

TOOLKIT 10 WHY AIRCRAFT FLY



OKLAHOMA
Aeronautics



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CareerTech

Overview: Students are introduced to the forces of flight and to jet propulsion. They demonstrate how lift can overcome weight (gravity) and how thrust (power) can overcome drag (air resistance). They also recognize the importance of aerodynamics in daily activities and they experience that for every action there is an equal and opposite reaction (Newton's Third Law of Physics).

Source: *The Aerospace Curriculum Guide: Grades K-3*, Oklahoma Department of Career and Technology Education

Grade Levels: 1-3

Location: All resources are provided in this toolkit.

1 Student Activity	2 Lesson Plan or Procedure	3 Activity Evaluation or Rubric	4 Suggested Activities	5 Glossary	6 Teacher Background or Concepts	7 Student Background or Concepts	8 Standards Alignment
x	x		x				
Notes: • Includes extension activities.							

KEY:

1. Student Activity: This is the focus of the toolkit. It is at least one complete activity or lab for students to complete that relates to a topic relevant to aviation/aerospace. It may include related worksheets.
2. Lesson Plan or Procedure: These are the steps or instructions for the teacher to use to deliver the activity.
3. Activity Evaluation or Rubric: These are answers to the activity or a rubric or other tool for evaluating students' results.
4. Suggested Activities: These are additional or extension strategies for the teacher that relate to the topic/activity.
5. Glossary: This is a list of the vocabulary terms and their definitions that relate to the activity and/or associated concepts.
6. Teacher Background or Concepts: This is any background information for the teacher that explains key concepts relating to the topic/activity, provides the aerospace context for the activity or otherwise helps prepare the teacher for the topic/activity.
7. Student Background or Concepts: This is any background information for the student about theory and concepts related to the topic/activity. It may be separate handout files or a text section within the larger topic/activity.
8. Standards Alignment: These are education or industry standards that align with the topic/activity.

SUPPLEMENTAL RESOURCES

General Resources

- *Pilot's Handbook of Aeronautical Knowledge*, Federal Aviation Administration, 2016. Free to download at https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/.
- Airport Acronyms and Abbreviations, Federal Aviation Administration, <https://www.faa.gov/airports/resources/acronyms/>
- Find an Airport, Oklahoma Aeronautics Commission, <https://oac.ok.gov/airports>
- K-12 Student/Teacher Resources, NASA, <https://www.nasa.gov/aeroresearch/resources/k-12-resources>
- "Science Takes Flight With Paper Airplanes," Edutopia, <https://www.edutopia.org/article/science-takes-flight-paper-airplanes>

Instructional Practice Resources

- *60 Formative Assessment Strategies*, Natalie Regier, 2012. Free to download at <https://www.okcareertech.org/educators/resource-center/teacher-trainer-tools>.
- *Student Learning That Works: How brain science informs a student learning model*, McREL International, 2018. Free to download at <https://www.mcrel.org/student-learning-that-works-wp/>.

Career Planning Resources

- OK Career Guide. Free to Oklahoma educators. For more information, see <https://www.okcareertech.org/educators/career-and-academic-connections/ok-career-guide>.
- Aviation Organizations, Oklahoma Aeronautics Commission, <https://oac.ok.gov/media-outreach/aviation-organizations>
- *Careers in Aerospace*, American Institute of Aeronautics and Astronautics. Free to download at <https://www.aiaa.org/get-involved/students-educators/Careers-in-Aerospace>.
- Flying for a Career, AOPA, <https://www.aopa.org/training-and-safety/learn-to-fly/flying-for-a-career>
- Oklahoma Aerospace: Building on a Rich Tradition, Oklahoma Department of Career and Technology Education, <https://www.okcareertech.org/business-and-industry/aerospace-and-aviation>

Activity-Specific Resources

- Aerospace Engineering STEMPack, AAUW, <https://www.aauw.org/resources/research/the-stem-gap/>
- Newton's Laws of Motion, NASA Glenn Research Center, <https://www1.grc.nasa.gov/beginners-guide-to-aeronautics/newtons-laws-of-motion/>
- Newton's Third Law of Motion (video), NOVA, <https://oeta.pbslearningmedia.org/resource/phy03.sci.phys.mfw.asrnt/newtons-third-law-of-motion-astronauts-in-outer-space/>
- The Four Forces: Lift and thrust battle with weight and drag, AOPA, <https://www.aopa.org/training-and-safety/students/presolo/topics/the-four-forces>

