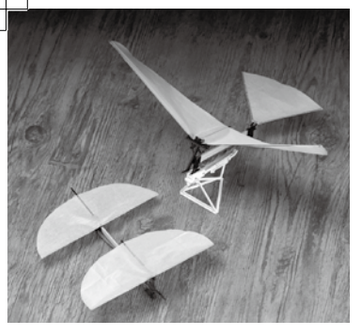


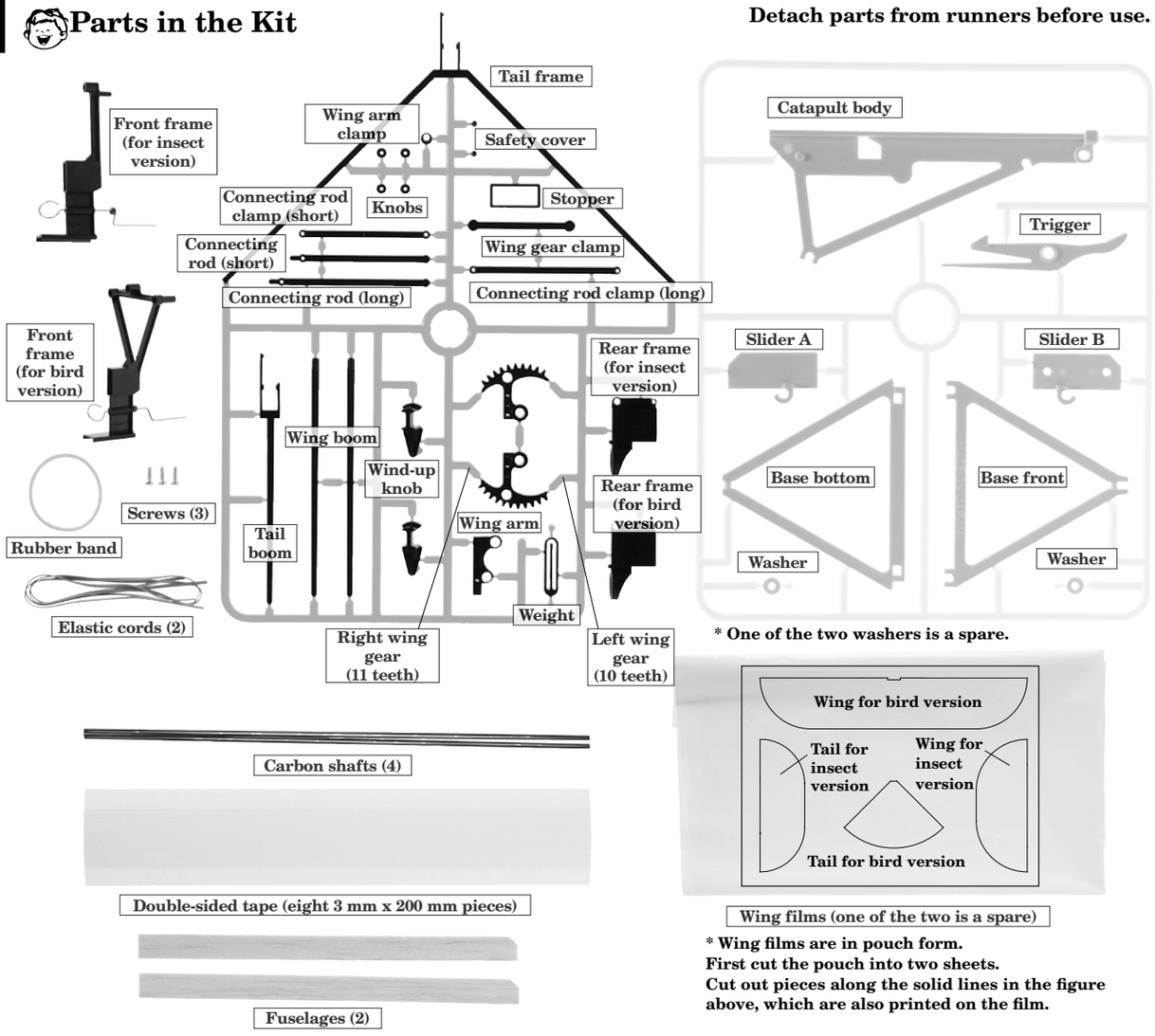
How to Assemble and Use the Supplement

Ornithopter Kit

Assembly time: Approx. 1.5 hour

Parts in the Kit

Detach parts from runners before use.



* Wing films are in pouch form.
First cut the pouch into two sheets.
Cut out pieces along the solid lines in the figure above, which are also printed on the film.

Things you will need

A Phillips head screwdriver (JIS No. 1), cellophane tape, a ruler, scissors and a cutter

⚠ CAUTION

Please be sure to read the following instructions before assembling this kit.

