



National Aeronautics and
Space Administration
Langley Research Center
Hampton, Virginia 23681

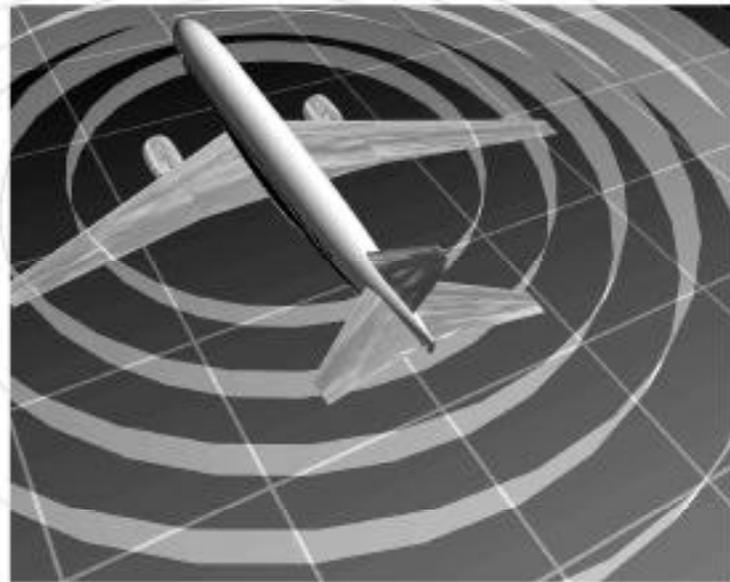
Educator's Guide

Teachers &
Students

Grades 4-8



Quieting the Skies





1998-1999 NASA CONNECT Program Overview

INTRODUCTION TO THE NASA CONNECT SERIES

NASA CONNECT is an award-winning instructional series produced by the NASA Langley Research Center's Office of Education (Hampton, VA). The series links the national mathematics and science standards to aeronautics and demonstrates the application of the standards through electronic visits by satellite and the Internet to the NASA workplace. Students engage in real or near real-time interactions with researchers and are exposed to innovative research, along with the tools and methods being used to conduct the research. The target audience is students in grades 4-8.

Each program in the NASA CONNECT series consists of a 30-minute instructional television broadcast accompanied by a web-based component designed to complement and extend the video and to facilitate the connection between the classroom and home. Inquiry into authentic questions is a central strategy used to "hook" the students into actively participating in the program and using the web components. Connections between mathematics and science concepts taught in the classroom and the workplace are emphasized.

Learning in a meaningful context is important for all students. The television and web activities within the NASA CONNECT series are linked to form in-depth investigations that can be used in flexible ways. The investigations can be complete replacement units for parts of the present school curriculum or blended with other sources to give students explanations of ideas or practice with skills that are introduced or used in basal texts. Full integration of the series teaching protocol allows for active student participation in activities, group work, data gathering, student discourse, and journal writing. The activities and investigations in NASA CONNECT will prove useful in helping upper elementary and middle school students learn mathematics and science.

The 1998-99 NASA CONNECT program season uses aeronautics and space technology (A-ST) as its organizing theme. This theme forms the creative basis for a series of five programs that demonstrate the problem-solving focus of NASA-Aero-Space Technology Enterprise research. NASA-Aero-Space Technology Enterprise goals are grouped into three areas or "Three Pillars": *Global Civil Aviation*, *Revolutionary Technology Leaps*, and *Access to Space*. These goals reflect national priorities for the NASA-Aero-Space Technology Enterprise and require taking risks and performing the long-term research and development programs needed to keep the United States the global leader in aeronautics and space exploration.

ABOUT THIS LESSON - QUIETING THE SKIES

The fifth and final program in the 1998 - 1999 NASA CONNECT series, *Quieting the Skies*, introduces the students to the science of sound and involves students in observing, measuring, and interpreting data to determine what sound is, how sound travels, and how to control sound. NASA researchers will show students how math and science are applied in the research to control aircraft noise. Students will see how NASA engineers and scientists are designing airplanes to run as quietly as cars. Students will learn how they hear sounds, how sound affects us and the environment, and how to measure sound. In this program, students will measure the speed of sound and will calculate the percentage of error in their experiment.

Quieting the Skies is a collaboration between the Federal Aviation Administration (FAA), the NASA Ames Research Center, the NASA Glenn Research Center at Lewis Field, and the NASA Langley Research Center. Additional program partners include the Children's Museum of Virginia, Lexington Public Schools (MA), Norfolk Public Schools (VA), and Roth Audiological Consulting.



PROGRAM FORMAT

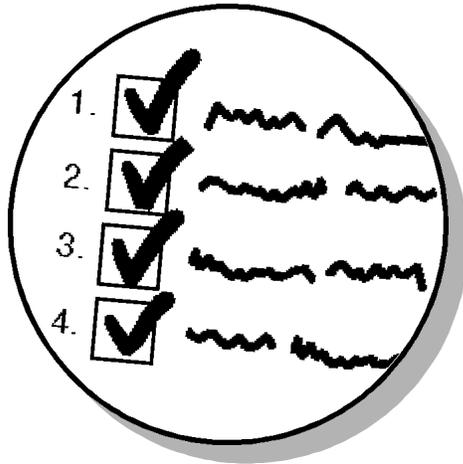
Each NASA CONNECT program includes the following:

- **Guests:** The program features program partners and a NASA engineer, scientist, or technician to illustrate the application of classroom lessons to the workplace.
- **Activities:** Students are involved in hands-on activities drawn from NASA educational products, including the National Council of Teachers of Mathematics (NCTM) math activity books, *Mission Mathematics*, developed in collaboration with NASA.
- **Students:** Middle school students who have conducted the program's experiment are highlighted. The results of their experiment are shared with viewers.
- **Challenge Point:** The programs include a pause period in the flow of the program, in which students are presented with data and, working in pairs or small groups, are encouraged to perform analysis and data interpretation.
- **Call-In/E-mail:** Students can call in following the Challenge Point portion of the program with questions related to the program topic, the activity, or the guest. Students can also e-mail questions one week prior to and two weeks following the live broadcast.
- **Print Materials:** Print materials are provided for registered educators. The materials include background on the program content and the featured activity, as well as a master copy of the Student Challenge Point Worksheets for copying and distribution to students. Also outlined is a teaching protocol for the implementation of the featured program activity and web investigation.
- **Web Site:** Throughout the program, the NASA CONNECT URL (<http://edu.larc.nasa.gov/connect>) will be displayed to indicate points where further details and/or interactive activities relating to the video presentation can be examined.

