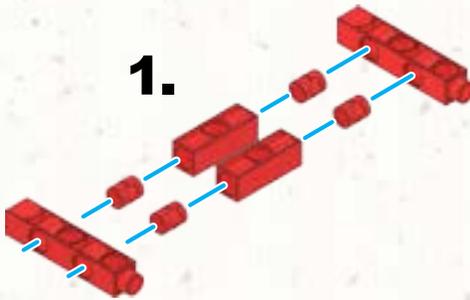
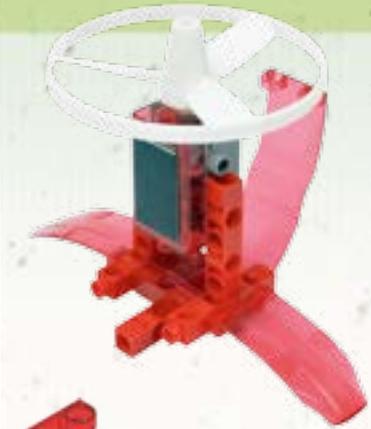




# SOLAR CAR | Gyrocopter

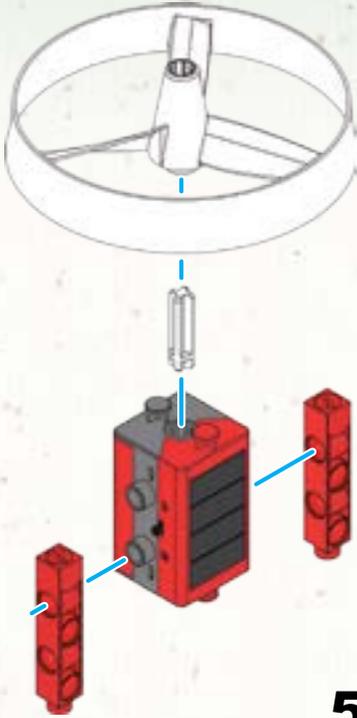
## Required Parts

 x1	 x1	 x2	 x1	
 x1	 x5	 x2	 x1	 x10

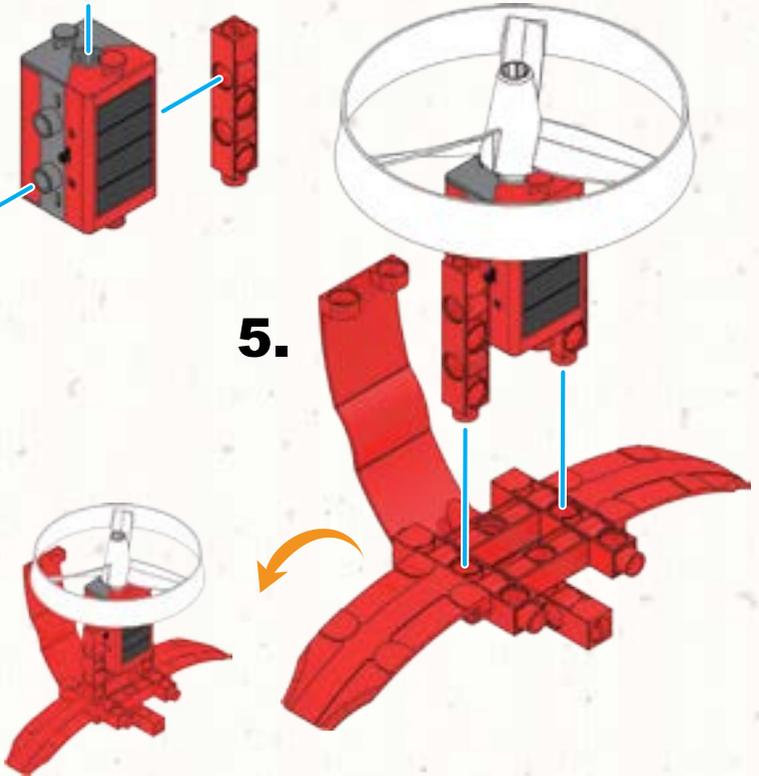




4.



5.



Completed



## EXPERIMENT 5

### How does a gyrocopter work?

#### YOU WILL NEED

- › **The assembled gyrocopter**
- › Energy source (sunlight, halogen energy-saving bulb, battery)
- › 1 sheet of white letter-sized paper
- › Scissors
- › Pencil
- › Paper clip
- › Adhesive tape
- › Chair

#### HERE'S HOW

1. Power the gyrocopter rotor with the solar cell or the battery by moving the switch to the appropriate setting.
2. Now start your experiment. Place the sheet of paper over the template shown on this page. Trace the template and cut the paper as shown.
3. Fold the paper at the dotted lines and slide the paper clip onto the bottom end. Put a piece of tape over the entire paper clip, so that it does not stick out or fall off of the paper.

