GEEK & CO. SCIENCE!

PROJECT KIT

Ages 8+

BUILD YOUR OWN

FLYING ORNITHOPTERS

THAMES & KOSMOS

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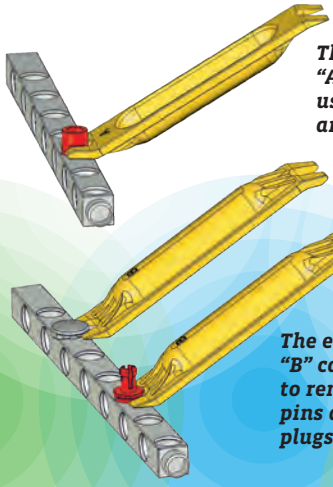
Safety information

Warning!
Not suitable for children under 3 years. Choking hazard — small parts may be swallowed or inhaled. Strangulation hazard — long rubber bands may become wrapped around the neck.
Store the experimental material and assembled models out of reach of small children.
Keep the packaging and instructions as they contain important information.
Warning! Do not aim at eyes or face.
Warning! Do not fly close to the eyes or face.
Do not throw the models toward other people or animals. Make sure people and animals are well out of the potential flight path of the flying models.
Flying models should be used in an open area with a 30-meter radius containing no people or animals.
A parent or other adult should supervise all outdoor experiments with the models. Outdoor experiments should not be conducted near streets or on sidewalks.
Keep your hands and other body parts clear of the moving parts.
Be careful that loose clothing or hair does not get caught in the moving parts.
Be careful when inserting the wooden dowels into the plastic components.
If you put too much force on them, they can warp, splinter, or break. Do not injure yourself!

Part separator tool

Use the part separator tool to help you separate small parts.

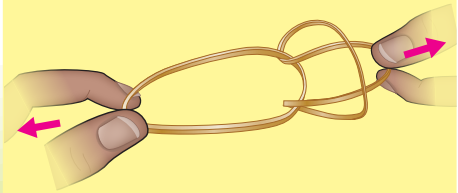


The end marked "A" can be used to remove anchor pins.

The end marked "B" can be used to remove button pins and shaft plugs.

TIP!

If the rubber bands in your kit ever break or wear out, you can use **regular-size rubber bands** from around the house. To make them long enough, simply loop two of them together like this and then pull apart to tighten.



KIT CONTENTS

1	Butterfly wings and tail
2	Bird wings and tail
3	Bat wings and tail
4	Dragonfly wings and tail
5	Dragonfly wings (small)
6	Ball joint
7	Left sector gear
8	Right sector gear
9	Ratchet socket
10	Snail cam lever
11	Triangle empennage (tail frame)
12	V-shaped connector
13	Triangle frame
14	Tube bolt caps (3)
15	Mortise caps (4)
16	Ratchet knob
17	Snail cam
18	Hooks with tenon (2)
19	Bamboo dowels, 135 mm (4)
20	Bamboo dowels, 220 mm (6)
21	Double-sided tape sheets (2)
22	Protective sticker sheet
23	Sandpaper piece
24	Part separator tool
25	Rubber bands (6)

YOU WILL ALSO NEED: *A "test flying" area at least 30 meters (about 100 feet) long*

Hey Flight Fanatics!

Are you ready to build four awesome rubber band powered flying ornithopters, learn how insects and birds fly, and how wings generate lift? Let's get started! With this kit you can build a mechanical flying bird, bat, butterfly, and dragonfly. Helo the Geeker will be your guide!

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PREPARING THE WINGS

Before you assemble the body of your ornithopter, follow these steps to attach the wings to the dowels.

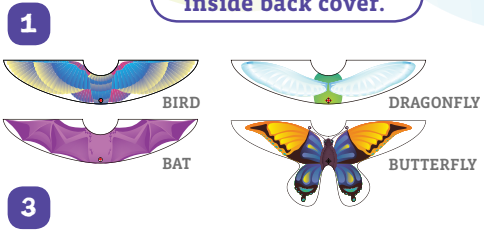
See the tips on the inside back cover.

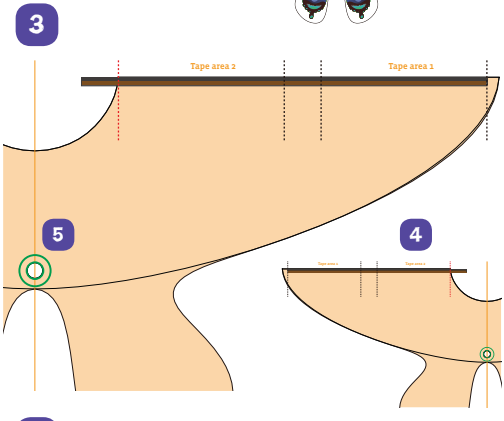
1 Select which model you want to build first. Get two 220-mm dowels ready.

2 Using the guides below, which are printed at actual size, affix two double-sided tape strips to the dowel in the spots indicated. Make sure the dowel is clean.

3 With the wing foil flat on the table, graphics side down, affix the dowel to one wing. Start sticking it at the dotted red line. Then stick it along the edge of the wing, outward to the wing tip.

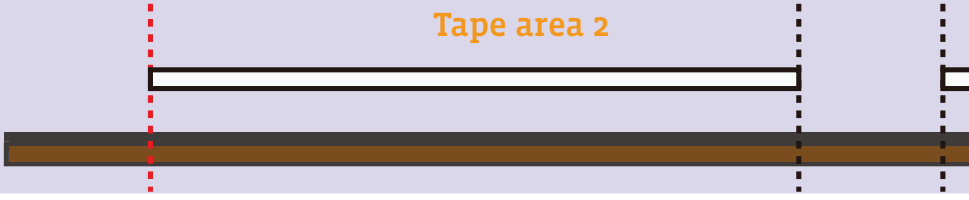
4 Repeat steps 2 and 3 on the other wing with a second dowel.