- **Handle sharp parts carefully, particularly the carbon shafts. Sharp parts can cause eye and other injuries.**
- **Be careful when using the smaller parts so that you do not put them in your mouth and accidentally swallow them. There is a risk of suffocation.**
- **Do not fly the plane in trafficked areas.**
- **Keep this kit out of the reach of small children when not in use.**

*** Please read the instructions and cautions thoroughly before use.**
*** For your safety, be sure to follow the instructions in this manual. In addition, do not use any parts that have become damaged or deformed during use.**

● Materials used in this kit

Ornithopter parts (black),
Catapult kit (white): ABS
Wing framework: Carbon-fiber-reinforced polymer (CFRP)
Wing films: PE
Fuselage: Balsa
Crankshaft, screws: Steel
*** Please dispose of this product in accordance with local regulations.**

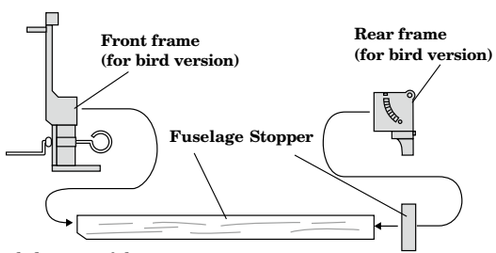
Building the bird-style ornithopter

Assembly time: Approximately 40 minutes

Parts used

Front frame (for bird version), elastic cord (1), fuselage (1), carbon shafts (2), double-sided tape (4 pieces), wing film (bird-style wing and tail), runner parts used in bird-style ornithopter [left wing gear (10 teeth), right wing gear (11 teeth), connecting rod (long), connecting rod clamp (long), knobs (2, also used on insect version), safety cover (also used on insect version), wing gear clamp, rear frame (for bird version), stopper, wing frame (also used on insect version), tail frame, wind-up knob (also used on insect version)]

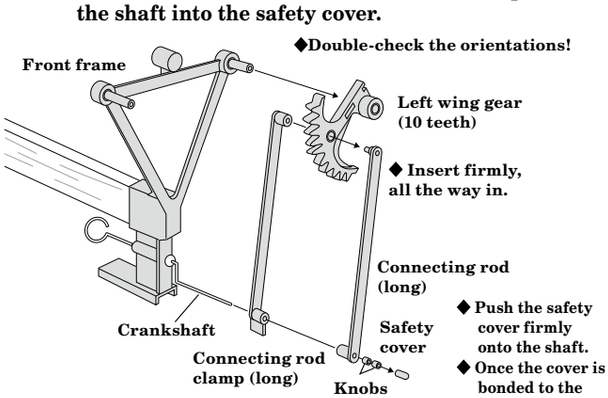
1 Insert the front frame, stopper, and rear frame into the fuselage.



◆The angled corner of the fuselage should face the bottom front.

◆Insert the fuselage into the stopper, then press the rear frame onto the stopper/ fuselage assembly. Insert the fuselage firmly so that it goes all the way into the holes of the front and rear frames.

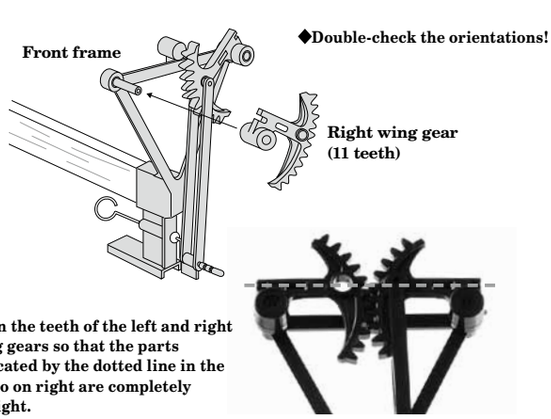
2 Insert the connecting rod (long) and connecting rod clamp (long) into the left wing gear in the orientation shown in the drawing and mount the assembly on the front frame. Also slide two knobs onto the crankshaft and insert the tip of the shaft into the safety cover.



◆ Push the safety cover firmly onto the shaft.

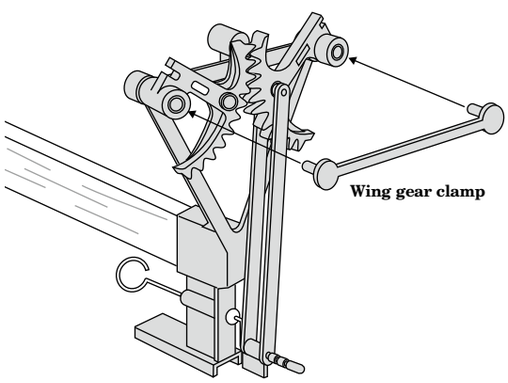
◆ Once the cover is bonded to the shaft, it will not come off.

3 Insert the right wing gear into the front frame.



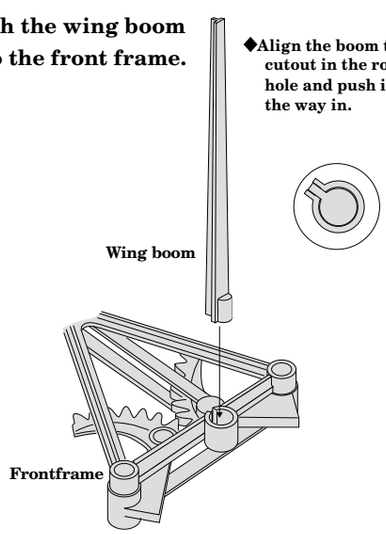
◆Align the teeth of the left and right wing gears so that the parts indicated by the dotted line in the photo on right are completely straight.