WEB FORMAT

The broadcast and the Internet are closely interwoven in the NASA CONNECT series. The series uses the Internet in several ways to enhance the teaching and learning process.

- **Inquiry Instruction:** Students are provided with questions and investigations that require them to discover the generalities of the subject on the basis of practice examples. Feedback and elaboration are provided. Students gain new insight by making observations, developing inferences, making comparisons, and interpreting data.
- **Home Connection:** Parents are encouraged to be partners in the explorations and activities. The web site provides a means for the parent and child to share in the learning process. Educators are encouraged to make parents aware of the web site and to encourage this one-on-one discovery between the parent and child about the mathematics and science concepts.
- **Internet Webcast:** Each NASA CONNECT program is webcast in real time through the Internet. Educators are encouraged to check the NASA Learning Technologies Channel (<http://quest.arc.nasa.gov/lrc/special/connect>) schedule for further details on technology requirements and the broadcast schedule.
- **Registration and Feedback:** Educators can register on-line for NASA CONNECT, can obtain broadcast schedule information for their state, can download print materials, and can evaluate the program through the NASA CONNECT web site (<http://edu.larc.nasa.gov/connect>).



NCTM* MATHEMATICS STANDARDS

- Problem Solving
- Number Sense and Numeration
- Statistics
- Measurement
- Geometry

NCTM ASSESSMENT STANDARDS

- Talking and writing about predictions and interpretation of data help students confirm their learning
- Observing which students can use a data-collections form and which students need to learn how
- Engaging students in tasks that involve problem solving, reasoning, and communication

NSTA† SCIENCE STANDARDS

- Science as Inquiry
- Science and Technology
- Science in Personal and Social Perspectives

* National Council of Teachers of Mathematics

† National Science Teachers Association



NASA CONNECT MATRIX

A simple grid can be an effective tool for integrating science and mathematic topics. The following grid will help teachers organize the concepts from the *Quieting the Skies* program that complement each other for better instruction. Teachers are encouraged to further extend and add to this grid after viewing the program and reviewing their curriculum.

Math Standards	Science as Inquiry	Science & Technology
Measurement	Measure distance to the nearest meter	NASA researchers illustrate the tools and techniques used to measure sound
Number Operations	Calculate the mean of recorded time Calculate speed of sound Calculate percentage of error	
Data Analysis	Collect data Keep records Graph results	NASA researchers show how data is collected and how the results from the data are used for on-going research
Problem Solving	Determine how weather conditions affect the speed of sound Engage in mathematical discourse to extend understanding of problem solving and capacity to reason and communicate mathematically	Technologies provide tools for investigations, inquiry, and analysis



NASA CONNECT Teaching Protocol

There is a definite difference between “doing science” and doing science activities. Classroom teachers have few opportunities to work with scientists to develop an understanding of the nature of scientific inquiry. The model proposed to educators through the NASA CONNECT series is a shift from “activitymania” – a collection of hands-on activities that are often disconnected from each other – to inquiry, in order to introduce students to the process of searching for patterns and relationships and to better develop higher order cognitive skills. Below is a six-step teaching protocol designed to prepare students for more active mental engagement with the video program so that they can make stronger connections between the NASA CONNECT program activities and appropriate mathematics and scientific concepts.

The six-step protocol includes reflective discussion, video engagement, dialogue notes, NASA CONNECT activity, journal writing, and NASA CONNECT web. This protocol is consistent with constructivist theory. A learning environment that promotes rich discourse among students is central to the approach. Student teams that engage in discovery, decision making, and problem solving give students opportunities to develop and present their findings to the entire class. The proposed format is flexible and is an effective way to teach students complex math and science concepts, to model science inquiry, and to emphasize connections.

STEP 1: REFLECTIVE DISCUSSION

Prior to viewing the NASA CONNECT program, list on the chalkboard the following questions to help students form their own theories and to give them a place to start constructing their knowledge about the show’s topic. Have students share their thoughts or write their responses. Keep these questions on the board during the video. In addition to helping students prepare for the video, these questions can also serve as a pretest for assessment purposes.

1. What effect does sound have on people and the environment?
2. How are math and science involved in studying sound?
3. What are the relationships between science and technology and sound?
4. What role do mathematics and mathematical tools have in the scientific inquiry of sound?
5. What value might collaborations and partnerships play in conducting sound research?

STEP 2: VIDEO ENGAGEMENT

1. *Sound Cards:* Students observe the NASA CONNECT hosts trying to resolve the dilemma of “quieting the skies,” that is, trying to keep sound waves created by the “Noodles” band from reaching grumpy ole Mr. Murphy. Special guests and NASA researchers provide answers to the questions: What is sound? How do we hear sound? How do we study sound? How is noise reduced? Teachers should copy the Sound Card Notes from page 7 and distribute them prior to the video showing. Encourage students to take careful “sound” notes during the video interviews with the Museum guests and the NASA researchers.
2. *Challenge Point:* Students work in cooperative groups to respond to the video’s Challenge Point segment. During the Challenge Point, students are shown data from an experiment and have a short period of time to respond to questions related to the data. A Student Challenge Point Worksheet is provided on page 9. Teachers should copy and distribute the worksheet to students prior to the Challenge Point. One calculator per student group is also recommended.
3. *Call-In/E-Mail Opportunity:* Students can call and ask questions of the NASA CONNECT guests during the call-in segment. E-mail questions can also be submitted for response one week before and two weeks following the live broadcast.
Call in with questions (accepted during the live broadcast only) at **Toll Free** 1-888-835-0026 or **Local** 864-3991. **E-mail** questions (one week before and two weeks following the live broadcast date) to **connect@edu.larc.nasa.gov**



STEP 3: DIALOGUE NOTES

1. Immediately after the video, students should spend five to ten minutes reviewing the questions in the Step 1: Reflective Discussion section (page 5). Teachers should ask students to give examples from the video presentation that support their responses to each question.
2. Review the Sound Card Notes (page 7) with students. Teachers should ask students to share what they recorded and learned from each museum guest and NASA researcher. The math and science concepts that students believe are important in the work performed by these individuals should also be discussed.
3. Return to the Student Challenge Point Worksheet (page 9) and, if necessary, provide students with additional time to complete the mathematical calculations and the data analysis. Educators should challenge students to think of different kinds of investigations that can be created from the experiment.

