

TOOLKIT 9

FOUR FORCES OF FLIGHT



OKLAHOMA
Aeronautics



OKLAHOMA
CareerTech

Overview: Students do simple experiments to become familiar with the four forces of flight: thrust, drag, lift and gravity (or weight).

Source: *Aeronautics* module, NASA Out-of-School Learning Network

Grade Levels: 6-8

Location: <https://www.nasa.gov/stem-ed-resources/aeronautics-module.html>

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		x	x	x
<p>Notes:</p> <ul style="list-style-type: none"> • States specific learning objectives addressed. • Includes a materials list. • Includes a student handout to record observations and conclusions. 							

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>
- *Aeronautics Educator Guide*, NASA, <https://www.nasa.gov/stem-ed-resources/aeronautics.html>
- "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

- Challenge of Flight (interactive), PBS-OETA (WGBH and The Documentary Group), <https://oeta.pbslearningmedia.org/resource/aeroeng-sci-eng-flight/challenge-of-flight/>
- Four Forces on an Airplane (includes a video), NASA Glenn Research Center, <https://www.grc.nasa.gov/www/k-12/airplane/forces.html>
- Four Forces of Flight (video plus activities), EAA Aviation Center (Experimental Aircraft Association), <https://www.eaa.org/eaamuseum/education-programs/eactivities/four-forces-of-flight>
- How Do Planes Fly?, Aviation Triad, <https://www.aviationtriad.com/how-do-planes-fly/>
- May the Force Be With You: Lift, TeachEngineering.org, University of Colorado, https://www.teachengineering.org/lessons/view/cub_airplanes_lesson02
- 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 BACKGROUND INFORMATION: THE FOUR FORCES OF FLIGHT

Four forces are continually acting on aircraft in flight:

- Weight or gravity — downward force acting upon everything that goes into aircraft, such as aircraft itself, crew, fuel and cargo.
- Lift — force acting vertically and counteracting weight or gravity.
- Drag — backward deterrent force caused by disruption of airflow over wings, fuselage and protruding objects.
- Thrust — forward force produced by powerplant to overcome force of drag.