4 Insert the wing gear clamp.



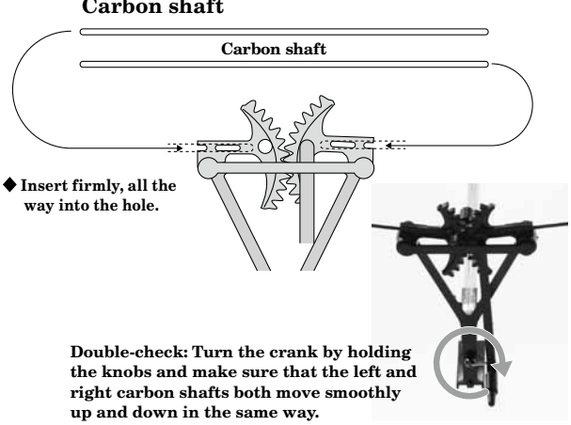
5 Push the wing boom into the front frame.

◆Align the boom to the cutout in the round hole and push it all the way in.



6 Insert the carbon shafts into the wing gears.

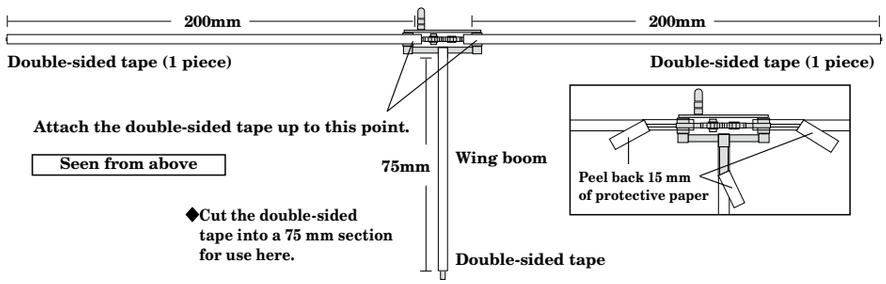
Carbon shaft



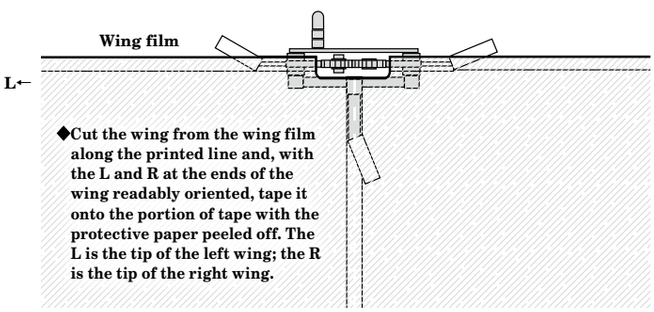
◆ Insert firmly, all the way into the hole.

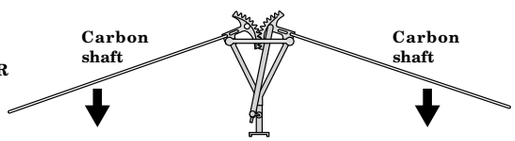
Double-check: Turn the crank by holding the knobs and make sure that the left and right carbon shafts both move smoothly up and down in the same way.

7 Tape the double-sided tape to the left and right carbon shafts and to the wing boom, as shown in the drawing, and then peel back 15 mm of protective paper in the areas near the centers of each.



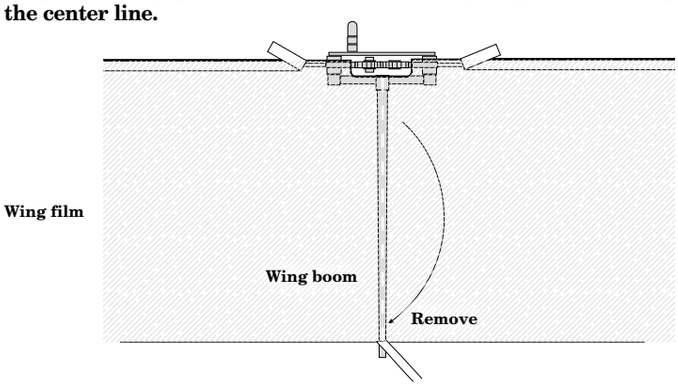
8 With the carbon shafts at their lowest position, put the bird-style wing film temporarily in place.





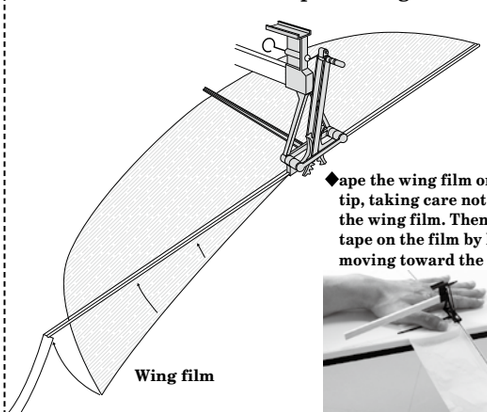
◆The carbon shafts must be at their lowest positions when taping on the wing film! If the film is attached with the shafts raised, the film will be too tight and the shafts will be unable to descend.

9 Remove the protective paper from the double-sided tape taped to the wing boom and tape on the wing film, aligning the center line.



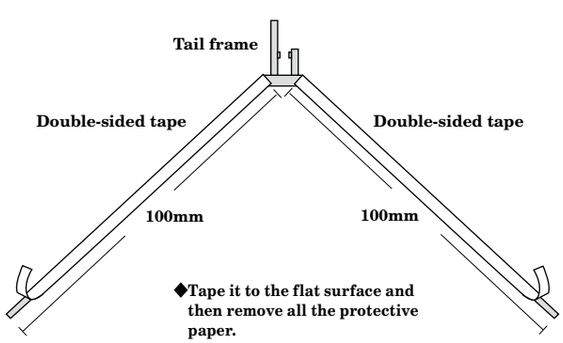
10 Place on the edge of a table or a similar surface, peel the protective paper from the double-sided tape taped to the carbon shafts, and tape on the wing film.