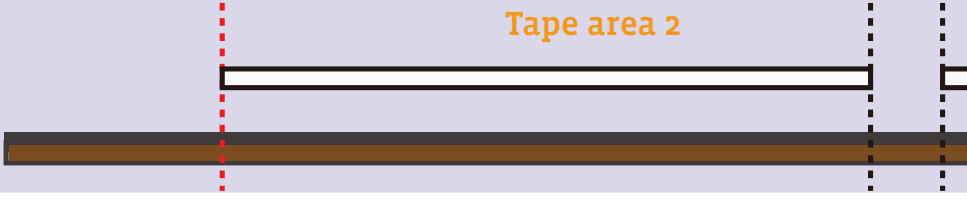


5 Affix a transparent round protective sticker around the hole on one side of the foil.

Taping Guide for large wings:



Taping guide for small wings (small dragonfly wings only):



PREPARING THE TAIL

Now assemble the tail.

1. Find the tail foil for the model you are building.
2. Affix three strips of double-sided tape to the top surface of the three sides of the triangular tail frame.
3. Attach the tail foil to the triangular tail frame.

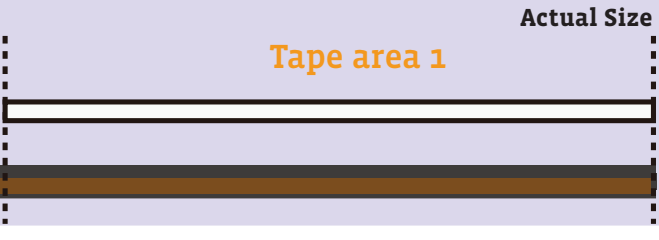
NOTE!
The dragonfly has two pairs of wings instead of one. Use the second taping guide below for the smaller pair of wings.

Actual Size

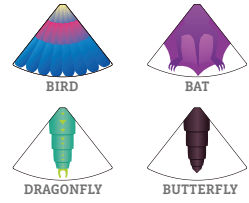
Tape area 1

Actual Size

Tape area 1



1



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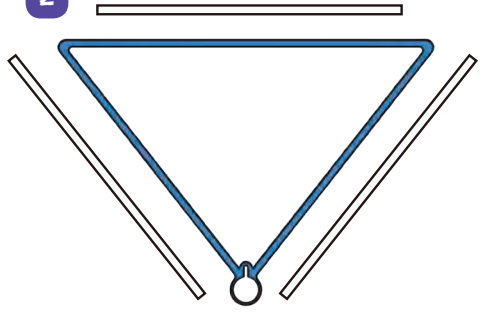

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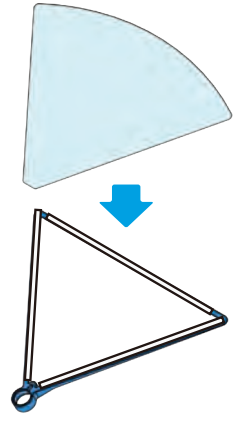


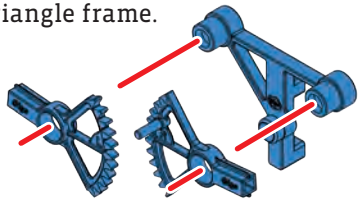
4

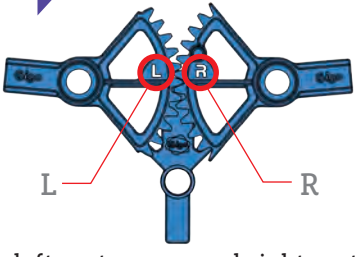
PART 1

YOUR FIRST FLAPPING FLIER

Model 1: Bird

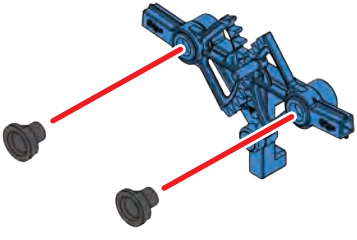
1 Put the sector gears onto the triangle frame.



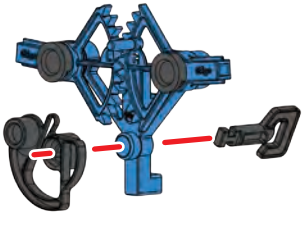


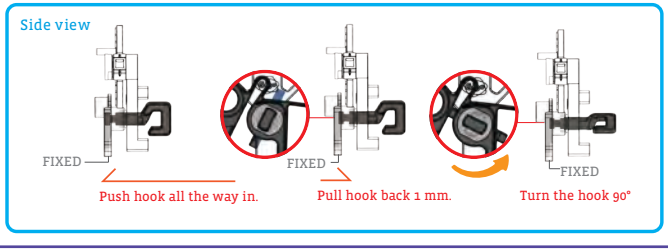
The left sector gear and right sector gear should be lined up evenly like this.

2 Put the tube bolt caps on the fronts of the sector gears.

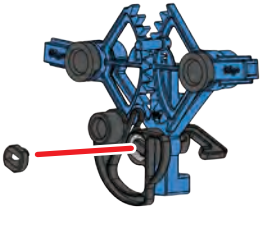


3 Attach the hook by inserting it into the snail cam and then turning it 90 degrees. Pay attention to the hook direction!

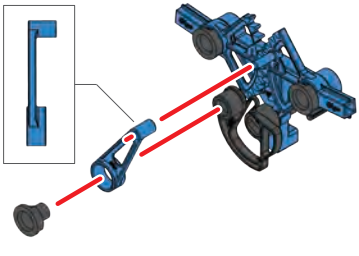




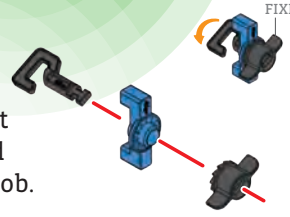
4 Attach a mortise cap to hold the hook in place.