STEP 4: NASA CONNECT ACTIVITY

Students learn from direct teaching, engaging in classroom discussion, conducting research, and taking notes. During the NASA CONNECT video, an experiment is described. This activity is provided for the classroom teacher to use as a math/science lab. When using the NASA CONNECT Activity (page 10), introduce students to the vocabulary, guide students toward connections, and explore possible misconceptions associated with sound. Data collected from the classroom activity can then be compared with the data collected by the Ruffner Middle School students and highlighted in the video. Finally, have your students relate the results of their classroom activity to the NASA research presented in the video.

STEP 5: JOURNAL WRITING

Journal writing supports students' reflective thinking processes. Students should reflect on what they learned from the video and from their own experimentation. Educators can also ask students questions that relate to the real-life applications of the concepts in the video and their lab experiment. Educators might use journal questions to assess student understanding of the concepts presented in the lesson guide.

What is the "flap" about noise? Have students write a pro and con news article using this headline question and relating it to a community where the issue is whether an increase in the number of airplanes landing and taking off from the local airport should be approved.

STEP 6: NASA CONNECT WEB

The web site uses the inquisitory instruction strategy to place students in a contextual environment to encourage them to understand the math and science concepts and skills presented in the program and to present multiple perspectives to specific questions raised in the video. A series of activities is incorporated into the NASA CONNECT web site for each program to augment the video theme and to provide additional opportunities for students to perform multiple trials and share their data with others. Also, from the web site, students might submit E-mail questions to the on-air program guests up to two weeks following a live broadcast.

Teachers might use this site to establish a connection between the classroom and the family by sending home a notice about the NASA CONNECT program and its Internet URL and by encouraging parents to explore this site and complete the activities with their children.

The web site for *Quieting the Skies* contains three elements: **(1) the Sound Machine** – an animated dictionary of sound terms, **(2) the NASA Kid Quiz** – a check of student understanding of sound concepts, and **(3) the Career Corner** – which depicts aerospace professionals involved in acoustics research.

Sound Card Notes

(Use this sheet when viewing the *Quieting the Skies* video.)

What is sound and how does it travel?

Leslie Bowie, Museum Curator



How do humans hear sound and how might sound affect learning?

Lynnette Roth, Audiologist



Describe how the “effects of sound on people” is being studied.

Brenda Sullivan, Psychoacoustician



**What are some sources of airplane noise?
What is NASA doing to reduce airplane noise?**

Rich Silcox, Senior Research Engineer
Martha Jones, Nozzle Researcher





Built within the program is a pause period (approximately four minutes) during which students will be asked to look at data and, working in pairs or small groups, respond to questions, one at a time, as listed in the Student Challenge Point Worksheet (page 9). The pause point provides students the opportunity to make inferences from the data and for teachers to apply the NCTM and NSTA standards presented in the lesson.

During the Challenge Point Period

Teacher as Facilitator

1. Depending on the number of students and student ability, teachers may wish to have a large group or to divide students into pairs or smaller groups. This grouping should be done before the program.
2. The teacher should act as a facilitator during this program time, supporting and guiding the students in discussion and in responding to the student challenge point questions.

Student as Researcher

By working in pairs or small groups, students can imitate NASA research teams as they work together to analyze and interpret findings and to communicate results in written, oral, and graph forms. Students should

1. Observe the data provided by students from Ruffner Middle School (Norfolk, VA) as it appears on the screen.
2. Formulate answers to the questions as read aloud by the NASA researcher.
3. Review answers in light of the responses provided at the end of the Challenge Point.



Student Challenge Point Worksheet

(Use this sheet during the Challenge Point segment of the program.)

Distance (m)	Mean Time (sec)	Calculated Value (m/sec)	Accepted Value* (m/sec)	Percentage of Error
50	.22	227.3	337.5	
100	.39	256.4	337.5	24
200	.70	285.7	337.5	15
300	.99	303.2	337.5	

* The accepted value is based on an air temperature of 10° C (50° F).

Challenge Point Questions:

1. As the distance increased from 50 m, what happened to the mean time?

2. Use the formula % of Experimental Error = $\frac{\text{Calculated Value} - \text{Accepted Value}}{\text{Accepted Value}} \times 100$ to calculate the percentage (%) of error at 50 m and 300 m.

Why do you think they are different?

3. The speed of sound is directly proportional to air temperature. Is the speed of sound faster in the summer or winter? Why?



NASA CONNECT Activity

Sound is a form of energy and the world is full of sound. Sound waves travel at different speeds or rates in different substances (e.g., solids, liquids, gases) and under various conditions. This activity affords students the opportunity to measure the speed of sound and to calculate the percentage of experimental error.

PREPARING FOR THE ACTIVITY

These books, web sites, and vocabulary help establish a context for the activity.

Books

Darling, Daniel. (1991) Sounds Interesting: The Science of Acoustics. New York, NY: Maxwell Macmillan.

Ward, Alan. (1991) Experimenting with Sound. New York, NY: Chelsea House Publishers.

Websites

http://www.exploratorium.edu/science_explorer/secret_bells.html

http://www.exploratorium.edu/science_explorer/ear_guitar.html

http://www.exploratorium.edu/science_explorer/can.html

Vocabulary

Acoustics - the scientific study of sound.

Doppler Effect - the change in pitch (frequency) between an approaching sound source and a receding one.

Frequency - the periodic change in sound pressure. Frequency is measured in cycles per second or in Hertz (Hz). A sound wave has a frequency of "n" Hz if in one second it goes through "n" cycles.

Intensity - the average rate at which sound energy is transmitted through an area between a source and a receiver. Sound energy is measured in watts/cm² or in decibels (dB).

Noise - sound with no set patterns in rhythm or frequency.

Pitch - the highness or lowness of a sound.

Resonance - the vibration of an object when exposed to sound at its own natural frequency, as in a window pane vibrating when a helicopter flies overhead.