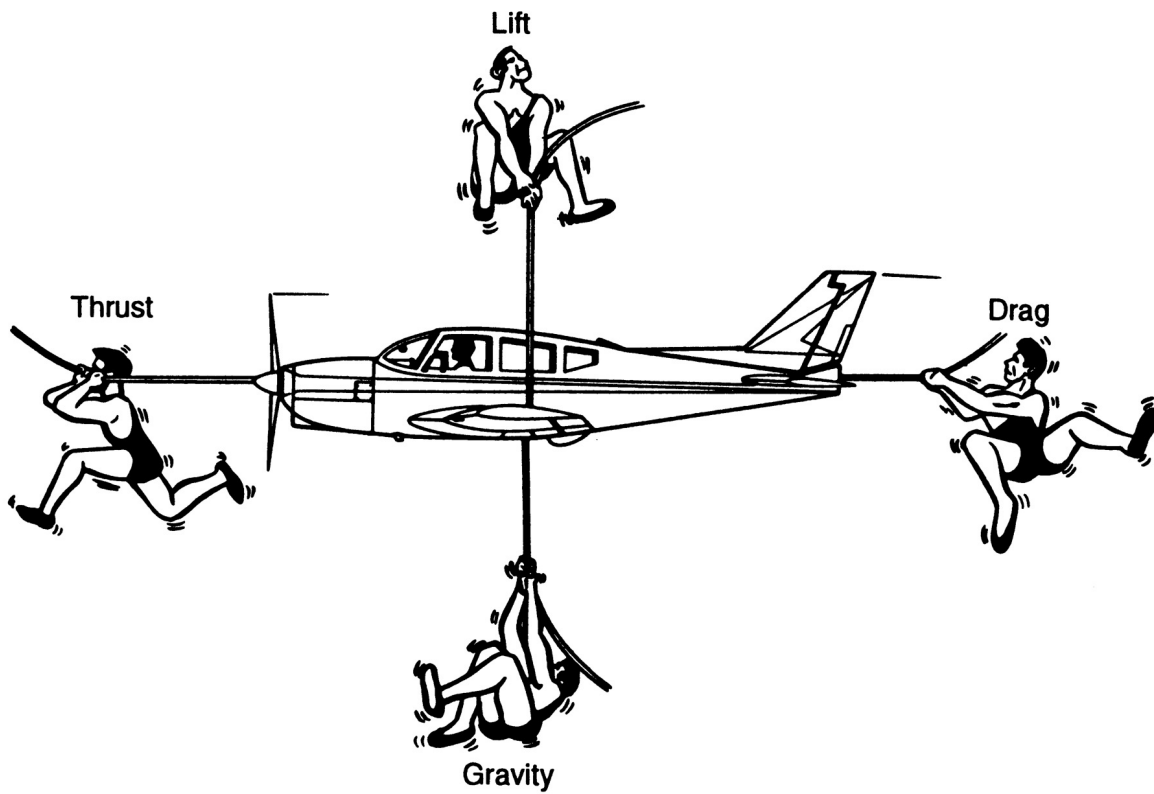
The relationship between forces

- Forces are in perfect balance only when aircraft is in straight and level unaccelerated flight.
- Lift and drag are direct result of relationship between relative wind and aircraft.
 - Lift acts perpendicular to relative wind.
 - Drag acts parallel to relative wind and in the same direction.
 - Lift and drag produce resultant lift force on wing.
- Lift and weight forces balanced — Aircraft neither gains nor loses altitude.
- Lift becomes less than weight — Aircraft loses altitude.
- Lift becomes greater than the weight force — Aircraft gains altitude.
- Thrust
 - Must overcome drag before aircraft can move.
 - Derived from jet propulsion, propeller/engine or a combination.
 - Jet propulsion — mass of air is accelerated rearward; the resulting reaction moves aircraft forward (based on Newton's third law that states for every action there is an equal and opposite reaction).
 - Propeller — rotating airfoil that is mounted on horizontal shaft; rotation causes lift in forward direction, pulling aircraft forward.

Note: *Airfoils* are specially shaped bodies designed to produce a reaction with air that passes over them. Examples include aircraft wing, helicopter rotor blade, propeller and flight controls.

Source: Oklahoma Department of Career and Technology Education

FORCES IN ACTION IN FLIGHT



Source: Oklahoma Department of Career and Technology Education

A-Z REVIEW

Student Reflection Worksheet

Your Name: _____

Date: _____

Instructions

- Think about what you have learned today.
- Write a word about what you have learned in each letter box. The word does not need to begin with that letter. Try to think of words others haven't used.
- At the end of the time given, you will get points for each word that applies. You will also get points for words no one else has written down.

Note: This activity can be done in groups or individually; your instructor will decide. Your instructor will decide the bonus for the winning individual or team.

A		N	
B		O	
C		P	
D		Q	
E		R	
F		S	
G		T	
H		U	
I		V	
J		W	
K		X	
L		Y	
M		Z	

CAREER REFLECTION WORKSHEET

Name: _____ Date: _____

Instructions

- Many factors go into deciding what career might be a good fit for you. You can be proactive and start researching careers to help you decide a career path.
- Choose 1-3 careers in Aviation & Aerospace Pathways that interest you. Use the career pathways videos and other resources that your instructor provides. Answer the questions below for each career.

1. List the career. Why does this career interest you?
2. What tools and technology does this career use? How would they make the job easier?
3. What knowledge is important to have for this career? Why is it important?
4. What skills and abilities are important to have for this career? Why are they important?
5. What work activities in this career might relate to things you already do at school, at home or at a job?
6. What about the work environment for this career would interest you?
7. Where can you develop the skills and abilities for this career?