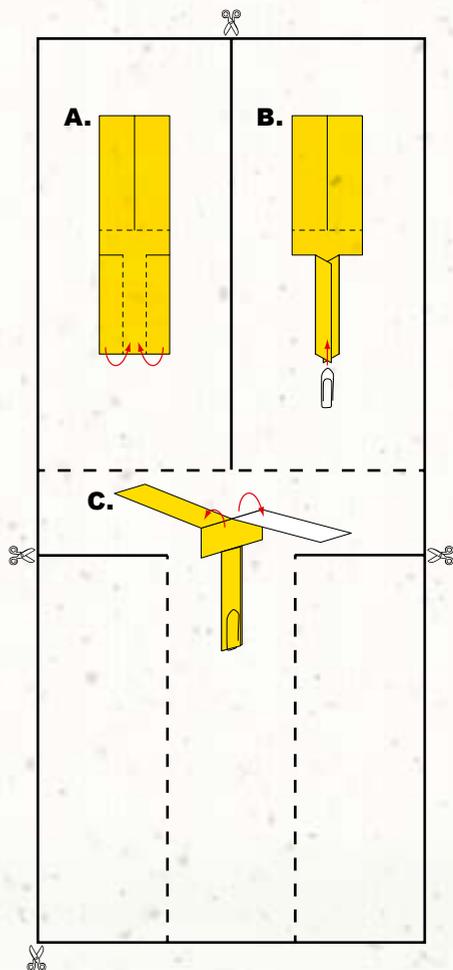
#### WHAT'S HAPPENING?

The paper gyrocopter starts to spin and proceeds to sail down to the ground. That's the same thing that happens with a real gyrocopter. The rotor is only electrically powered when it's taking off. As soon as the autogyro is in the air, the headwinds turn the rotor blades. The propeller in the rear is just needed for moving forward. If it malfunctions, the gyrocopter can still land safely.

#### KEYWORD MAPLE SEED

The principle of an object spinning as it floats downward is one that you will find in nature, too. Maple seeds also have a special shape that lets them glide down from the treetops in this same manner. This technique lets them descend to the ground relatively slowly, giving the wind enough time to take hold of them and spread them over a broad area.

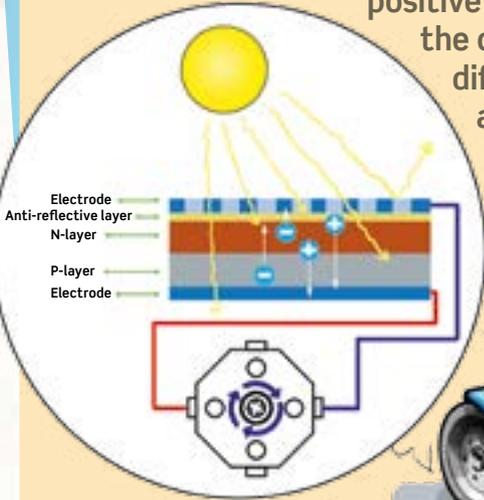
4. Climb carefully onto a chair, hold your paper gyrocopter in front of you with the paper clip end pointing down, and let it go.





## 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.





### KEYWORD

### PHOTOVOLTAIC SYSTEM

If you want to supply a home with electricity from sunlight, you need more than solar cells on the roof. You also have to install a photovoltaic system, which includes large rechargeable batteries to store current converted from the sun's energy during the day. That way, the people in the home will have electricity available at night when it's dark.



## A race for solar cars

The toughest race for solar cars is held in Australia. Since 1987, teams have been sent from all over the world to compete on behalf of schools, universities, and the automobile industry.





## SOLAR AIRSHIP

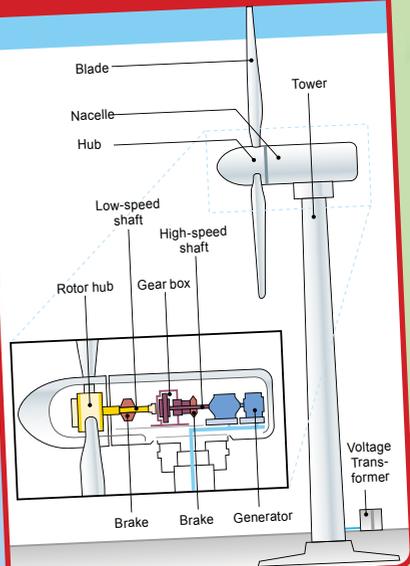
This is "Lotte," the first German solar airship. It was developed at the University of Stuttgart in Germany. Lotte has already spent a lot of hours up in the sky on air quality measurement missions. Its power comes from a stern propeller supplied by a solar cell.

A LOT OF WIND TURBINES IN ONE PLACE ARE KNOWN AS A "WIND FARM." IF THIS KIND OF FACILITY IS LOCATED IN THE OCEAN, IT IS KNOWN AS AN "OFFSHORE WIND FARM." ON LAND, IT IS CALLED AN "ONSHORE WIND FARM."



## TO SEE HOW A WIND TURBINE LOOKS ON THE INSIDE...

TAKE A LOOK AT THIS PICTURE.





## 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.

### 007 - ON A SECRET MISSION

Even James Bond has flown a gyrocopter. In the 1967 film "You Only Live Twice," he used one called "Little Nellie" to go chasing after criminals. That autogyro really was able to fly. It was also able to be dismantled and transported in just four suitcases!



### NIMBLE LITTLE BEE...

THIS GYROCOPTER CAN FLY UP TO 160 KM/H!



### GYRO ... WHAT?

The word "gyro" comes from Greek, meaning "turn." That is why a Greek sandwich made from meat cooked by turning it on a spit is also known as a "gyro."





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