Ultrasound - sound that is too high in frequency to be heard by the human ear.

SOME SOUND ADVICE

Sound is one of the most important ways we have of sensing our surroundings and of communicating with others. The following information is presented to help the reader develop a better understanding of sound. How is sound made and how does it travel?

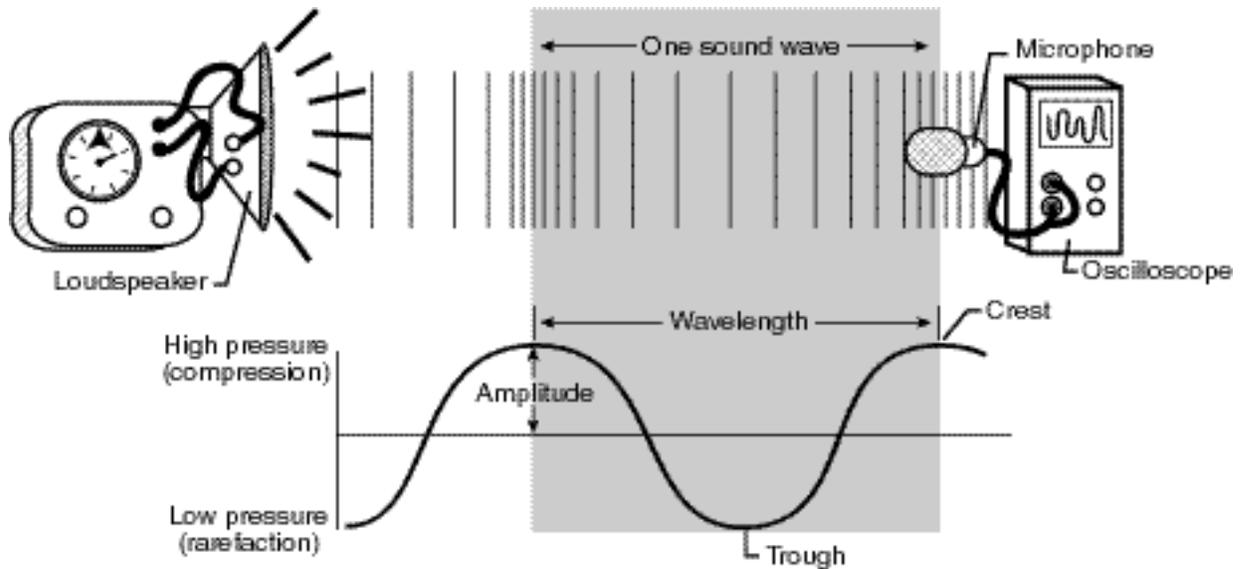
- Sound is produced by vibrating objects.
- Sound is transmitted through the air and can travel through solids, liquids, or gas. Question: Can sound travel in a vacuum?
- As seen in the chart, sound travels slowly in air compared to solids and liquids.

	Solid Steel	Sea water	Air
Speed of sound in m/sec at 21°C (70°F)	5,182	1,524	344

(The speed of sound in air is 331.5 m/sec at 0°C and increases by 0.6 m/sec for each degree thereafter.)

NASA CONNECT Activity Continued...

- The speed of sound changes with altitude. At 12-km altitude, the speed of sound is about 293 m/sec or 655 mph.
- The speed of sound is dependent (directly proportional) to temperature.
- Sound waves are longitudinal: they move by alternately squeezing (compression) and stretching (rarefaction). Sound waves can be monitored by connecting a microphone and speaker wires to an oscilloscope.



- Wave science: Frequency = No. of waves/sec
- Velocity = wave length X frequency
- Frequency of sound and pitch are related – the higher the pitch, the greater the frequency.
- Frequency and pitch vary according to the length of a vibrating object such as wind chimes.
- Multiple sound waves can reinforce or interfere with each other.
- Sound insulation is designed to absorb sound energy. Many of the same materials used in temperature insulation can also be used to reduce sound.
- The normal range of sound that humans can hear is 40-18,000 Hertz (Hz).
- Many domestic animals (e.g., dogs) and wild animals (e.g., bats) can detect a wider range of sound frequencies than humans can.
- Sound can be reflected or refracted; that is, sound can bounce off or go around objects.
- Sound levels decrease rapidly as the distance from the point of origin or transmission to the receiver increases.

Source	Decibel Rating
Jet plane at takeoff	110-140 dB
Loud rock music	110-130 dB
Chain saw	110-120 dB
Storm	40-110 dB
Vacuum cleaner	60- 80 dB
Normal voices	50- 70 dB
Purring cat	20- 30 dB
Whisper	20- 50 dB
Falling leaves	10 dB

NASA CONNECT Activity Continued...

CLASS REFLECTION/JOURNAL

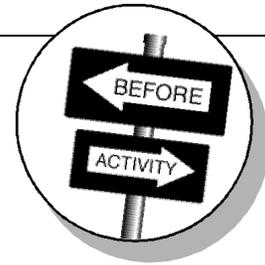
Listed below are questions that can be used to further establish a context for understanding sound and for preparing students for the activity.

1. If you could not hear a powerful, low frequency sound, how might you be able to detect it? (You can feel it. Heavy machinery and thunder can cause vibrations.)
2. As a siren approaches, does the pitch increase or decrease? Why? (Increase) (The waves are compressed to form a higher frequency. This change in shift is called the Doppler shift.)
3. Would a long or a short pipe produce a high pitch? Why? (A short pipe.)
4. What household items help reduce household noise? (Carpets, draperies, or other porous materials such as ceiling tiles.)
5. Before a storm or earthquake, animals may show signs of agitation. Why? (It is possible they are hearing sounds humans cannot hear.)
6. How would you go about studying noise?
7. Is sound absorbed by hard or soft surfaces? (Soft)
8. Is sound reflected by hard or soft surfaces? (Hard)

BEFORE BEGINNING THE ACTIVITY

1. Secure the following materials:

- 2 pots or pans
- Cardboard box
- 4-6 sheets of tissue paper
- Sewing thread
- Confectionery powdered sugar (flour may be substituted)
- Tablespoon
- Tape - masking or transparent
- 4-8 stop watches
- Long (100 m) measuring tape or distance wheel
- Approximately 2 m black or other dark bulletin board paper
- Celsius thermometer
- Large open field
- 4 disposable masks
- 4 goggles
- 1 hat
- 1 plastic raincoat or plastic parka to protect clothes (a sheet of cloth or plastic fastened at the neck with a clothes pin will also work fine)
- Calculator
- Ear plugs (obtained at most drug and hardware stores)



2. Visit the web sites, review the vocabulary, and discuss the “Sound Advice” concepts (page 10).

3. Make copies of the Student Challenge Point Worksheet (page 9).

4. Pour one or two tablespoons of powdered sugar or flour into the middle of four sheets of tissue paper.

5. Tie each bag with approximately one foot of sewing thread to form four bags (Make two extra bags in case of breakage.)