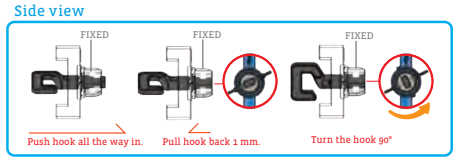


5 Attach the snail cam lever with a tube bolt cap.

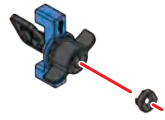


6 Slide the rear hook through the ratchet socket and ratchet knob.

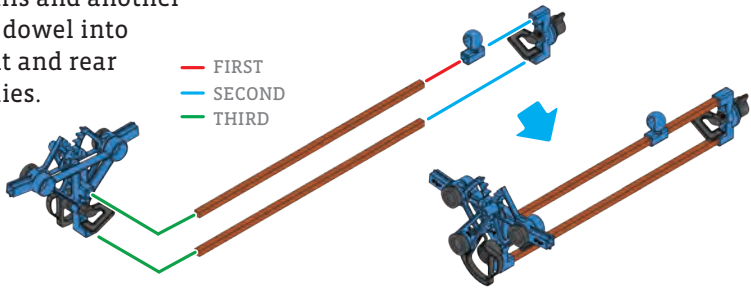




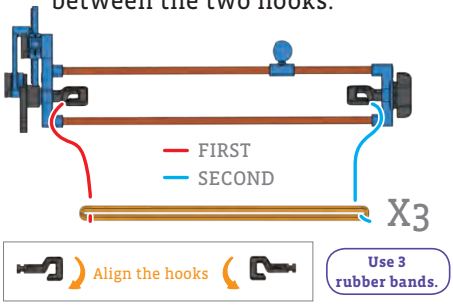
Secure with a mortise cap.



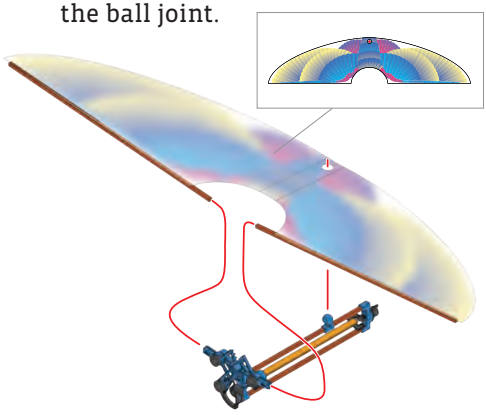
7 Slide the ball joint piece onto a 135-mm bamboo dowel. Then insert this and another 135-mm dowel into the front and rear assemblies.

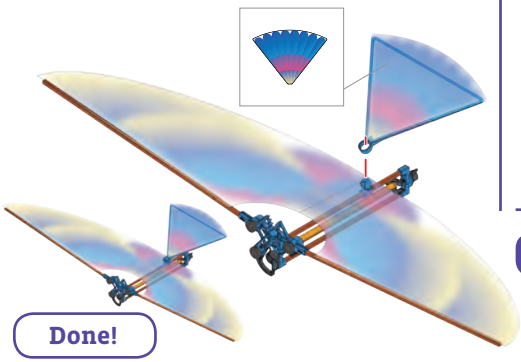


8 Attach three rubber bands between the two hooks.



9 Attach the wings to the front assembly by pushing the bamboo dowels into the holes in the sector gears. Then push the hole in the back of the wing foil over the ball joint.





10 Attach the tail to the ball joint. Position the tail with its back angled upward.

How to fly

To fly the ornithopter models, follow these steps.

1 Make sure all of the components, especially the caps, are securely assembled, nothing is twisted, and the two sides are symmetrical. Take the model to an open space with a 20-meter-long "test flying" area. Grass or smooth flooring is preferable to keep your model safe upon landing.

2 Make sure the wing tips and tail are angled upward when you start.

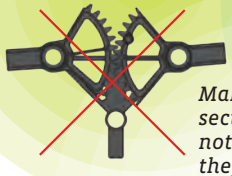
3 Make sure the wing foil is not too tightly stretched backward by the ball joint tail holder, but the foil should be taut and flat.

4 With one hand holding the front assembly so it cannot turn, turn the ratchet knob to start winding the rubber band.

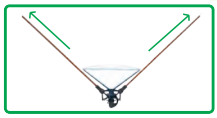
5 Twist the knob 20 times — which is about 20 half rotations or 10 full rotations — when you have 3 rubber bands installed. Don't wind it more than 20 full rotations.

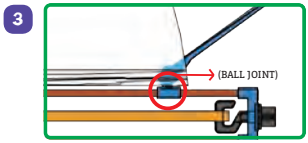
6 While holding the front assembly, fling the model forcefully forward, letting go of the model. The rubber band will start to unwind, the wings will flap, and it will fly forward.

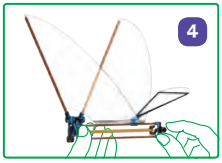
7 Make adjustments — such as tilting the tail up, down, or to the side — until you get it to fly nicely! Try winding the rubber bands differing numbers of times.

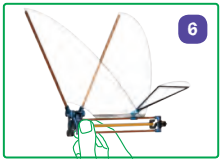


Make sure the sector gears are not uneven, as they are here.



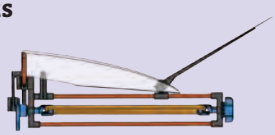




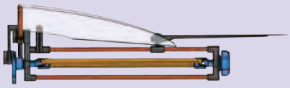


Adjustments

Angle tail up to make it fly upward.



Angle tail down to make it fly downward.



Viewed from the back:

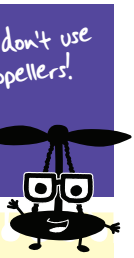
To fly in a straight line

To fly to the left

To fly to the right

GEEK OUT!

HOW DO BIRDS FLY?



How are birds able to fly but humans are not?

