



Drexel-SDP GK-12 ACTIVITY

Science

Weather and Aeronautics

Up, Up and Away! Building an airplane



Grade Level _6_ (_5_-_8_)

Lesson # _6_ of _10_

Lesson Dependency Lessons 1 through 10 of the Weather and Aeronautics Lesson and Activity Group

Time Required: 2 Hours

Summary

In this lesson, students apply what they have learned about the parts and axes of an airplane to construct a small airplane model themselves, and test it in flight.

Engineering Connection

The aeronautics course is intended as a multi-disciplinary course in physics, math and history of aviation. Navigation, forces of flight, principles of flight, history of flight, and environmental factors (including weather and landforms) are specifically investigated. The core curricular items are emphasized, and aviation is considered an underlying theme. The intent is to provide grounding to the curriculum components learned in a typical K-12 school year. Aviation easily generates a lot of excitement among this age group, and as a result, measurable results are expected in these subjects.

Keywords

- Aeronautics
- Weather
- Aviation
- Flight

PA Science Educational Standards

- 3.1.7A Explain the parts of a simple system and their relationship to each other.
- 3.1.7B Describe the use of models as an application of scientific or technological concepts.
- 3.2.7A Explain and apply scientific and technological knowledge.
- 3.2.7C Identify and use the elements of scientific inquiry to solve problems.
- 3.4.7C Identify and explain the principles of force and motion.

Pre-Requisite Knowledge

Principles of lift and flight demonstrated through experimentation described by the Bernoulli Lessons in this unit.

Learning Objectives

After this lesson, students should be able to:

- Build a simple aircraft.
- Identify the parts of the airplane.
- Justify the controls of the aircraft in flight.

Materials

Squirrel Parts

- 1/16 x 3/16 x 12" bag (Wing LE and TE)
- 1/16 x 3/16 x 6" bag (Stabilizers)
- 1/16 x 3/16 x 2" bag (Ribs, Winglets, Fins)
- 1/16 x 3/16 x 1" bag (Shims)
- 1/8 x 3/8 x 12" bag (Motor Sticks)
- 1/8 x 3/8 x 4" bag (Wing Seats)
- 1/8 x 1/4 x 1/2" bag (Motor Block)
- Toothpicks
- Thread Spool
- #8 elastics
- Pre-cut Tissue
- Propellers with Hardware
- Rubber Motors

Workshop Tools

- Scissors (1 set for every 3 builder)
- Glue Sticks (1 per builder)
- White Glue (1 bottle)
- Wax paper to distribute glue

Discussion

Take the wood pieces and label them as follows:

- A = x3 1/16x3/16x12 (wing)
- B = x2 (fin and wing supports)
- C = x6 (stabilizer)
- D = x1 (wing shim)
- E = 1/8x1/4x12 (body)
- F = x1/2 (prop mount)
- G = x4 (Wing seat)

This will make assembly easier for students. The original instructions, taken from [Building the Airplane], are shown in the following figure. However, they are best described using the following procedure:

1. Using two "A" pieces and three "B" pieces, assemble a rectangular wing using the "B" pieces as wing supports. It is not necessary to create winglets as shown in the figure. Glue with wood glue.
2. Using another "A" piece, glue a wing rib around two thirds of the way up the wing. What is the purpose of this? Think of Bernoulli's principle and increased surface area for faster airflow over the wing. Glue with wood glue.
3. Wrap the wing in tissue paper, gluing on with Elmer's glue.

4. Using a “B” and “C” piece, create a stabilizer and fin. This is done by Elmer’s gluing each wood piece to separate tissue paper so that about 2 inches hangs back and ½ inch on either side of the paper.
5. Wood glue the motor block / prop mount (“F” piece) and the wing seat (“G” piece) to the body (“E” piece). The wing seat sits above the body, about 1 ½ inches from the front. The prop mount rests below the body, directly on the front.
6. Wood glue the fin and the stabilizer to the back of the body. The stabilizer should sit horizontally across the back, and the fin should sit vertically across the back in the middle. Leave a little wood overlapping below the airplane from the fin. In both cases, the tissue paper should face backwards from the airplane.
7. Wood glue the wing shim (“D” piece) to the center of the front of the wing, on the bottom of the front “A” piece. Then use the rubber band to loop the wing onto the body above the wing seat. The rubber band should loop vertically across the body of the aircraft, from the front to the back of the wing seat.
8. Using thread, tie a toothpick to the overhanging wood from the fin. The toothpick should face downward from the plane and will be used to attach a rubber band to the propeller, which will attach to the prop mount. Loop the thread around the stabilizer and fin several times, and also between the tissue paper between the stabilizer and fin. Elmer’s glue the stabilizer tissue paper to the fin tissue paper.
9. Attach the propeller to the prop mount, and a rubber band from the prop to the toothpick. To launch, wind up the rubber band and throw slightly downward. Experiment with the position of the wing and the angle of throw.