NASA CONNECT Activity Continued...

6. Put bags inside cardboard box to be taken outside.

7. Divide the class into four to six groups. Duties for the groups are as follows:

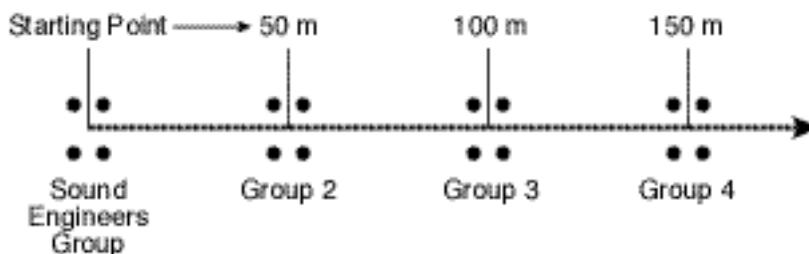
Group 1: Comprised of Sound Engineers, Sound Person, and Sound Assistant. The Sound Engineers wear goggles, masks, and ear plugs. They attach powder bags to pans. The Sound Person produces sound "bang." The Sound Assistant holds bulletin board paper behind "Sound person."

Group 2-6: Comprised of Linear Speed Engineers who measure and record the air temperature in degrees Celsius, measure the distance between sound points in meters, and record the time it takes the sound to travel (in seconds).

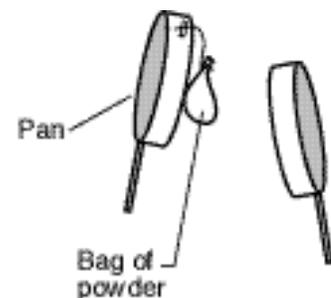
CONDUCT THE ACTIVITY

Follow these directions to complete the activity:

1. Record weather conditions (e.g., windy) and outdoor air temperature in degrees Celsius.
2. Have groups assemble outdoors as shown below:



3. Have Sound Engineers put on goggles, masks, and ear plugs. Sound Person should also put on hat and clothes protector.
4. Have Sound Person clash the pans together to acquaint the Linear Speed Engineers with the sound to listen for. It may help to synchronize striker and timers if striker calls out a countdown, "three, two, one," before striking, or if assistant lowers an arm as a signal to start.
5. Have the Linear Speed Engineers, Groups 2 - 6, take their places in the field to measure the distance, 50 meters between "sound" points.
6. Have the Sound Engineers attach the string on the bag of powder to one pan with tape so it hangs down in the middle outside the pan bottom.
7. Wave the empty pan in the air to signal everyone to be ready!
8. Slam the two pans together to burst the bag, and produce the bang!
9. Linear Speed Engineers are to start their stop watches at the first sign of white smoke and to stop them as soon as the sound is heard! (You need to react quickly.)
10. Each group records its times on the NASA Connect Activity Student Worksheet in the Group Time Trial Chart (page 17).
11. Repeat the entire procedure three times. Students will record three times, T_1 , T_2 , and T_3 .
12. Return to the classroom to complete the group's calculations.
13. Each Linear Speed Engineer group determines the average of its group's times and, using that information, calculates the experimental speed of sound for the distance:
Speed = Distance/Time ($S = D/T$).



NASA CONNECT Activity Continued...

14. The Sound Engineer group should calculate the accepted value for the speed of sound at the recorded outside temperature using the formula:

The accepted value for the speed of sound in air is 331.5 m/sec at 0°C, plus 0.6 m/sec for each degree Celsius above 0°C. Temperature Celsius = (5/9) x (Temp Fahrenheit - 32).

15. Post each group's results on the Speed of Sound Chart on the NASA Connect Activity Student Record Sheet (page 17). Make a plot of speed versus distance for each group.
16. Finally, calculate the percentage of error in the experiment. First, have students find the difference between the experimental (what they measured) and the accepted speed of sound at a given temperature. Then, have them plug information into the listed equation and compute:

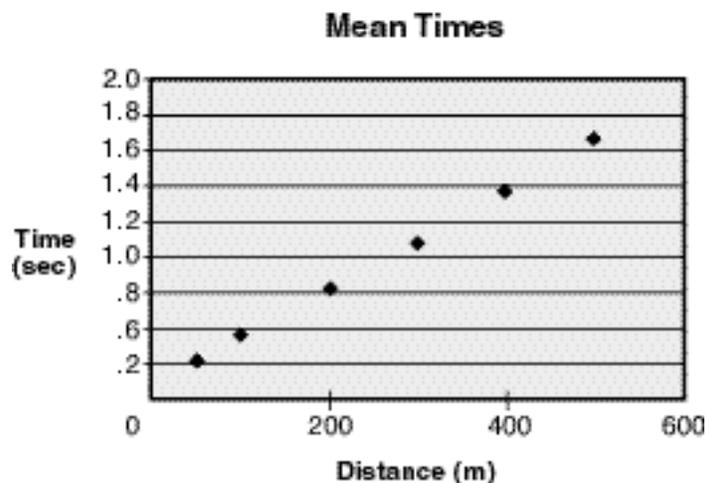
$$\text{Percentage error} = \frac{(\text{Calculated value} - \text{Accepted value})}{(\text{Accepted value})} \times 100$$

Students should review their observations and data and respond to these questions in their logs.

1. What caused the differences in the average times between the Linear Speed Engineer groups? Which group had the highest percentage of error?
2. Did the weather conditions affect the results of the activity? If so, how?
3. What other factors can be identified that could affect the results of the activity?