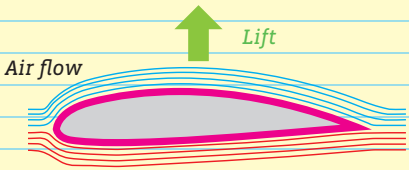
There are four forces that control how a bird flies: lift, drag, weight, and thrust. A **force** can be thought of as a push or a pull.

A force you are familiar with is **weight.** Weight is the force on an object due to gravity, and points down toward the Earth.

To overcome this force, a bird or a plane has to generate a force called **lift.** Birds have a special adaptation for flying that humans do not: Birds have hollow bones. This reduces the weight of a bird, so birds have to generate much less lift to fly.

A bird and an airplane generate lift due to the way that the air flows around their wings.

When the bird or plane moves through the air, the air stream hits the wing and is split into two streams. One stream flows over the top of the wing and the other flows over the bottom. Because of the shape of the wing, the air curves as it flows around. This curving causes the air to generate an overall higher pressure on the bottom of the wing and lower pressure on the top of the wing.



But how do birds and planes move forward through the air in the first place to generate this lift? A plane uses a propeller or jet engine to push air backward and pull itself forward through the air. Amazingly, a bird doesn't need a separate "engine" to generate its forward **thrust:** It uses its wings! So the wings of a bird act to generate both lift and thrust.

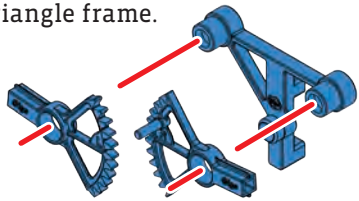
Because the air bumps into the wing as it moves the air, the wing experiences a force in the opposite direction as its motion. This force is called **drag.** You can experience drag if you move your hand through water. The bird needs an aerodynamic shape to minimize drag and maximize its forward thrust.

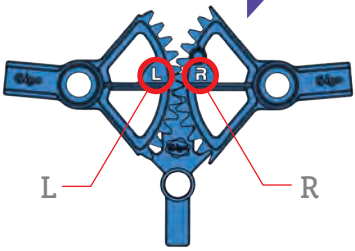
PART 2

MORE FLYING THINGS

Model 2: Bat

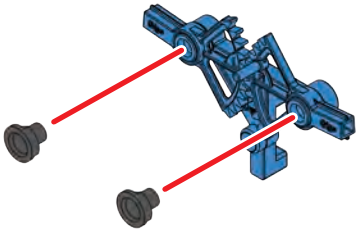
1 Put the sector gears onto the triangle frame.



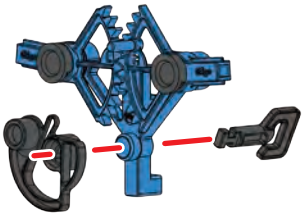


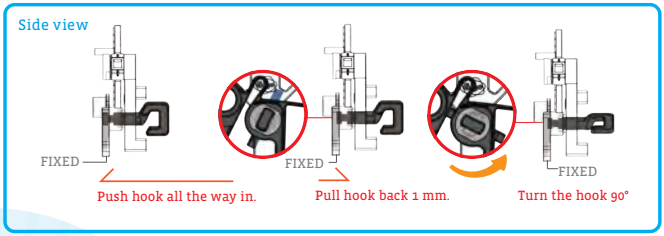
The left sector gear and right sector gear should be lined up evenly like this.

2 Put the tube bolt caps on the fronts of the sector gears.

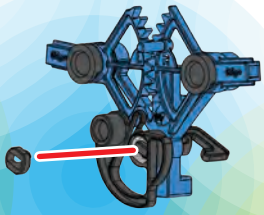


3 Attach the hook by inserting it into the snail cam and then turning it 90 degrees. Pay attention to the hook direction!

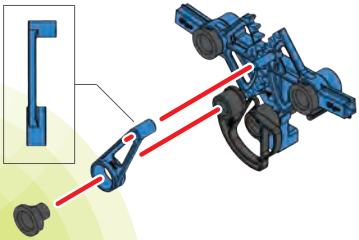




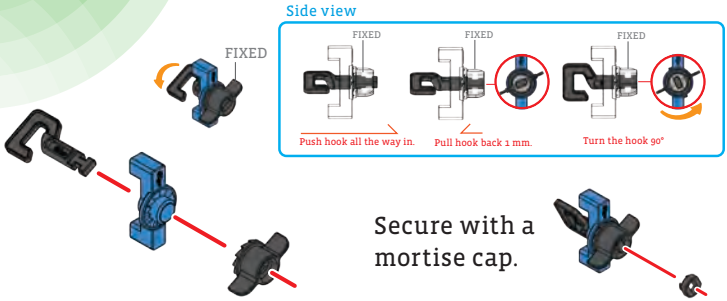
4 Attach a mortise cap to hold the hook in place.