Squirrel

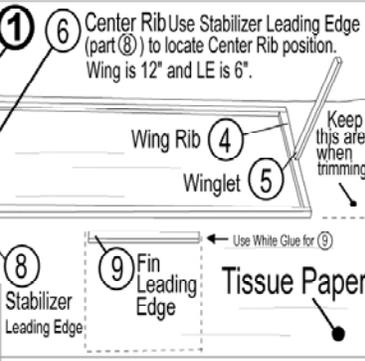
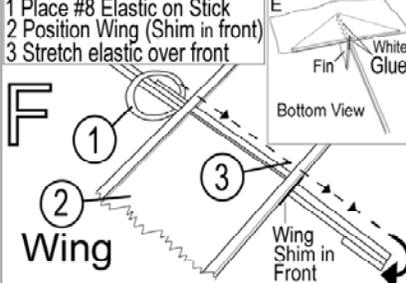
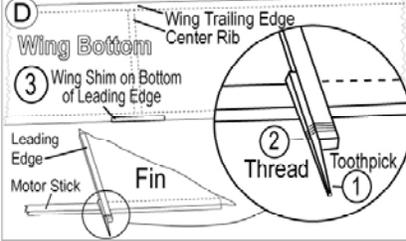
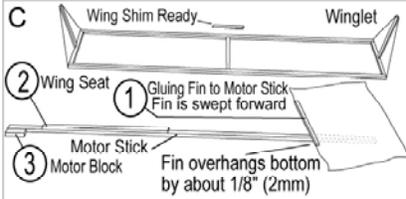
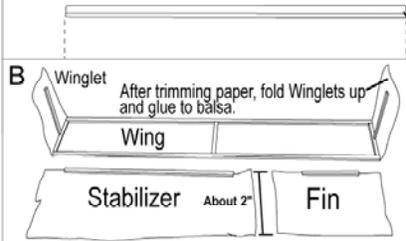
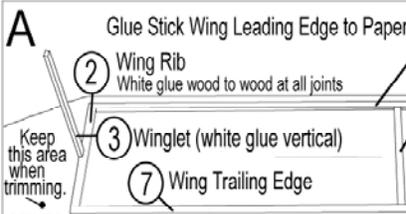


Put on your running shoes because this balsa-tissue rubber-powered model airplane flies out of sight! Squirrel flies so well because it is light and simple. With sliding wing adjustment it's easy for beginners to fly but performs well enough to please experts. **Super simplified balsa-tissue construction makes it a great first model.** A drawn plan isn't needed. Fin and Stabilizer use Leading Edge Only (LEO) technology. Traditional music wire motor hanger has been replaced with a toothpick wound with tread. This plan is for a building party or workshop and is with the assumption that parts are pre-cut.

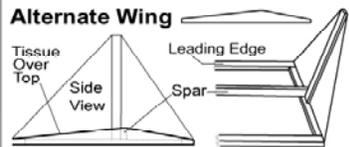
Design By Darcy Whyte

©Darcy Whyte, www.Rubber-Power.com, Dec. 2004

Suggestions and improvements are very welcome!
email workshops@rubber-power.com



- Steps** (Best assembly order.)
- 1) Fig A: Glue parts in numbered order. Use white glue on Fin Leading Edge.
 - 2) Fig. B: Cut Fin and Stabilizer tissue.
 - 3) Fig. C: White Glue Fin to Motor Stick. Glue Wing Seat 1" from front on side of Motor Stick flush with top. Glue Motor Block to front bottom of Motor Stick.
 - 4) Fig. B: Remove Wing from building board and trim paper leaving **extra for Winglets**. White glue tissue to Winglets.
 - 5) Fig. D: Trim Fin tissue and white glue toothpick in place. Add extra glue to toothpick and wrap in place with thread.
 - 6) Fig. D: White glue Wing Shim to Wing bottom.
 - 7) Fig. E: White Glue Stabilizer in place.
 - 8) Fig. F: Mount Wing using #8 Elastic. Trim Stabilizer.
 - 9) Add Propeller and 10" Rubber Motor. Use square knot to tie loop if necessary. Knot goes at back of plane.