EXTENDING THE ACTIVITY

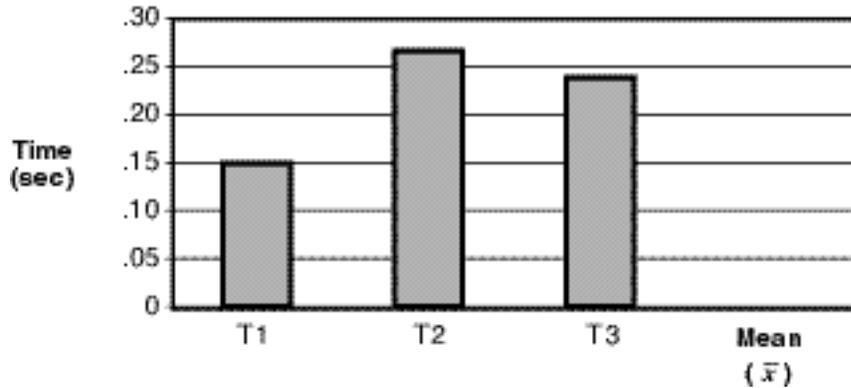
1. Visit the *Quieting the Skies* web site at: <http://edu.larc.nasa.gov/connect/quiet.html>
2. Using data collected and plotted from the NASA Connect Activity, have students make comparisons, predictions, and inferences.



- A. Using the above graph, find the mean time at 400 meters.
- B. Estimate the mean time at 600 meters.
- C. Is the mean time at 0 meters equal to zero? Is a measurement at 0 meters possible?

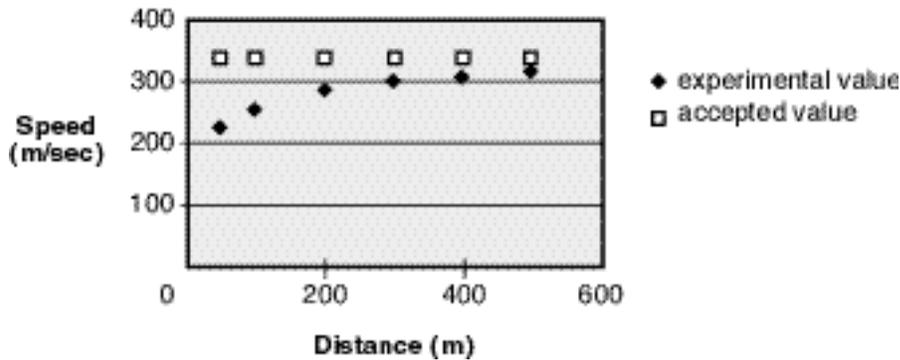
NASA CONNECT Activity Continued...

Group Data at 50 Meters



- A. Suppose the three times in the graph above were recorded by a student at 50 meters from the sound source. What is the longest time recorded? What is the shortest?
- B. Calculate the mean (i.e., the average of the three times).
- C. Plot the mean value as a bar on this graph.

Speed of Sound



- A. What is the experimental value for the speed of sound calculated by students at 200 meters?
- B. What is difference between the experimental and accepted value for the group at 200 meters?
- C. Which group seems to have the greatest error? Why do you think this is the case?

3. Have students conduct or complete the following activities.

A. Length of Vibrating Object and Change in Pitch

Supplies: Empty Christmas wrapping tubes, Bounty paper tubes, and cutter.

1. Let's form a rock group: "The Bounties and the Tubes"!
2. Leave one tube full length. Cut the other tubes into various lengths.
3. Hold your mouth open, "bonk" yourself on the head with a tube and listen to the sound.
4. Compare the sound the full-length tube makes to the sounds the different length tubes make.
5. Line everyone up by tube size and have the teacher or a student point to alternating people. See if you can create a tune!
6. What did you learn about how the length of a vibrating object affects pitch?

NASA CONNECT Activity Continued...

B. Decibels, Sound Transmission, and Sound Insulation

Supplies: Several metal cans of various sizes (check with your school's cafeteria)

(Smallest can must be large enough to hold a sound source.)

Sound source (smoke detector or bicycle siren)

Sound meter (check school system's science supply center)

Available from Radio Shack : digital model # 33 - 2055 -- \$59.99

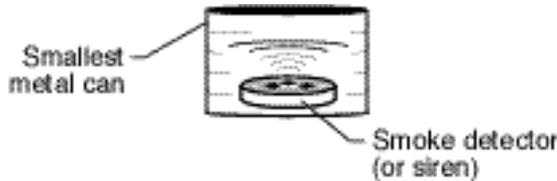
and analog (needle) model # 33 - 2050 \$34.99

Meter stick

Duct tape or other large strong tape

Fiberglass/foam insulation/loose fill insulation (vermiculite, perlite, cellulose (chopped paper), etc.)

1. Set detector or siren on table. Remove cover on detector.
2. Set sound meter on table 1 meter away (be sure to point toward sound source).
3. Turn on sound (use tape to hold switch down) and record reading.
4. Put smallest metal container over sound source.



5. Record reading.
6. Put next size larger can over first can, leaving an air space between each.



7. Record reading.
8. If available, try another can that gives you two air spaces.
9. Remove all cans and cut off sound. Turn cans right side up.
10. Put two cans inside each other and pack air space with insulation. Put tape on top of insulation to hold it in.



11. Turn on sound source and insert two cans over it.
12. Record reading.
13. Repeat steps 9 - 12 with other available types of insulation.
14. Make a chart showing what you used and its decibel rating.



NASA Connect Activity Student Record Sheet

Group _____

Temperature _____ °C

Distance _____ M

Group Time Trial Chart				
	Trial 1	Trial 2	Trial 3	Mean*
Time (sec)				

Speed of Sound				
Distance (m)	Mean Time (sec)	Calculated Value [†] (m/sec)	Accepted Value [§]	Percentage of Error [‡]
50				
100				
150				
200				
250				
300				

Formulas			
$*Mean = \frac{T_1 + T_2 + T_3}{3}$	$† Speed = \frac{Distance}{Time}$	$§ 331.5 \text{ m/s at } 0^\circ \text{C plus } 0.6 \text{ m/s for each degree Celsius above } 0^\circ \text{C}$	$‡ \frac{Calculated - Accepted Value}{Accepted Value} \times 100$



NASA Aeronautics Educator Resources

The NASA Aero-Space Technology (A-ST) Enterprise and educational communities are partners in developing materials to stimulate student interest and enthusiasm for mathematics and science. By augmenting learning environments with ideas and experiences that use mathematics and science, we share with students and educators the excitement of how these tools can be used and how their power can change the world.