Perform this step one wing at a time.



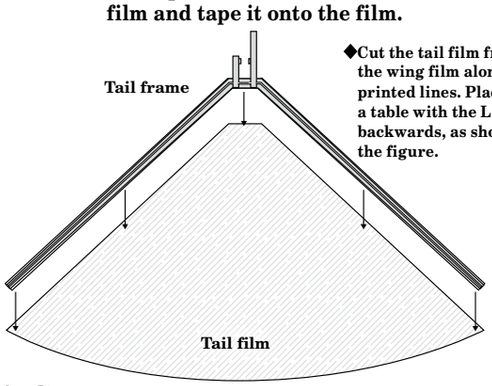
◆ape the wing film on, starting at the tip, taking care not to let slack into the wing film. Then, progressively tape on the film by lightly pressing, moving toward the center, and then

11 Cut the double-sided tape to half-length and tape it to the tail frame as shown in the drawing.



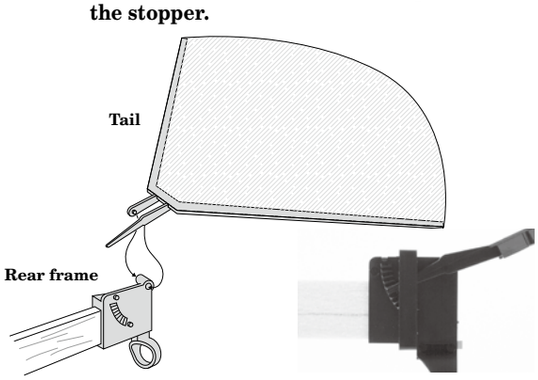
◆Tape it to the flat surface and then remove all the protective paper.

12. Turn the tail film upside down, place it on a table, position the tail frame so it covers the film and tape it onto the film.



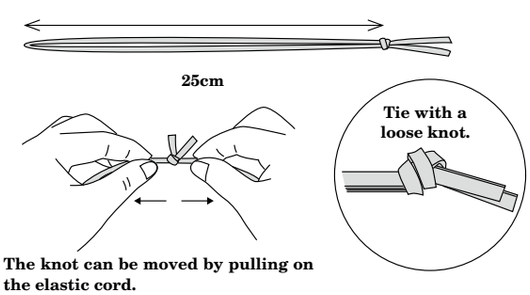
◆Cut the tail film from the wing film along the printed lines. Place it on a table with the L and R backwards, as shown in the figure.

13 Insert the tail into the rear frame, adjust the angle, and secure the tail in place with the stopper.

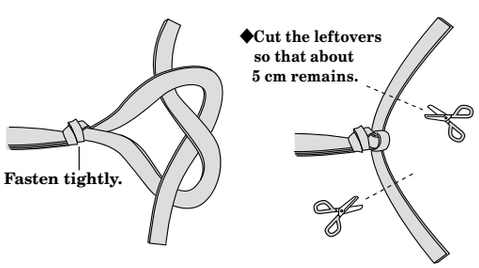


◆ Line up the tail with the fifth or sixth groove from the top of the rear frame and secure it in place with the stopper.

14 Make a loop of about 25 cm out of the elastic cord.

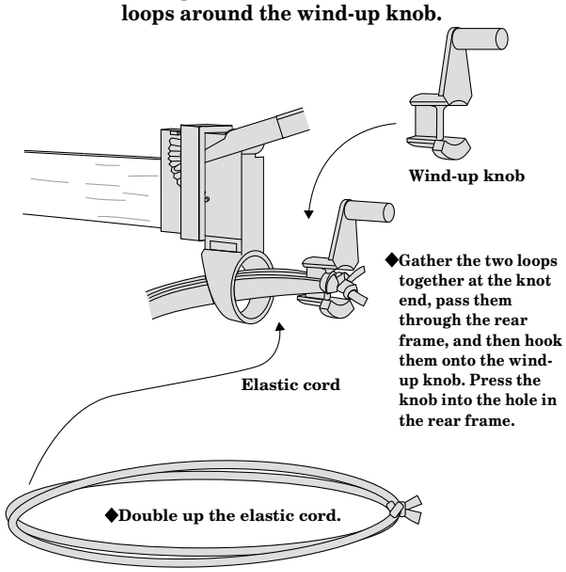


15 When the loop is 25 cm long, tighten the knot, and then tie another knot at the end.



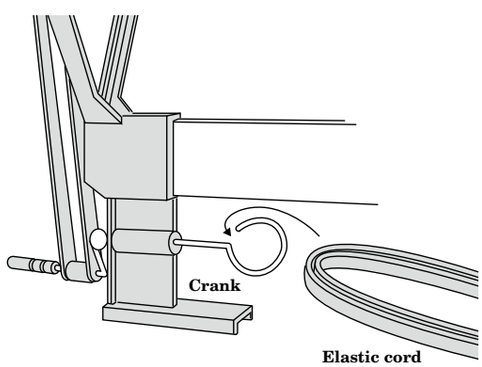
◆Cut the leftovers so that about 5 cm remains.

16. Double up the elastic cord, pass the loops through the hole in the frame, and hook the loops around the wind-up knob.