5 Attach the snail cam lever with a tube bolt cap.

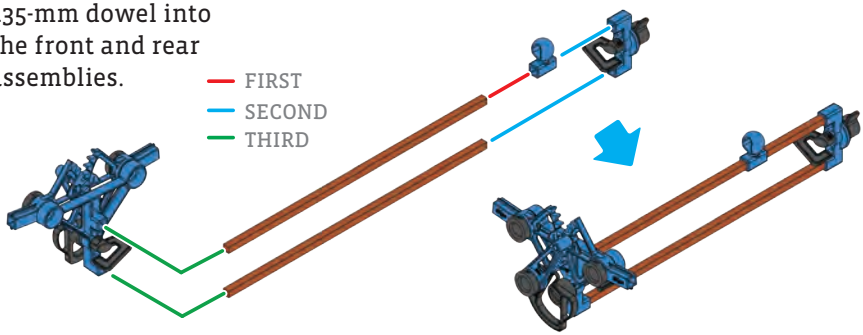


6 Slide the rear hook through the ratchet socket and ratchet knob.

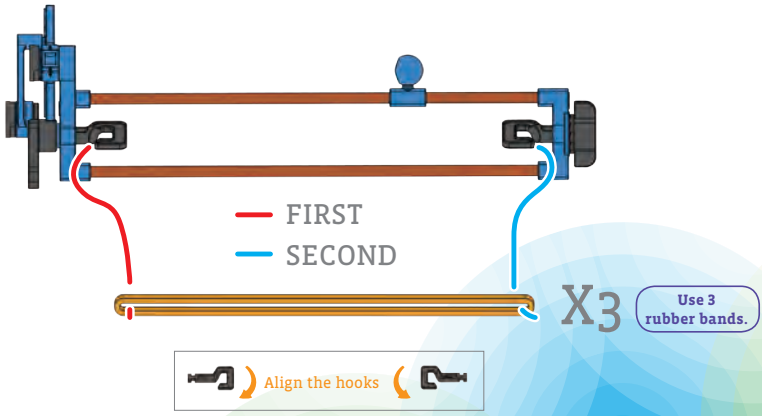


Secure with a mortise cap.

7 Slide the ball joint piece onto a 135-mm bamboo dowel. Then insert this and another 135-mm dowel into the front and rear assemblies.



8 Attach three rubber bands between the two hooks.



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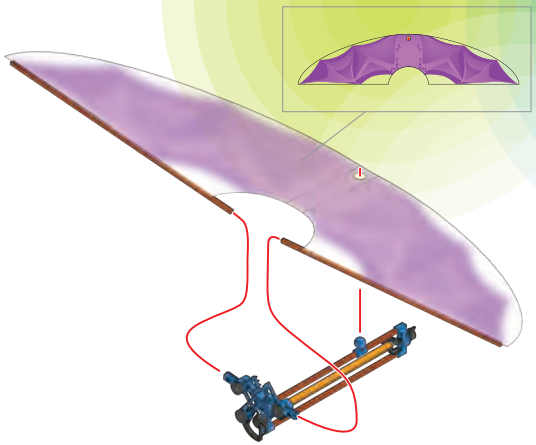
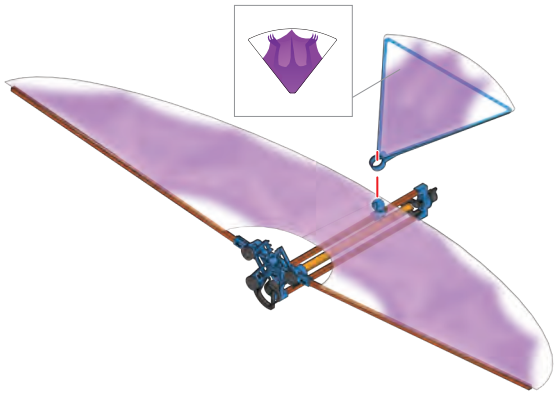
9 Attach the wings to the front assembly by pushing the bamboo dowels into the holes in the sector gears. Then push the hole in the back of the wing foil over the ball joint.

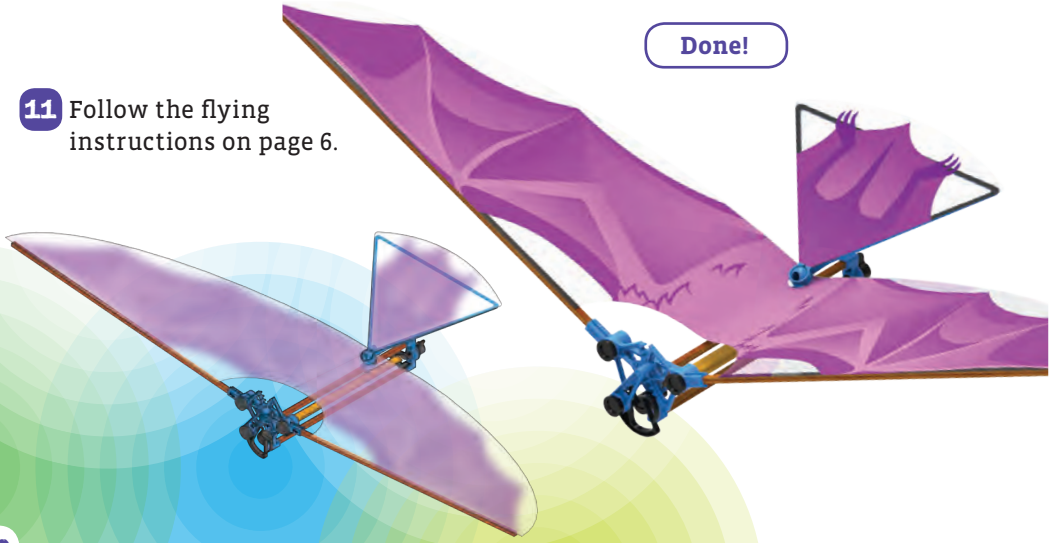


10 Attach the tail to the ball joint. Position the tail with its back angled upward.



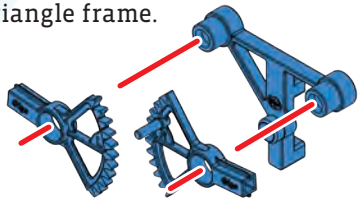
11 Follow the flying instructions on page 6.

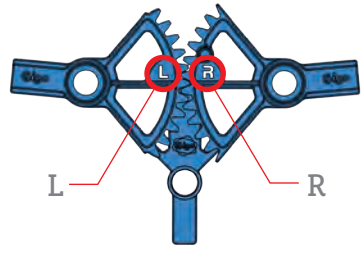
Done!



Model 3: Butterfly

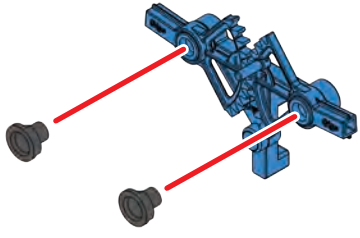
1 Put the sector gears onto the triangle frame.