NASA ON-LINE AERONAUTICS PROJECTS

Follow these on-line links to more aeronautics-related projects that provide curriculum, interactive materials, activities, and more, as developed by the NASA A-ST Centers and Learning Technologies Project (LTP) Offices and by external partners through LTP-funded electronic projects.

Aeronautics and Aviation Science Careers and Opportunities (Massachusetts Corporation for Educational Telecommunications)	http://mcet.edu/nasa
Aeronautics Learning Laboratory for Science, Technology and Research (ALL STAR) (Florida International University)	http://allstar.fiu.edu/aero
Internet-based Curriculum on Math and Aeronautics for Children with Physical Disabilities (InfoUse, Inc.)	http://planemath.com/
K-8 Aeronautics Internet Textbook (Cislunar Aerospace, Inc.)	http://wings.ucdavis.edu/
Kids Corner (NASA Langley)	http://kidscorner.larc.nasa.gov/
Lego Data Acquisition and Prototyping System (Tufts University)	http://ldaps.ivv.nasa.gov/
NASA Aeronautics Enterprise Web Ground School (NASA Headquarters)	http://www.hq.nasa.gov/office/aero/edu/
Sharing NASA (NASA/Ames)	http://quest.arc.nasa.gov
Wright Flyer Online (NASA/Ames)	http://quest.arc.nasa.gov/aero/wright/

NASA ON-LINE RESOURCES FOR EDUCATORS

NASA Spacelink (<http://spacelink.nasa.gov>) is one of NASA's electronic resources specifically developed for use by the education community. This comprehensive electronic library offers teacher guides, wall sheets, and listings of videos, computer software, and other materials that have been developed to meet national education standards. Educators can search specific curriculum materials by grade level and subject matter. Current and historical information related to NASA's aeronautic and space research can be found from Spacelink. Links to NASA ERC, CORE, news releases, current state reports on agency projects and events, and television broadcast schedules for NASA Television are also provided.



Quest (<http://quest.arc.nasa.gov>) is the home of NASA's K-12 internet Initiative. The electronic resource specializes in providing programs, materials, and opportunities for teachers and students to use NASA resources as learning tools to explore the Internet. One of its unique projects is "Sharing NASA," a series about on-line, interactive units where students can communicate with NASA scientists and researchers to experience the excitement of real science in real time. During the 1998-99 academic year, Aero Design Team On-line will be a featured project of "Sharing NASA."

Learning Technologies Channel (LTC) (<http://quest.arc.nasa.gov/ltc/>) is a NASA location on the Internet that allows you to participate in on-line courses and to remotely attend some NASA workshops and seminars. A primary focus of the LTC is to broaden the uses of the Internet to include in-service teacher training and to bring new internet experiences into the classroom.

NASA CENTRAL OPERATION OF RESOURCES FOR EDUCATORS (CORE)

NASA's CORE is a worldwide distribution center for NASA multimedia educational materials. Educational materials include videotape programs, slide sets, and computer software. For a minimal fee, NASA CORE will provide educators with materials through its mail order service. A free NASA CORE catalog is available.

NASA CORE
15181 State Route 58
Oberlin, OH 44074-9799
phone: (440) 775-1400
fax: (440) 775-1460
E-mail: nasaco@leeca.esu.k12.oh.us
URL: <http://core.spacelink.nasa.gov>

NASA EDUCATIONAL PROGRAMS AND MATERIALS

The widest possible distribution and use of NASA educational programs and materials is encouraged. Specifically, there is no claim of copyright by the U.S. Government concerning the NASA CONNECT series. Therefore, permission is not required to either tape each broadcast or to copy the associated print materials for classroom use and/or retention in your school's library.

ADDITIONAL ON-LINE RESOURCES

NASA CONNECT partners provide additional on-line resources that relate to the *Quieting the Skies* program.

Federal Aviation Administration (FAA)	http://www.faa.gov/education
Department of Transportation (DOT)	http://www.dot.gov/edu
Garrett A. Morgan Technology and Transportation Futures Program	http://education.dot.gov



NASA EDUCATOR RESOURCE CENTERS (ERC)

The NASA ERC Network is composed of Educator Resource Centers located at or near all NASA installations and ERCs located at planetariums, universities, museums, and other nonprofit organizations nationwide. These centers supply instructional activities, videotapes, slides, and computer software generated by NASA programs, technologies, and discoveries. These materials are designed for educators of all disciplines and are aligned to the national education standards.

For more information on NASA education programs and aeronautics-related materials, educators may contact the ERC at the following NASA Centers. The NASA field centers that have leading roles and responsibilities in the Aero-Space Technology (A-ST) Enterprise are in bold face:

AK, AZ, CA, HI, ID, MT, NV, OR, UT, WA, WY

NASA Ames Educator Resource Center
Mail Stop 253-2
Moffett Field, CA 94035-1000
(650) 604-3574

CA cities near the center

NASADryden Educator Resource Center
45108 North Third Street East
Lancaster, CA 93535
(805) 948-7347

CT, DE, DC, ME, MD, MA, NH, NJ, NY, PA, RI, VT

NASA Goddard Educator Resource Center
Mail Code 130.3
Greenbelt, MD 20771-0001
(301) 286-8570

CO, KS, NE, NM, ND, OK, SD, TX

NASA Johnson Educator Resource Center
Mail Code AP2
2101 NASA Road One
Houston, TX 77058-3696
(281) 483-8696

NASA JPL Educator Resource Center

Mail Stop 601-107
4800 Oak Grove Drive
Pasadena, CA 91109-8099
(818) 354-8080 - fax

FL, GA, PR, VI

NASA Kennedy Educator Resource Center
Mail Code ERL
Kennedy Space Center, FL 32899-0001
(407) 867-4090

KY, NC, SC, VA, WV

NASALangley Educator Resource Center
Virginia Air and Space Center
600 Settlers Landing Road
Hampton, VA 23669-4033
(757) 727-0900, ext. 757