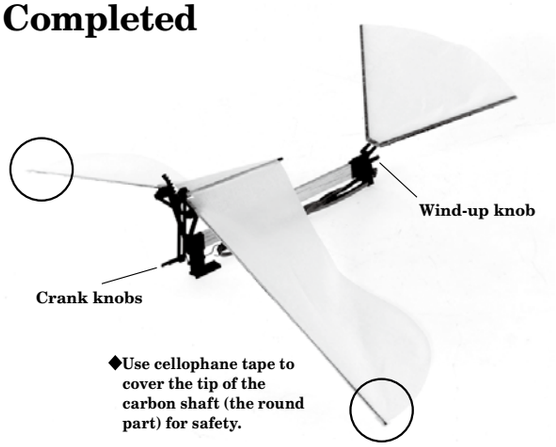


◆Gather the two loops together at the knot end, pass them through the rear frame, and then hook them onto the wind-up knob. Press the knob into the hole in the rear frame.

17 Hook the other ends of the elastic cord loops around the crank of the front frame.



Completed



Hold the crank knobs of the front frame and test the movement of the wing by winding the elastic a little. When you try this, check that the part sticking out of the rear frame wind-up knob catches and is facing upwards.

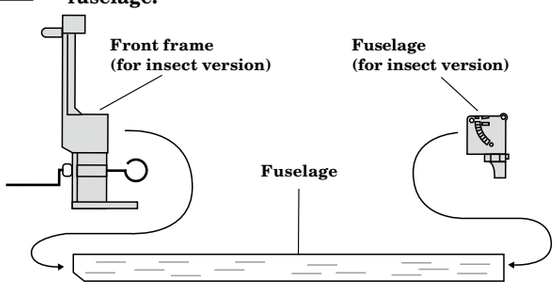
Building the insect-style ornithopter

Assembly time: Approximately 30 minutes

Parts used

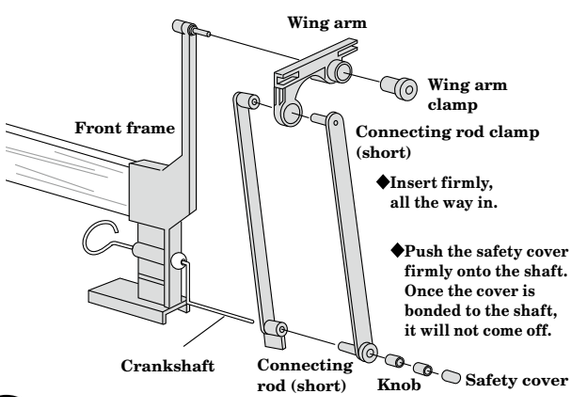
Front frame (for insect version), elastic cord (1), fuselage (1), carbon shafts (2), double-sided tape (3 pieces), wing film (insect-style wing and tail), runner parts used in insect-style ornithopter [wing arm, wing arm clamp, connecting rod (short), connecting rod clamp (short), rear frame (for insect version), knobs (2, also used on bird version), safety cover (also used on bird version), wing boom (also used on bird version), tail boom, wind-up knob (also used on bird version)]

1 Insert the front and rear frames into the fuselage.

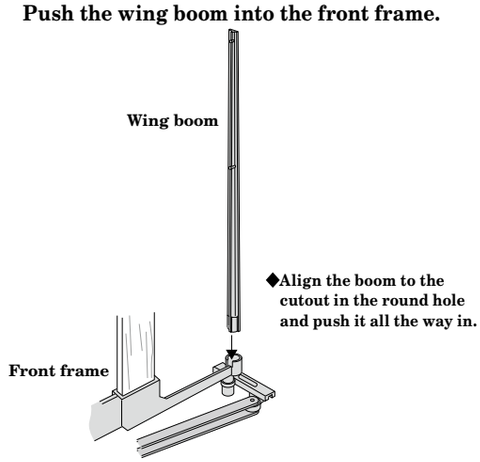


◆The angled corner of the fuselage should face the bottom front. Insert firmly so that it goes all the way into the holes of the front and rear frames.

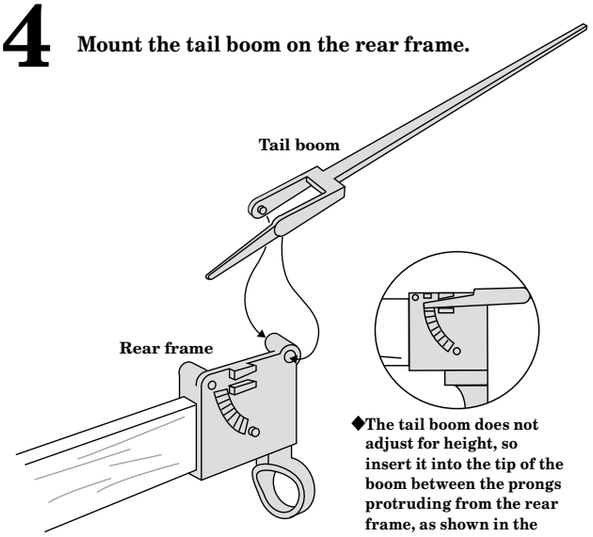
2 Insert the connecting rod (short) and connecting rod clamp (short) into the wing arm in the orientation shown in the drawing, mount the assembly on the front frame and hold it in place with the wing arm clamp. Also slide two knobs onto the crankshaft and insert the tip of the shaft into the safety cover.