You can upgrade the Wing. Add a 1/16x1/8x12 stick as a "spar". Glue it 1/3 of the way from the leading edge so that it braces the Winglets. Cover the top.

Or, when building, leave 3" of extra tissue in front of leading edge and after adding the spar, wrap the tissue over the top and glue it to trailing the edge.

Safety
•Never climb trees. •Instruct children about traffic risks when chasing airplanes and not to climb trees.



Test fly with around 200 winds on the rubber. Holding by motor stick underneath wing, throw airplane like a dart. Throw nose down at direction and speed as if throwing to point on the ground about 20 feet ahead. If it dives downward, adjust wing forward. If it climbs too much, move the wing backward. If it shows a pattern of climbing and diving then it is "stalling". Move wing back. Once it can hold nearly level flight, start winding the propeller more for each flight. With practice and patience you will be surprised how far and how long it can fly.

- Tips** (Read first for best luck!)
- Write your name and phone number on your Squirrel.
 - Glue tissue to balsa using glue stick (except Fin Leading Edge, Winglets and Stabilizer). Place balsa on table and run glue stick across it. Add white glue where required and press onto tissue. All other joints use white glue. Apply all white glue with a toothpick and use very little. It will dry faster and be lighter. Keep a small blob on a piece of wax paper to dip toothpick. If white glue doesn't tack well and dry fast, there's too much.
 - Mark top of Motor Stick with a series of tick marks so you can note where the wing is positioned and adjust it precisely.
 - Tissue has grain like wood. Using a small section of tissue off to corner of your sheet, pull in different directions to determine the strongest direction. The strongest direction is the direction of the grain. Grain should run along the length of a wing. Grain should be perpendicular to the leading edge of the Fin and Stabilizer. (This is less critical but may reduce tearing away from the leading edge).
 - Add a 2x1" piece of tissue paper to the trailing edge of one wing near the wing tip. Bending this "Aileron" will turn the airplane. You may need to move wing forward to turn.
 - Fly in a gym or in calm weather. (<5km/hr)
 - Pick a nice colour for your tissue. It gives your Squirrel charisma. It will help you find it in trees too!

- Materials**
- 1/16 x 3/16" Balsa Strips (1/16 x 1/8 is OK too):
 - 2 - 12" Wing Leading Edge and Trailing Edge
 - 6 - 2" Wing Ribs, Winglets and Fin Leading Edge
 - 1 - 6" Stabilizer Leading Edge
 - 1 - 1" Wing Shim
 - 1/8 x 2/8 x 12" Motor Stick
 - 1/8 x 1/8 x 1/2" Motor Block
 - 1/8 x 1/8 x 4" Wing Seat
 - 1/2 Toothpick
 - Thread 3" (tie toothpick)
 - #8 Elastic Band Wing Mount
 - Propeller with Hardware (5-6")
 - 10" Elastic Motor Loop (Use 3/32" Rubber)
 - Tissue Paper: Wing 17x2 1/2", Fin 3x3", Stabilizer 7x3"

- Tools**
- Scissors
 - Toothpick
 - White craft glue (such as Aleene's Tacky Glue)
 - Glue stick (lipstick type such as UHU Glue Stick)

Outdoor Squirrel
Try an 18" Squirrel. Use 1/8" square for wing leading and trailing edge. 4" chord and winglets, 9" and 5" stabilizers and an 18"x3/8x1/8 motor stick. I used the alternate wing (needed two pieces of 3/16 to get the height). I also needed a #16 elastic to attach the wing. At this point you may want to use a music wire motor hanger rather than a toothpick. Or just use a pair of toothpicks for more strength. Works well with wheels.

workshops@
rubber-power
613 563-4444 ext 9
.com

Revised February 8, 2005 Mentor Sheet 1.031

References

Image: <http://www.af.mil/photos/index.asp?galleryID=2>

Building the Airplane: <http://www.rubber-power.com/h/rp/About.htm>

Owner

Drexel University GK-12 Program

Contributors

William M. Mongan

Date: 12/2/2007

Copyright

Copyright 2007 Drexel University GK12 Program. Reproduction permission is granted for non-profit educational use.