



Drexel-SDP GK-12 ACTIVITY

Science

Weather and Aeronautics

Up, Up and Away! Testing a Model using a Wind Tunnel



Grade Level _6_ (_5_-_8_)

Lesson # _7_ of _10_

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

Time Required: 2 Hours

Summary

When the Wright Brothers began designing their first airplane, they started by forming hypotheses about how it will fly. How did they do this? After all, they knew very little about flight, and their "real

job" was actually making bicycles on the ground. They made their predictions using math. It turns out that mathematical equations can predict how much air pressure is needed to make the wing's lift equal its weight (and make it float).

Do you think their results were perfect? In fact, they were far from perfect -- and sometimes downright wrong. They went out onto a beach in Kitty Hawk and tried their design, and even got hurt because of their mistakes. It wasn't until later that they discovered their error by realizing that their designs just didn't work.

But, considering that they were actually trying to fly an airplane by trial and error, they really didn't want to spend all that time taking their model outside only to get hurt again when they fall. How could they solve this? They had to be a little clever. They built a **wind tunnel** that they would use to simulate the airplane moving through the sky. Instead of moving the airplane, they will move the air in a tunnel.

Picture putting a fan into a tunnel and pointing it at an airplane. It should work! And if they alter the wing designs, they should be able to see the plane turn from left to right and go up and down. What would you change on an airplane to make it move in every direction?

This week, you will build a wind tunnel and a model airplane. You will add moveable parts to the plane to create ailerons, elevators, and rudder. Let's label them now so that we know what they really are. What do you think will happen when we move each one?

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
- Wind Tunnel

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.

Learning Objectives

After this lesson, students should be able to:

- **Identify the three axes of flight.**
- **Identify the components of an aircraft that impact motion about the axes of flight.**
- **Manipulate the components of an aircraft to achieve specific movement about the axes of flight.**

Materials List

Each group needs:

- 1x Packaging Tape
- 1x Metersticks
- 1x Cardboard
- 1x Strong Scissors
- 1x Light thin wood block like a popsicle stick
- 1x Writeup of directions
- 1x Roll String
- 1x Window Screen

To share with the entire class:

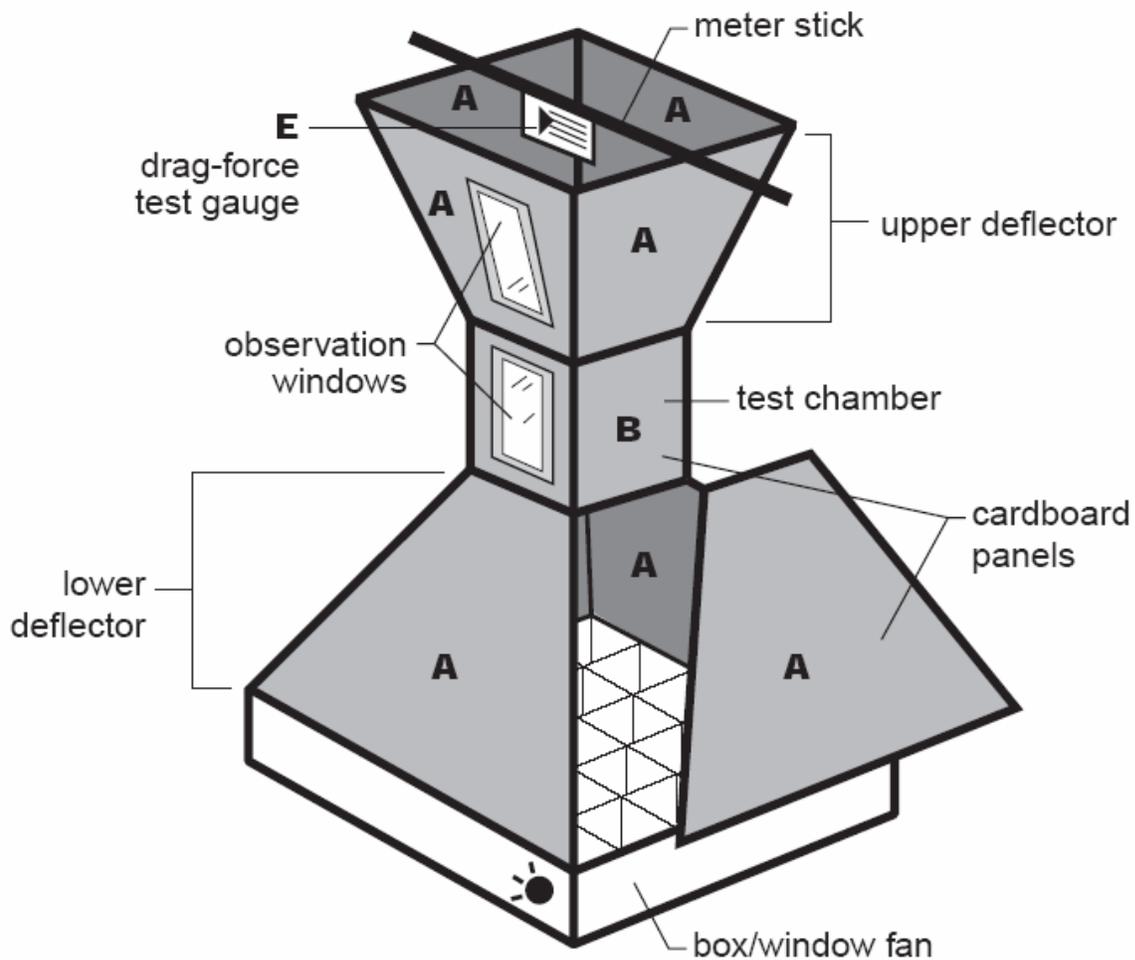
- 2x Box fan
- 1x pack transparency film