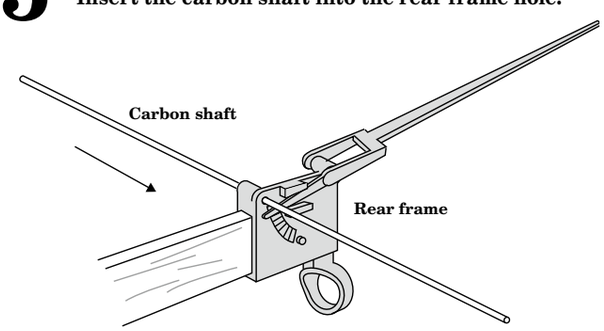
3 Push the wing boom into the front frame.



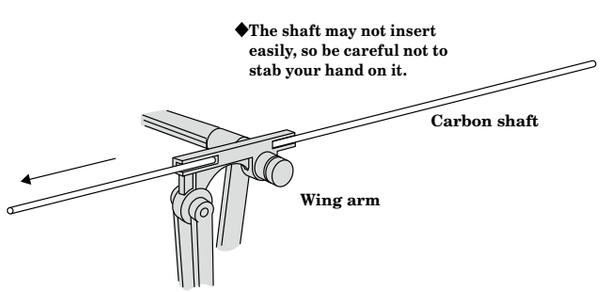
4 Mount the tail boom on the rear frame.



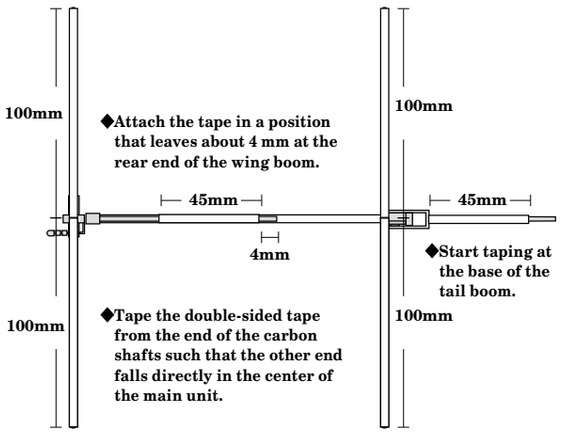
5 Insert the carbon shaft into the rear frame hole.



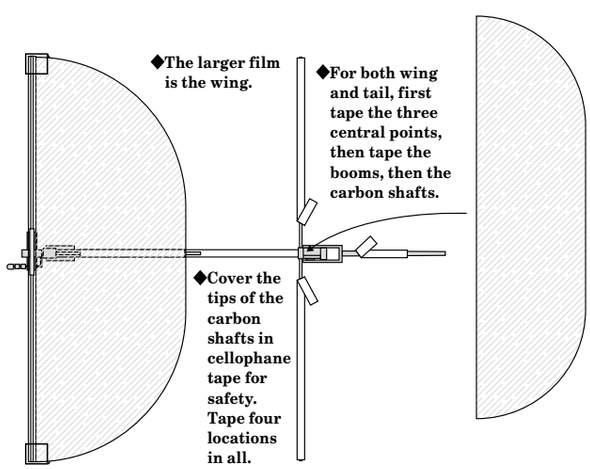
6 Insert the carbon shaft into the wing arm.



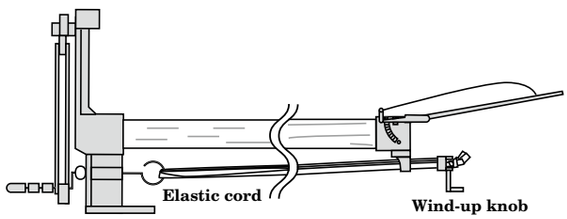
7 Adjusting the lengths of the left and right carbon shafts as shown in the drawing, tape the carbon shafts of the wing and tail onto their respective booms.



8 Tape on the wing and tail films using the method described for the wing of the bird-style ornithopter wing (steps 7 to 10 on page 78).



9 Attach the elastic cord to the wind-up knob and crank using the method described for the bird-style ornithopter wing (steps 14 to 17 on page 79).



Completed

Hold the crank knobs of the front frame and test the movement of the wing by winding the elastic a little. When you try this, check that the part sticking out of the rear frame wind-up knob catches and is facing upwards, just as with the bird-style ornithopter.

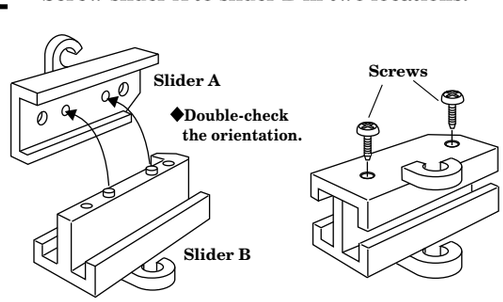
Building the catapult

Assembly time: Approximately 20 minutes

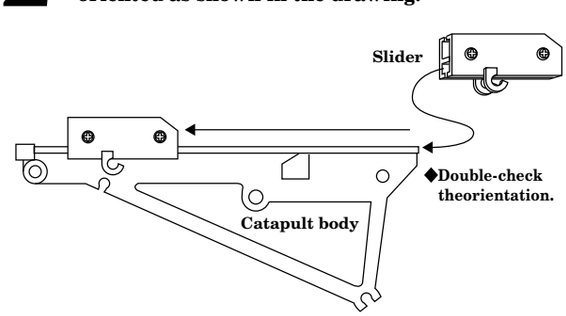
Parts used

Catapult body, trigger, slider A, slider B, base bottom, base front, washer (1), screws (3), rubber band

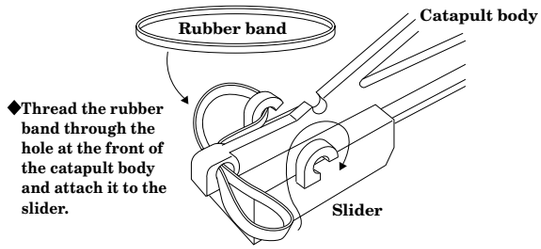
1 Screw slider A to slider B in two locations.