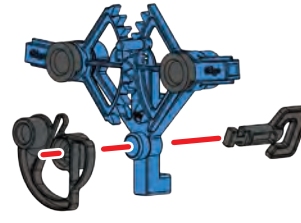


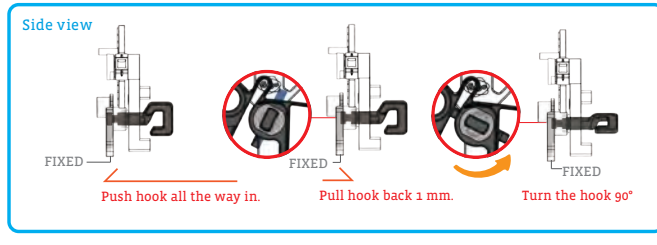
The left sector gear and right sector gear should be lined up evenly like this.

2 Put the tube bolt caps on the fronts of the sector gears.

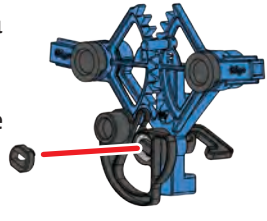


3 Attach the hook by inserting it into the snail cam and then turning it 90 degrees. Pay attention to the hook direction!

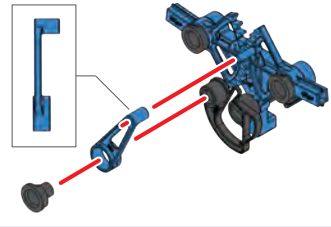




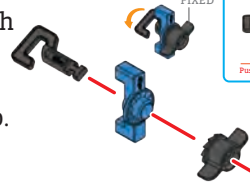
4 Attach a mortise cap to hold the hook in place.

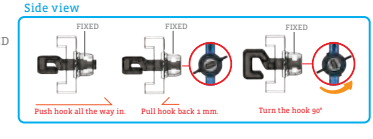


5 Attach the snail cam lever with a tube bolt cap.

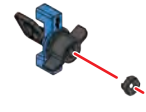


6 Slide the rear hook through the ratchet socket and ratchet knob.



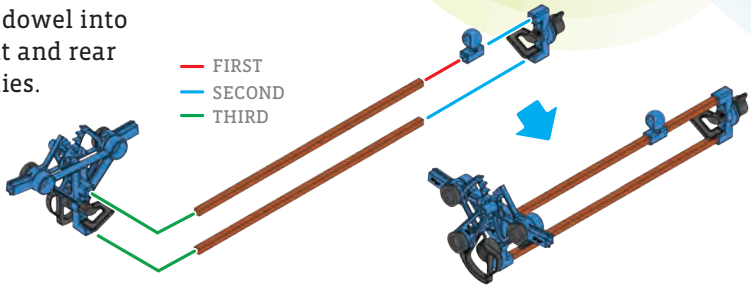


Secure with a mortise cap.

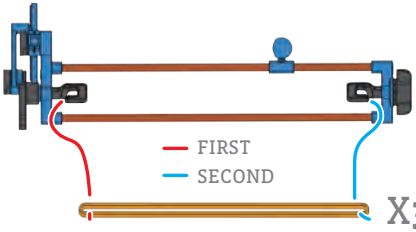


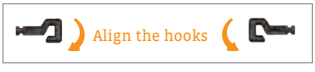
Continued on next page

7 Slide the ball joint piece onto a 135-mm bamboo dowel. Then insert this and another 135-mm dowel into the front and rear assemblies.



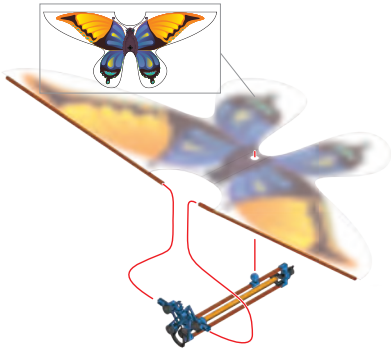
8 Attach three rubber bands between the two hooks.



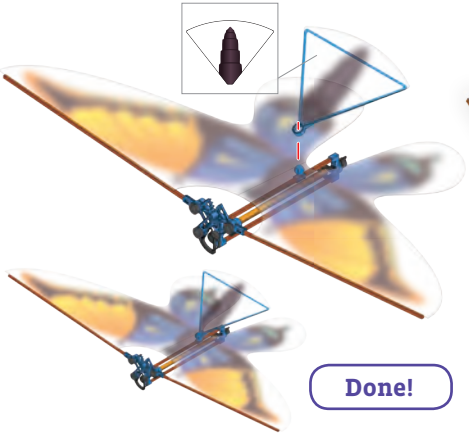


Use 3 rubber bands.

9 Attach the wings to the front assembly by pushing the bamboo dowels into the holes in the sector gears. Then push the hole in the back of the wing foil over the ball joint.



10 Attach the tail to the ball joint. Position the tail with its back angled upward.



Done!

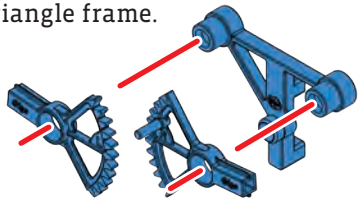
11 Follow the flying instructions on page 6.

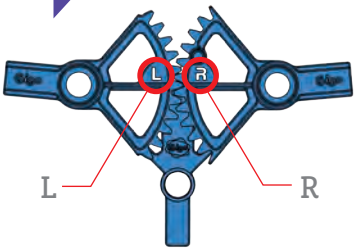
PART 3

ANOTHER PAIR OF WINGS

Model 4: Dragonfly

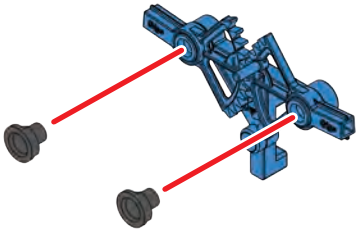
1 Put the sector gears onto the triangle frame.