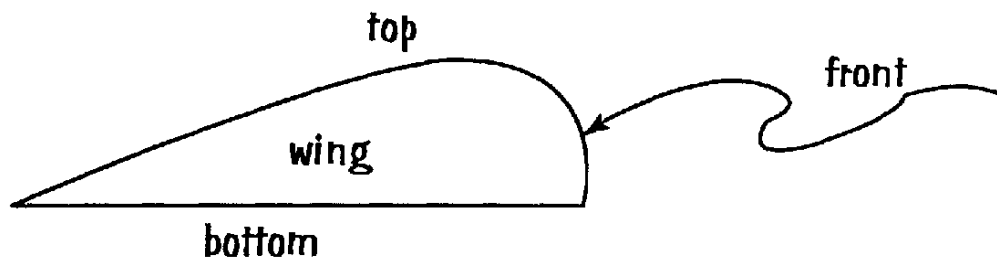
TEACHER INSTRUCTIONS

LIFT VS. WEIGHT

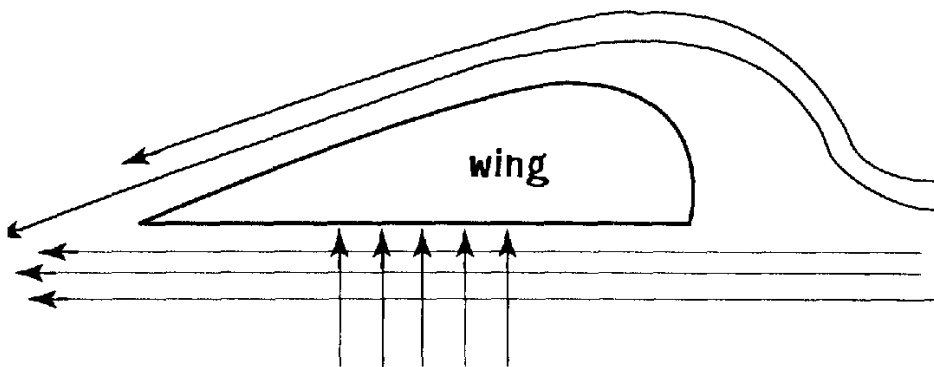
1. Probe the students' imagination by asking questions like the following:

- Will an airplane float like a balloon? Why? (Answer: No, it is too heavy.)
- What holds an airplane on the ground? (Answer: Weight, or gravity, holds an airplane on the ground.)
- If an airplane will not float, then what lifts it into the air? (Answer: Air moving over the wings creates lift that is greater than the weight of the airplane.)

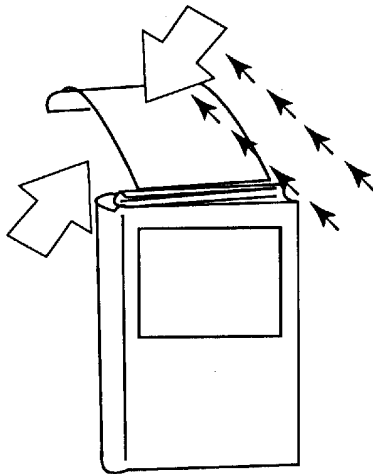
2. Explain to the students that weight or gravity holds an airplane on the ground. A force greater than the weight of the airplane must be used to lift it. The force that lifts an aircraft and keeps it in the air is created by the air flowing over the wings and the angle of the wings into the wind. Most aircraft wings are flat on the bottom and curved on the top. Draw this diagram to show and explain the cross-section of a wing:



3. Explain that air traveling over the wing must reach the other side of the wing at the same time as the air traveling under the wing. This means the air traveling over the wing must move faster. This creates a lower air pressure. Lower air pressure creates a suction that causes the wing to lift upward. Draw the diagram below to illustrate lift:



4. Distribute strips of paper that are each 2 inches by 10 inches. Ask the students to make a wing by placing one end of the paper strip between the pages of a book so that the other end hangs over the top of the book:



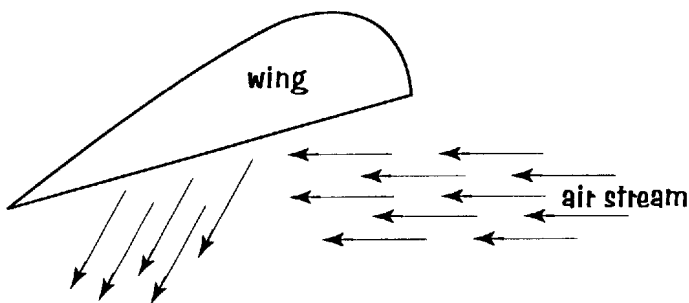
5. Encourage the students to analyze what will happen when air passes over the strip of paper by asking questions like these:

- What will the paper do with no air passing over it?
- Will the paper move up or down with air passing over it?

6. Ask the students to blow across the top of the paper strip. Ask them to explain what happened.

Extension Activities

- Explain to the students that air flowing over the wing is not the only thing needed to lift the aircraft; the wing must also be at the correct angle. Draw the diagram below to help with your explanation:



Further explain that the aircraft will climb or lift higher according to the angle of the wing.

- Hold two sheets of notebook paper about 4 inches apart. Blow between them.

Question: What happens? Why?

Answer: The paper comes together. The rapid movement of air between the two pieces of paper creates less pressure than the air pressure on the outer sides of the paper.

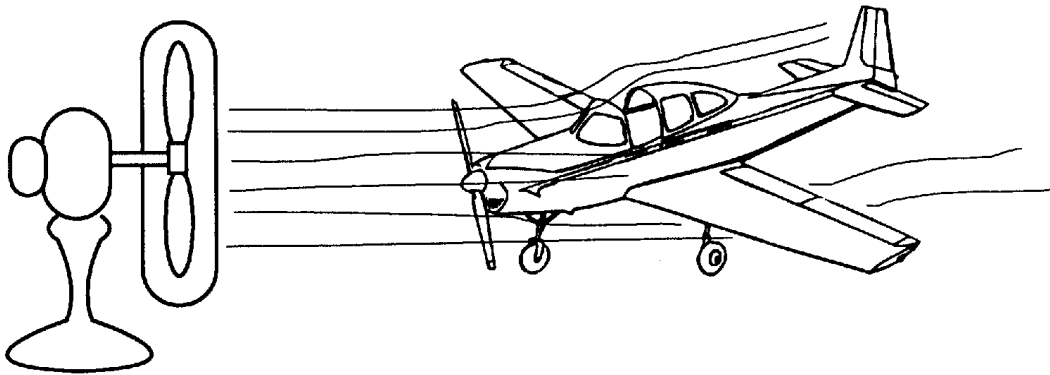
TEACHER INSTRUCTIONS: THRUST

1. Explain to the students' that thrust is the force needed to propel an aircraft through the air.

Pose questions like the following:

- What is used to thrust (propel) an aircraft through the air? (Answer: Add an engine to thrust an aircraft through air.)
- What can be done to thrust an aircraft through the air faster? (Answer: To thrust an aircraft through the air faster, reduce drag or increase power.)

2. Allow time for discussion. After considering a variety of ideas, tell students that an airplane propeller, turned by the engine, pulls the airplane through the air as it blows air over the wings and the fuselage. Show how the propeller pulls an airplane through the air by drawing the following illustration. Pretend the fan is the propeller:



3. After discussing the illustration, ask the students to think about the following question:

Where would you stand so you could feel the wind of the propeller—in front of the airplane or behind it?

TEACHER INSTRUCTIONS: DRAG

1. Explain to the students' that, as the propeller pulls the airplane forward, another force called drag holds the airplane back. Air cannot flow quickly around large, bulky objects. For objects to travel quickly through the air, they must be streamlined (aerodynamic). Show the students two sheets of paper that are the same size. Crumple one sheet and leave the other one flat. Ask questions like the following:

- If dropped, which sheet will hit the floor first?
- If thrown, which sheet will go the farthest?

2. Give each student two sheets of paper. Ask them to crumple one and leave the other as is.

A. Drop each sheet from a pre-determined height.

B. Throw each sheet.

3. Ask the students to answer this question:

Question: Why did the crumpled sheet travel the fastest in both cases?