2 Insert the slider onto the catapult body while oriented as shown in the drawing.

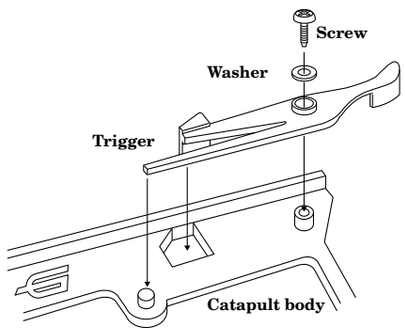


3 Place the rubber band onto the catapult body and slider.

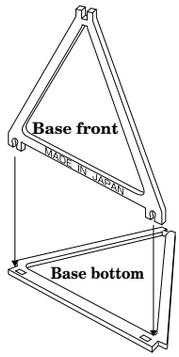


◆Thread the rubber band through the hole at the front of the catapult body and attach it to the slider.

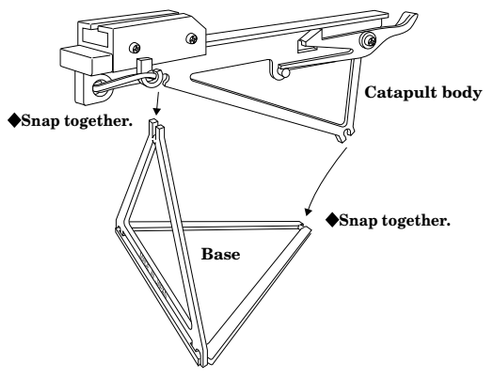
4 Put a washer on the screw and screw the trigger onto the catapult body.



5 Insert the base front into the base bottom.



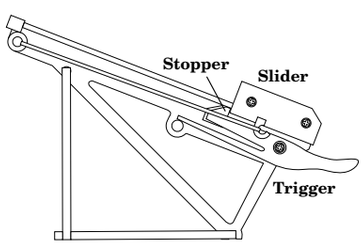
6 Insert the catapult body into the base.

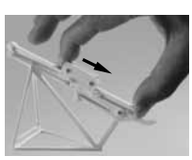


Flying the ornithopter

Place the ornithopter on the catapult

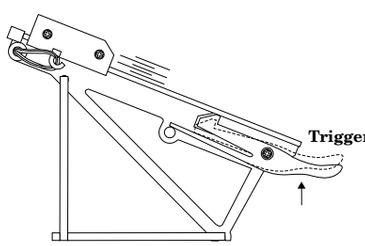
1 Move the slider back until it hits the trigger stopper.





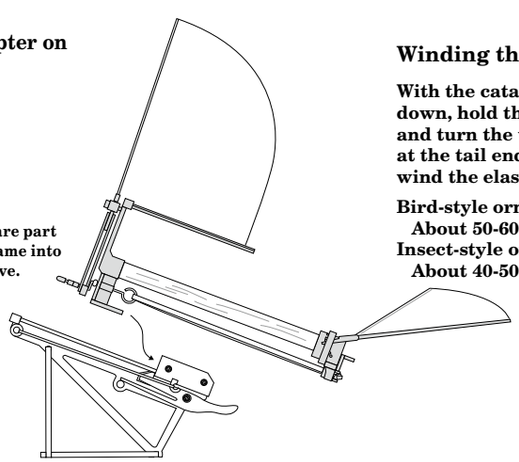
◆When moving the slider back, keep your finger where it will not touch the trigger, as shown in the photo.

2 Press the trigger to release the stopper, which shoots the slider powerfully forward.



◆ If the trigger is stiff, press the part near the screw upwards.

3 Set the ornithopter on the catapult.

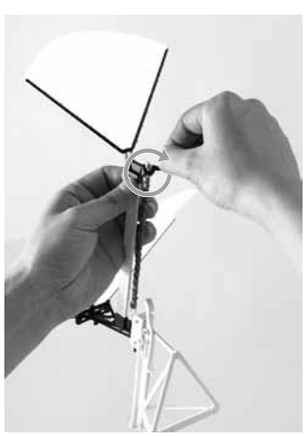


◆Insert the square part on the front frame into the slider groove.

Winding the elastic

With the catapult hanging down, hold the rear frame and turn the winding knob at the tail end clockwise to wind the elastic.

Bird-style ornithopters:
About 50-60 revolutions
Insect-style ornithopters:
About 40-50 revolutions



Q&A

Q: The plane does not fly straight, or even very well.
A: The wing film may be taped on unevenly. Use the spares to tape on new wing films.

Q: It is difficult to turn the crank.
A: Recheck the front frame assembly. (If it is a bird-style ornithopter, pay particular attention to the meshing of the wing gears, which is step 3 on page 2.)