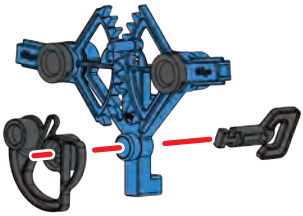


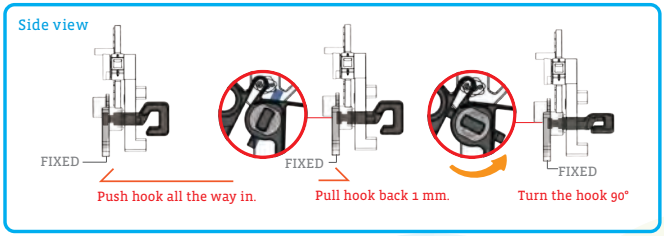
The left sector gear and right sector gear should be lined up evenly like this.

2 Put the tube bolt caps on the fronts of the sector gears.

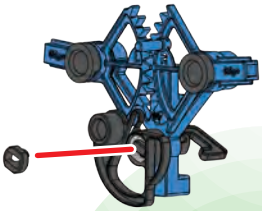


3 Attach the hook by inserting it into the snail cam and then turning it 90 degrees. Pay attention to the hook direction!

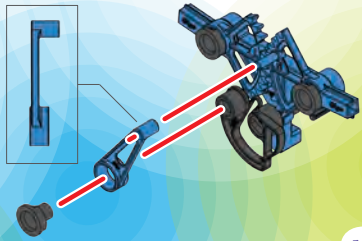




4 Attach a mortise cap to hold the hook in place.

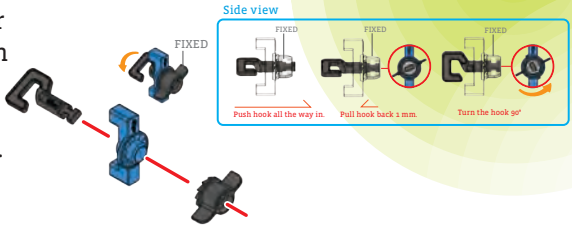


5 Attach the snail cam lever with a tube bolt cap.

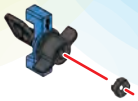


Continued on next page

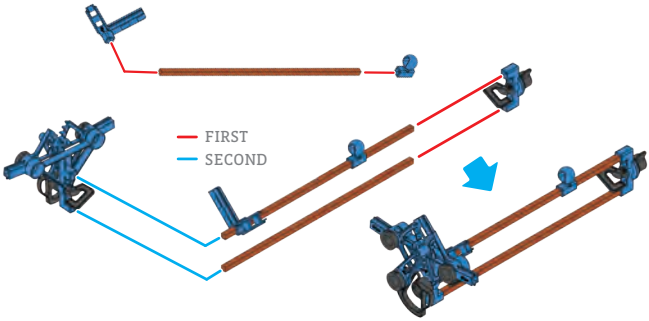
6 Slide the rear hook through the ratchet socket and ratchet knob.



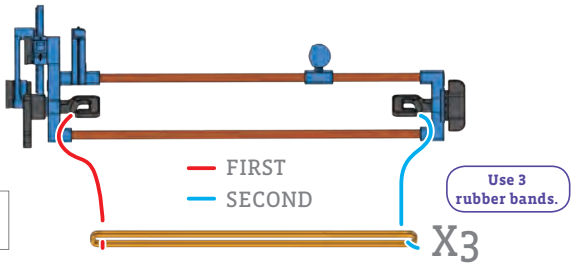
Secure with a mortise cap.



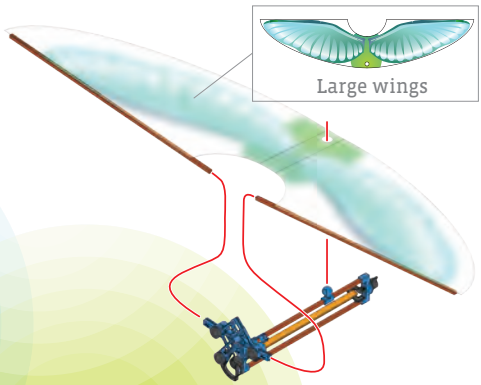
7 Slide the ball joint piece and the V-shaped connector onto a 135-mm bamboo dowel. Then insert this and another 135-mm dowel into the front and rear assemblies.



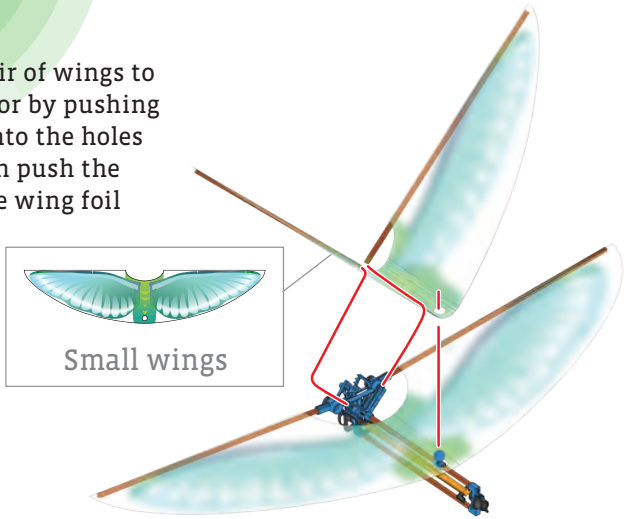
8 Attach three rubber bands between the two hooks.