IL, IN, MI, MN, OH, WI

NASAGlenn Educator Resource Center
Mail Stop 8-1
21000 Brookpark Road
Cleveland, OH 44135-3191

AL, AR, IA, LA, MO, TN

NASA Marshall Educator Resource Center
U.S. Space and Rocket Center
P.O. Box 070015
Huntsville, AL 35807-7015
(205) 544-5812

MS

NASA Stennis Educator Resource Center
Building 1200
Stennis Space Center, MS 39539-6000
(601) 688-3338

VA's and MD's Eastern Shore

NASA Wallops Educator Resource Center
Education Complex - Visitor Center
Building J-1
Wallops Island, VA 23337-5099
(757) 824-2297/2298



**FEDERAL AVIATION ADMINISTRATION
AVIATION EDUCATION PROGRAM MANAGERS**

National Program: Phillip S. Woodruff, AHT-100
FAA Headquarters
Aviation Education Program
800 Independence Avenue SW
Tele: (202) 267-3788
Fax: (202) 267-7737

Aeronautical Center: Robert L. Hoppers, AMC-3
FAA Mike Monroney Aeronautic Center
P.O. Box 25082
Oklahoma City, Oklahoma 73125
Tele: (405) 954-5332
Fax: (405) 954-4779

Technical Center: Carleen Genna-Stoltzfus, ACT-70
FAA William J. Hughes Technical Center
Atlantic City International Airport
Atlantic City, New Jersey 08405
Tele: (609) 485-6515
Fax: (609) 485-4825

Tom Christian, ACT-10
FAA William J. Hughes Technical Center
Atlantic City International Airport
Atlantic City, New Jersey 08405
Tele: (609) 485-6182
Fax: (609) 485-6660

Alaskan Region: Alice L. Gommol, AAL-233 Alaska
FAA Alaskan Region
222 West 7th Avenue, #14
Anchorage, Alaska 99513-7587
Tele: (907) 271-3017
Fax: (907) 276-6207
alice.l.gommoll@faa.gov

Central Region: Maria Z. Navarro, ACE-41F Iowa
FAA Central Region Kansas
Room 1514 Missouri
601 East 12th Street Nebraska
Kansas City, Missouri 64106
Tele: (816) 426-6547
Fax: (816) 426-3124
Maria.Navarro@faa.gov

Eastern Region: Mary Ann Poindexter, AEA-60 Delaware
FAA Eastern Region Maryland
John Fitzgerald Building New Jersey
JFK International Airport New York
Jamaica, New York 11430 Pennsylvania
Tele: (718) 553-3363 Virginia
Fax: (718) 995-5663 West Virginia
Maryann.Poindexter@faa.gov



**FEDERAL AVIATION ADMINISTRATION
AVIATION EDUCATION PROGRAM MANAGERS (CONT.)**

Great Lakes Region	Estela Hamersma, AGL-4 FAA Great Lakes Region O'Hara Lake Office Center 2300 East Devon Avenue Des Plaines, Illinois 60018 Tele: (847) 294-7106 Fax: (847) 294-7184 Estela.Hamersma@faa.gov	Illinois Indiana Michigan Minnesota North Dakota Ohio South Dakota Wisconsin
New England:	Sheila Bauer, ANE-40 FAA New England Region 12 New England Executive Park Burlington, Massachusetts 01803 Tele: (781) 238-7378 Fax: (781) 238-7377 Sheila.Bauer@faa.gov	Connecticut Maine Massachusetts New Hampshire Rhode Island Vermont
North Mountain Region:	Megan Pursell, ANM-15 FAA Northwest Mountain Region 1601 Lind Avenue SW Renton, Washington 98055 Tele: (425) 227-1725 Fax: (425) 227-1010 Megan.Pursell@faa.gov	Colorado Idaho Montana Oregon Utah Washington Wyoming
Southern Region:	Opal R. Neely, ASO-17B FAA Southern Region 1701 Columbia Avenue College Park, GA 30337 Tele: (404) 305-5310 Fax: (404) 305-5311 Opal.Neely@faa.gov	Alabama Florida Georgia Kentucky Mississippi North Carolina South Carolina Tennessee
Southwest Region	Debra Myers, ASW-18B FAA Southwest Region 2601 Meecham Blvd Fort Worth, Texas 76137-4298 Tele: (817) 222-5833 Fax: (817) 222-5950 Debra.Myers@faa.gov	Arkansas Louisiana New Mexico Oklahoma Texas
Western Pacific Region:	Hank Verbais, AWP-4 Program Manager, External Services FAA Western Pacific Region P.O. Box 92007 WPC Los Angeles, California 90009 Tele: (310) 725-3802 Fax: (301) 536-8404 Hank.Verbais.@faa.gov	Arizona California Hawaii Nevada



Return by Fax to: (757) 864-8835

1998-99 NASA CONNECT Series Program Evaluation

About the Program

- 1. The program was used (please circle)
a. to introduce a curriculum topic, objective, or skill. Yes No
b. to reinforce a curriculum topic, objective, or skill. Yes No
c. as a special interest topic. Yes No
d. other (please specify)
2. The program was viewed Live Videotaped
3. Indicate the grade level(s) that viewed the program: 4 5 6 7 8
Other (please specify)

The Program's Value

Please circle the number that best reflects your opinion.

Table with 7 columns: Item, Strongly Disagree, 1, 2, 3, 4, Strongly Agree, No Opinion. Rows 4-12 describe program objectives, content alignment, integration, and technical aspects.

The Lesson Guide/Classroom Activity's Value

Table with 7 columns: Item, Strongly Disagree, 1, 2, 3, 4, Strongly Agree, No Opinion. Rows 13-15 describe lesson guide completeness and classroom activity appropriateness.

Overall Evaluation

Table with 7 columns: Item, Strongly Disagree, 1, 2, 3, 4, Strongly Agree, No Opinion. Row 16: The program was a valuable instructional opportunity.

Please record any comments or suggestions on an additional sheet of paper and fax with this form.

Evaluator's Characteristics (please circle)

- 17. Gender: Female Male
18. Ethnicity: African American Asian Caucasian Hispanic Native American Pacific Islander Other (please specify)
19. Highest Degree attained: Baccalaureate/BA or BS, Master's/Master's Equivalency, Doctorate
20. Total years' teaching experience