Vocabulary / Definitions

Word	Definition
Lower Deflector	The chamber nearest the fan that takes in the most amount of air.

Upper Deflector	The chamber away from the fan that allows air to flow out of the wind tunnel, thereby allowing air to pass through the test chamber.
Test Chamber	The chamber that houses the model airplane.
Vortex	The tornado-like movement of air that is not conducive to airplane testing. This vortex is formed from large jet aircraft wingtips, as well as from the helical-shaped propeller blades of a box fan. Using a screen, we filter the vortex into straight streams of air, which is more conducive to a wind tunnel test chamber.

Procedure



First, we build the wind tunnel as above:

1. Measure a trapezoid 24" x 12" just like figure A shows at the bottom. This can be done by measuring (carefully!) 24 inches across the top, 12 across the bottom, and diagonals to make them match up. Trace your cuts in pencil first, then cut them out. You should have 4 trapezoids.

2. Tape the trapezoids together to make the **lower deflector**.
3. Cut and tape the **screen mesh material** to the **lower deflector**'s large opening. This will be to mitigate turbulence from the fan propellers.
4. Cut out a cube like figure B – the **test chamber**. It should be 12 inches cubed and will tape to the **lower deflector**. Cut out a side to be replaced with the **observation transparency window**, but don't tape the window in just yet (so we can get the plane in!).
5. It is **not** necessary to make a smaller trapezoid as in this figure (the **upper deflector**), but if you have extra cardboard please do! It is a 12" x 6" trapezoid that tapes to the test chamber.
6. Cut a small hole at the top of the test chamber (on the side next to the observation window, if the wind tunnel were laying on its side). Through this hole will go a string tied to a popsicle stick, and the popsicle stick will rest on top of the test chamber. We will attach our airplane to this string, and then put the **observation window** in place.
7. Lay the wind tunnel on its side and power the fan into the **lower deflector**. We are ready to augment our airplanes, make predictions and test them out!

Next, we will build our airplanes.

1. Building the model or using an existing model airplane, attach index cards or extra wood to the ailerons, elevators, and rudder of the plane.
2. Predict what will happen when you rotate each surface one at a time, and try it! Record what happens and whether or not you were right.
3. What if you move two surfaces at the same time? For example, try moving both ailerons in the same direction. How about different directions.
4. How does the rudder work differently from the ailerons? What did each do?

References

<http://www.sciencenetlinks.com/lessons.cfm?BenchmarkID=3&DocID=148>

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