Q: The crankshaft gets hard to turn at one spot in each revolution.
A: The crank may have become bent. Adjust the rubber cord axis of the crankshaft and the controlling rod axis so they are parallel. Another possibility is that the wing film is stretched too tight. Adjust the tension so that there is a little play when the carbon shaft is at its lowest position.

Q: The ornithopter begins falling as soon as it is launched.
A: The rubber band of the catapult may be weak. Try double or triple looping a regular rubber band. The strength is good when the plane flies out parallel to the catapult slider. The angle of the tail and the launch angle are also important. Check these as well.

Q: I want the bird-style ornithopter to fly for an even longer period of time.
A: The ornithopter will fly longer if you use a longer elastic of the same weight. The best elastic you can currently get is FAI rubber. It will fly about 1.5 times longer.

Q: The tail doesn't stay adjusted.
A: The stopper may be loose. Once you have adjusted the tail, keep it in place with cellophane tape.

Q: The safety cover comes off too easily.
A: Attach it with an instant adhesive or other material.

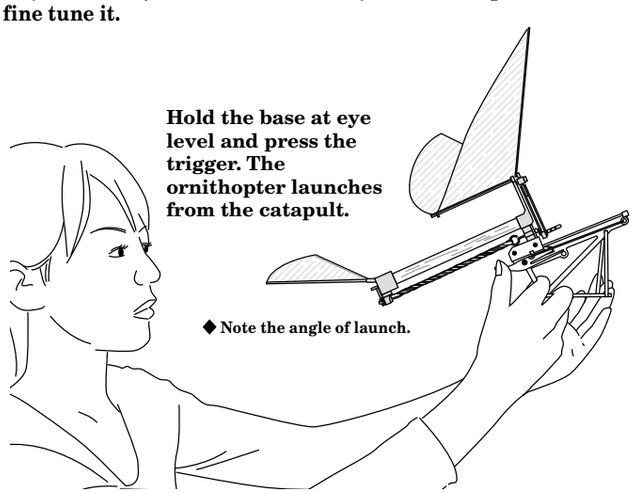
Q: The elastic broke. Or it is no longer long enough.
A: Replace it with elastic for model aircraft (3 x 1 mm), which is sold commercially. If you can get FAI rubber, that performs the best.

Q: The insect-style ornithopter flies up. I want it to fly for a longer period of time.
A: The thrust is too great. Try winding it about 40 times. It can also be made to fly longer by making the elastic half as long, having only a single loop and winding it more times.

Q: Can I replace the wing film?
A: You can use plastic grocery bags you get from supermarkets or convenience stores. Try to find one the same thickness (20 microns) as the wing film in the kit. Plastic bags for produce are generally light and give good flights.

Flying and adjusting the ornithopter

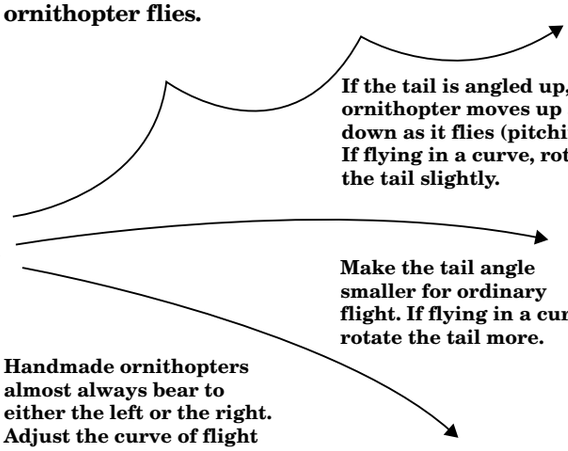
You can adjust the ornithopter to make it fly in different ways.Make adjustments and then fly the ornithopter to fine tune it.



Hold the base at eye level and press the trigger. The ornithopter launches from the catapult.

◆ Note the angle of launch.

The angle of the tail changes the way the bird-style ornithopter flies.



If the tail is angled up, the ornithopter moves up and down as it flies (pitching). If flying in a curve, rotate the tail slightly.

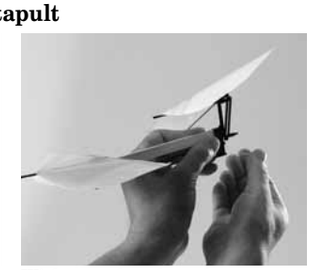
Make the tail angle smaller for ordinary flight. If flying in a curve, rotate the tail more.

If the tail is near horizontal, the ornithopter falls sharply downward.

Handmade ornithopters almost always bear to either the left or the right. Adjust the curve of flight by changing the tail angle or using weights as explained below.

Launching without the catapult

If you are not using the catapult, hold the fuselage firmly and rotate the knobs on the crank to wind the elastic.



With your hand on the fuselage pressing the crank to keep the elastic from unwinding, move your hand forward and gently toss the ornithopter into the air.

Using the weight

Clip the weight to the tip of the wing and attach it with tape. Now, when the ornithopter flies, it will circle toward the weighted tip. If it circles even without the weight, place the weight on the opposite tip to straighten out the flight path. The more forward you place the weight, the more effect it has.

If you fly the ornithopter outdoors, the wind may help it fly a great distance. Fly it away from traffic where you have plenty of space. Do not launch the ornithopter at another person. Doing so may cause injury.