



## Getting Off the Ground Into the "Smart Skies"!

### DESCRIPTION

This lesson is an entirely computer-based online mathematics-focused introduction into the Air Traffic Control (ATC) system. Using the Smart Skies: Line Up With Math activity, students learn how NASA engineers use ATC simulations to make flying safer and more efficient.

### OBJECTIVES

Students will

- Use the vocabulary of ATC and introduce them to the national airspace system
- Apply a variety of problem solving approaches, tools, skills and experiences in the context of challenging real-world problems.

**NASA SUMMER OF INNOVATION**

**UNIT**  
*Engineering—Aeronautics*

**GRADE LEVELS**  
5 – 9

**CONNECTION TO CURRICULUM**  
*Forces and Motion and Ratio and Proportion*

**TEACHER PREPARATION TIME**  
*60 minutes*

**LESSON TIME NEEDED**  
*Introductory lesson: 1 hour (includes viewing videos)*  
*Lesson Activity: 2 hours*                      *Complexity: Moderate*

The graphic features a collage of images related to aerospace and education, including an astronaut, a rocket launch, and students working on a project.

### NATIONAL STANDARDS

#### National Science Education Standards (NSTA)

*Science as Inquiry*

- Skills necessary to become independent inquirers about the natural world

*Physical Science*

- Motions and forces

*Science in Person and Social Perspectives*

- Risks and benefits
- Science and technology in society

#### Common Core State Standards for Mathematics (NCTM)

*Ratios and Proportional Relationships*

- Analyze proportional relationships and use them to solve real-world and mathematical problems

*Expressions and Equations*

- Understand the connections between proportional relationships, lines, and linear equations

*Geometry*

- Solve real-life and mathematical problems involving angle measure, area, surface area, and volume

## MANAGEMENT

View Introductory materials: Start by viewing four short introductory videos, which can be downloaded from the Smart Skies Web site. To use the simulator; computers must have required free software downloads. Additional details for teachers are on the Quick Start Guide.

## CONTENT RESEARCH

LineUp With Math was developed under Smart Skies, a key part of the NASA Airspace Systems Program's educational efforts. NASA is working with the Federal Aviation Administration (FAA) to develop advanced computer-based systems to help pilots and air traffic controllers operate the nation's air transportation system with reduced flight delays and improved efficiency and access.

Using LineUp With Math, students conduct experiments and use a variety of math methods to analyze traditional distance-rate-time problems in ATC. As students identify conflicts in these two-plane problems, they develop and apply proportional reasoning to predict distance-rate-time relationships.

## KEY CONCEPTS:

- Air traffic controllers use the same traditional distance-rate-time-type problems to solve "real world" ATC problems that students study in mathematics classes in school.
- Basic mathematics problems using proportional reasoning and prediction are essential elements in air traffic flow.
- New designs for improved ATC systems will depend on testing with models.
- Engineers must predict how each design technology for new air traffic models will affect the final result.
- Testing of the final design prior to implementation is an essential part of the design process.

## KEY TERMS:

- **Sector:** A geographic area of the airspace for which a controller is responsible.
- **Nautical Mile:** Unit of measure for distance in air and sea travel. A nautical mile is 1.15 times a statute mile used in land travel.
- **Conflict:** When two aircraft do not meet the minimum separation standards.
- **Route:** A defined path, consisting of one or more courses in a horizontal plane, which aircraft traverse over the surface of the Earth.

## MATERIALS

### Teacher Materials

- Teacher Quick Start Guide "LineUp With Math Educator Guide"
- Teacher Guide for six selected Problem Set with answers to all worksheets and solutions
- Complete set of solutions to all ATC Simulator problems

### Student Materials (per two-student group)

- Movie clips (viewed online or downloaded by student)
- ATC Simulator (viewed online or downloaded by student)
- Student Workbook for selected problem sets (#1 to #6 as needed)
- Simulator Quick Start Guide

## LESSON ACTIVITIES

The listed sequence leads the students into learning about the ATC systems and how math, science, and technology can be used to sequence different aircraft to ensure flight safety.

<http://smartskies.nasa.gov/lineup/>

Each problems set is a complete lesson with student and teacher materials.

**Problem Set A:** Students learn the basics of the airspace system and are introduced to the environment of real ATC.

**Problem Sets B and C:** Students use the interactive ATC Simulator and the Workbook to analyze conflicts between two or three planes and resolve the conflicts by rerouting.

**Problem Set D:** The workbook introduces students to the basic effects of differences in speed.

**Problem Sets E and F:** Students use the interactive ATC Simulator and the workbooks to analyze conflicts between two or three planes and to resolve the conflicts by changing plane speed.

### **ADDITIONAL RESOURCES**

Federal Aviation Administration Education: <http://www.faa.gov/education/>

How Stuff Works: <http://pustaka.ictsleman.net/how/a/air/air-traffic-control.htm>

### **DISCUSSION QUESTIONS**

- What are the major purposes of the ATC system? *ATC is a service provided by ground-based controllers who direct aircraft on the ground and in the air. The primary purpose of ATC systems worldwide is to separate aircraft to prevent collisions, to organize and expedite the flow of traffic, and to provide information and other support for pilots.*
- What is the job of air traffic controllers? *Air traffic controllers expedite and maintain a safe and orderly flow of air traffic in the global ATC system. The position of the air traffic controller is one that requires highly specialized skills.*

### **ASSESSMENT ACTIVITIES**

Observing student ATC teams as they run the simulator and completing each assigned problem will assess student progress for each activity. Solving each problem with the aircraft lined up with proper spacing without creating an aircraft “conflict” will indicate success. The teacher may want to assign weighted scores for the difficulty of each problem set.

### **ENRICHMENT**

Students can learn more about the ATC career field by viewing segments from the NASA/FAA-produced *Gate to Gate* CD. This is archived at <http://www.open-video.org/details.php?videoid=6091>