Answer: The crumpled sheet of paper had less drag (resistance to the air) because it was more streamlined or compact. As a result, it traveled through the air faster with less drag.

Extension Activities

- Ask the students to think of other ways that aerodynamics (streamlining) is used. Ask them to give reasons for using aerodynamics (such as speed and fuel efficiency).

Examples: cars; semi-trucks with sleek cab designs and air spoilers between the truck and the trailer; clothing used by athletes such as speed skaters and cyclists; motorcycles; speed boats

- Experiment using paper airplanes. Have students discover how sleek designs travel through the air faster than bulkier designs.
- Brainstorm ways in which drag can be reduced on an airplane.

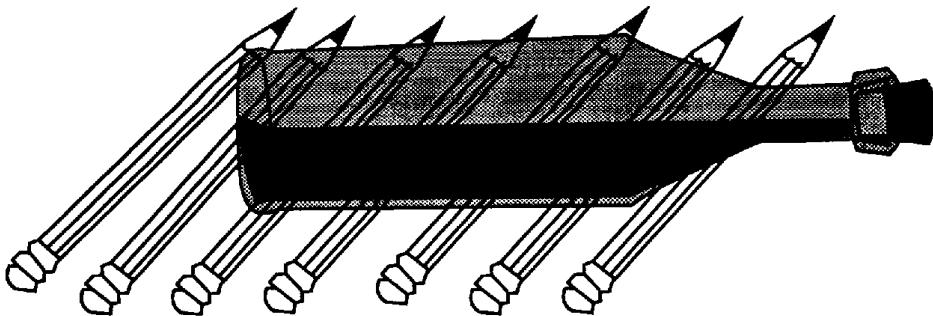
Examples: hood (cowling) over the engine; sleek fuselage design; cover over the open cockpit; wheels up inside the fuselage or wing

TEACHER INSTRUCTIONS: BALLOON JET

1. Direct the students' attention to jets. Ask questions like the following:
 - Do all airplane engines have a propeller?
 - What kind of airplane engine has no propeller?
 - How do jet engines provide thrust?
 - Do you think jets are like rockets?
2. Explain to the students that the fuel burned in a jet engine gives off hot gases. The gases shoot out the back of the engine in a stream called a jet. As the gas shoots out the back of the engine, the jet airplane is pushed forward. This forward movement is called thrust or jet propulsion.
3. Conduct this experiment to illustrate how jet propulsion works. Tape a string to a ceiling or to a tall bookcase. (Get help if needed.) Thread the loose end of the string through a straw and tape the other end of the string to the floor at a 45-degree angle. (Be sure the string is stretched tight.) Inflate a balloon and, while holding the neck of the balloon closed, tape the bottom of the balloon to the straw. Let go of the neck of the balloon. Let students take turns inflating a balloon and releasing the neck.
4. Ask the students questions such as these:
 - What did the balloon do?
 - What caused the balloon to travel to the ceiling?
 - How does the balloon compare to a jet engine?

TEACHER INSTRUCTIONS: NEWTON'S THIRD LAW OF PHYSICS

1. Tell the students that, for every action, there is an equal and opposite reaction, just like every problem has a cause. Ask the students to think about these actions and determine the reaction:
 - A tossed ball
 - Air escaping from a balloon
2. Illustrate this concept by conducting this experiment. Fill a bottle, half full, with a mixture of 50 percent water and 50 percent vinegar. Pour two teaspoons of baking soda into the bottle. Lubricate a cork with petroleum jelly and insert it into the top of the bottle. Place the bottle on its side on top of a row of round pencils.



3. After completing the experiment, help the students assess the outcome by asking questions such as these:
 - What was the action?
 - Describe the reaction.
 - Explain what caused the reaction.
 - Relate the reaction to a jet engine.
4. Explain that the pressure building up inside the bottle, caused by the vinegar, water, and baking soda mixture, will pop the cork. The force from the cork popping will thrust (push) the bottle in the opposite direction across the pencils.
5. Clean the area after the experiment, if needed.

TEACHER ACTIVITY REFLECTION WORKSHEET

- What instructional objectives were met? How do I know?
- Were students actively engaged? How do I know?
- Did I alter my instructional plan? How and why?
- What formative assessment(s) did I use?
- What would I do differently the next time?
- What additional resources and/or support would enhance this activity?