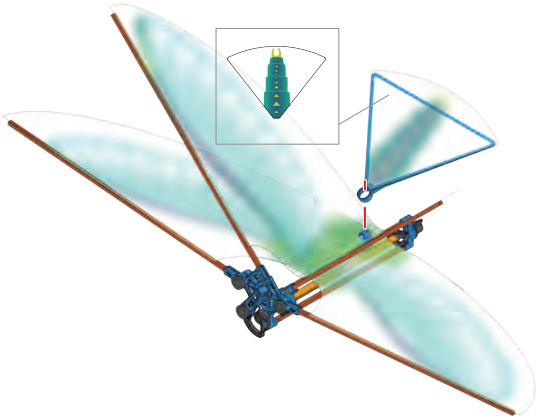


9 Attach the larger pair of wings to the front assembly by pushing the bamboo dowels into the holes in the sector gears. Then push the hole in the back of the wing foil over the ball joint.



10 Attach the smaller pair of wings to the V-shaped connector by pushing the bamboo dowels into the holes in the connector. Then push the hole in the back of the wing foil over the ball joint.





11 Attach the tail to the ball joint. Position the tail with its back angled upward.

12 Follow the flying instructions on page 6.

Done!

GEEK OUT!

ALL ABOUT INSECT WINGS

Insects are the only group of invertebrates, or animals that do not possess a vertebra or backbone, that evolved wings and flight.

The muscles that dragonflies use to fly are attached directly to their wings. They insert directly at the base of the wing and are hinged so that a small movement of the wing base produces a large movement of the whole wing. This motion is much like rowing. The front and back sets of wings operate independently, allowing for more maneuverability. This adaptation enables dragonflies to be effective predators.

Because the flight muscles of dragonflies are directly attached to their wings, this method of flight is called **direct flight.** Direct flight is only found in insects belonging to the species *Odonata*, which include dragonflies and damselflies. All other winged insects use a method of flying called **indirect flight.**

In indirect flight, the flight muscles attach to the thorax, or the middle part of an insect body. When different muscles contract and relax, they stretch and compress the thorax, which moves the wings up and down!

Kosmos Quality and Safety

More than one hundred years of expertise in publishing science experiment kits stand behind every product that bears the Kosmos name. Kosmos experiment kits are designed by an experienced team of specialists and tested with the utmost care during development and production. With regard to product safety, these experiment kits follow European and US safety standards, as well as our own refined proprietary safety guidelines. By working closely with our manufacturing partners and safety testing labs, we are able to control all stages of production. While the majority of our products are made in Germany, all of our products, regardless of origin, follow the same rigid quality standards.

TIPS FOR BAMBOO

Bamboo is a super strong natural material. The thickness of the bamboo dowels can vary, as the material can be affected by humidity and other factors. When working with the bamboo dowels, you may find that some of them do not slide easily into the plastic connectors.

1. If a bamboo dowel does not slide smoothly into a connector, try the other end of the dowel or a different dowel. Or you can turn the dowel 90 degrees and try again.
2. We have included a piece of **sandpaper:** With the sandpaper, you can sand down the bamboo dowel to reduce its thickness. Slide the sandpaper back and forth along the part of the dowel that you want to sand down, and test it often until it fits.
3. We have included extra bamboo dowels in case one doesn't work.

TIPS FOR USING TAPE

If the double-sided tape runs out, you can try to use regular double-sided tape.

Make sure you clean the surface of the bamboo dowel before applying tape.

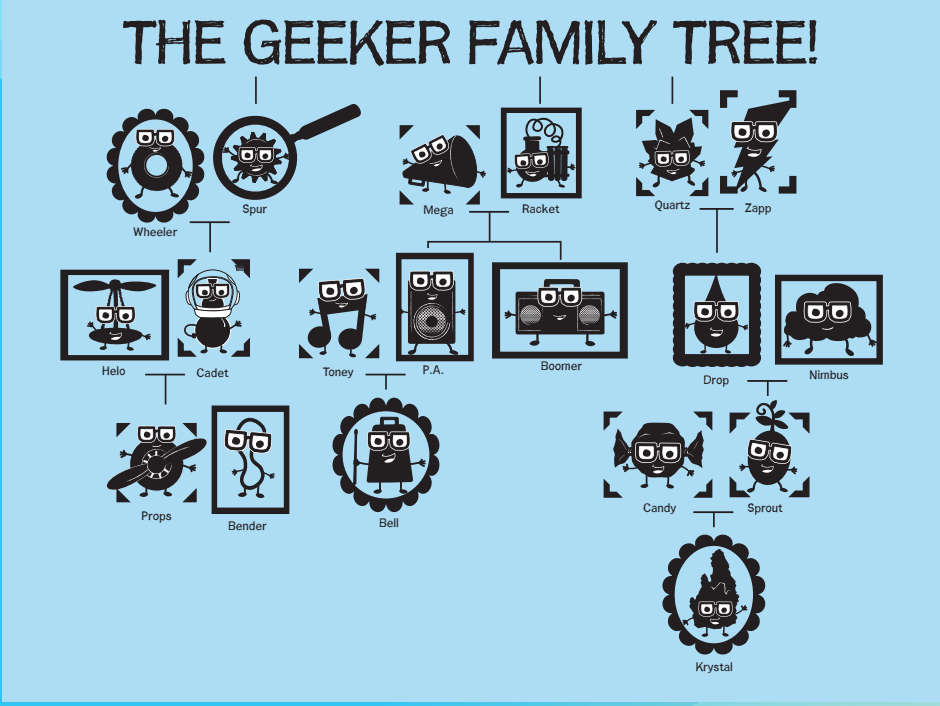
If a transparent wing tears, you can use regular transparent tape to fix it.

TIPS FOR RUBBER BANDS

We recommend using 2 or 3 rubber bands for each model. Please note that if you use more rubber bands or wind them too many times, the release power may be too strong and this may cause the plastic parts to break.

- 2 Rubber bands: Wind 60 times (30 rotations), Limit: 80 times (40 rotations)
- 3 Rubber bands: Wind 20 times (10 rotations), Limit: 40 times (20 rotations)

Please try additional windings gradually and carefully.



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