



Lesson Title: Four Forces of Flight

Description

The Four Forces of Flight game helps students learn the terms associated with flight: lift, thrust, drag and weight.

Objectives

The students will:

- Identify the four forces of flight: lift, thrust, drag and weight.
- Explain how the four forces of flight affect the direction of flight of an airplane.
- Classify which forces of flight are positive and which forces of flight are negative (which forces oppose each other).
- Construct and play an aviation game.

NASA SUMMER OF INNOVATION

UNIT
Physical Science -- Aeronautics

GRADE LEVELS
4-6

CONNECTION TO CURRICULUM
Science, Mathematics and Technology

TEACHER PREPARATION TIME
1 hour

LESSON TIME NEEDED
1 hour Complexity: Basic

The graphic features a collage of images related to aviation and space exploration, including a rocket launch, an astronaut in a space suit, and people working in a laboratory or classroom setting.

National Standards:

National Science Education Standards, NSTA

Science as Inquiry

- Understanding of scientific concepts.
- An appreciation of "how we know" what we know in science.
- Understanding of the nature of science.
- Skills necessary to become independent inquirers about the natural world.
- The dispositions to use the skills, abilities and attitudes associated with science.

Physical Science Standards

- Position and motion of objects.
- Motions and forces.

Science and Technology Standards

- Abilities of technological design.
- Understanding about science and technology.

Common Core State Standards for Mathematics, NCTM

Operations and Algebraic Thinking

- Use the four operations with whole numbers to solve problems.
- Generate and analyze patterns.

Operations and Algebraic Thinking

- Write and interpret numerical expressions.
- Analyze patterns and relationships.

National Geography Standards, NCGE

The World in Spatial Terms

- How to use maps and other geographic representations, tools and technologies to acquire, process and report information from a spatial perspective.

ISTE NETS and Performance Indicators for Students, ISTE

Creativity and Innovation

- Use models and simulations to explore complex systems and issues.

Critical Thinking, Problem Solving and Decision Making

- Plan and manage activities to develop a solution or complete a project.

Management

Copy game board, game pieces and game cube on card stock paper. Laminate game board, game pieces and game cube so they will be more robust, and collect them to reuse again in future classes. Students play the game in small groups (from two to four).

Content Research

Key Concepts:

The four forces of flight: lift, thrust, drag and weight

- **Lift** is a force that acts upward against gravity and makes it possible for aircraft to rise in the air.
- **Thrust** is a forward force that pushes an aircraft through the air.
- **Drag** is the force of resistance to the motion of a vehicle body as it moves through a fluid such as water or air; drag acts in the opposite direction to thrust.
- **Weight** is a response of mass to the pull of gravity. It acts downward against lift. (**Gravity** is the force that pulls down on objects and gives them weight.)
- What are opposing forces? **Lift** works opposite of **weight**. **Thrust** works opposite of **drag**.

Opposing forces (lift and weight; thrust and drag; positive and negative):

- **Lift** works opposite of **weight**.
- **Thrust** works opposite of **drag**.
- **Positive** direction is either up or forward, and **negative** direction is down or backward.

Misconceptions:

Weight and gravity are the same on Earth and are sometimes used interchangeably.

Weight is a response of mass, and gravity is a force that gives weight.

(Note: This distinction is beyond the 4–6 grade level, but this is additional knowledge for the teacher and can be discussed if a student brings up the question from seeing weight and gravity used interchangeably in a four forces diagram.)

Lesson Activities

The Four Forces of Flight board game is played by students who use the four forces of flight to be the first to fly from Thrust City airport to Liftville airport. The board game contains problem solving.

http://scifiles.larc.nasa.gov/docs/guides/guide4_00.pdf

Additional Resources

The Beginner's Guide to Aeronautics Home Page

- Aircraft Motion -- interactive simulators, animated movies.
- Airplane Parts -- interactive, fact sheets.
- Aircraft Forces -- interactive, animated movies.
- Thrust -- interactive simulator, fact sheets.
- Weight -- movies, fact sheets.
- Lift -- interactive, interactive simulator, animated movies.
- Drag -- interactive simulator, fact sheets.
- Gliders -- fact sheets, paper templates.
- Wind Tunnels -- interactive simulator, fact sheets.

<http://www.grc.nasa.gov/WWW/K-12/airplane/index.html>

The Courage to Soar Educator Guide

Activity Eight -- The Four Forces of Flight

- Lesson 15 -- The Four Forces of Flight at Work.
 - Vocabulary list, student text and diagram.
- Lesson 16 -- The Pull of Gravity.
 - Vocabulary list, student text and six gravity experiments.
- Lesson 17 -- It Lifts Me Up -- The Force of Lift.
 - Vocabulary list, student text, diagram and six lift experiments.
- Lesson 18 -- The Opposing Forces of Thrust and Drag.
 - Vocabulary list, student text and experiments.
- Lesson 19 -- Thrust and Drag Experiments.
 - Vocabulary list, student text, three thrust experiments and three drag experiments.

http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/The_Courage_to_Soar.html

The 1902 Glider -- How the Problem of Control Was Solved

- Poster and Web-based resources to integrate into classroom activities.

http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/1902_Glider.html

Discussion Questions

- What is force? **Force** is a push or pull used to lift something, start it moving or hold it in place against another force.
- What is lift? **Lift** is a force that acts upward against gravity and makes it possible for aircraft to rise in the air.
- What is thrust? **Thrust** is a forward force that pushes an aircraft through the air.
- What is drag? **Drag** is the force of resistance to the motion of a vehicle body as it moves through a fluid such as water or air; drag acts in the opposite direction to thrust.
- What is weight? **Weight** is a response of mass to the pull of gravity. It acts downward against lift.
- What is gravity? **Gravity** is the force that pulls down on objects and gives them weight.
- What are opposing forces? **Lift** works opposite of **gravity**. **Thrust** works opposite of **drag**.

Assessment Activities

- Have students describe the four forces of flight, listing the parts of an airplane that affects each of the four forces.

Enrichment

Play another game using concepts of thrust, lift, weight and drag plus addition of coordinate grid chart and probability of the four different spinners.

- Rescue at Sea.

http://scifiles.larc.nasa.gov/docs/guides/guide4_00.pdf

- Materials: Game board, Spinners.
 - Extensions:
 - Add fuel consumption to the problem.
 - Make a new game board that favors a different spinner.
 - Make new spinners that would best suit the game.
 - For advanced students, create a game board that would involve positive and negative integers and that would extend into other quadrants of the coordinate plane.