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Hampton, VA 23681-2199

Educational Product	
Educators	Grades 6-8

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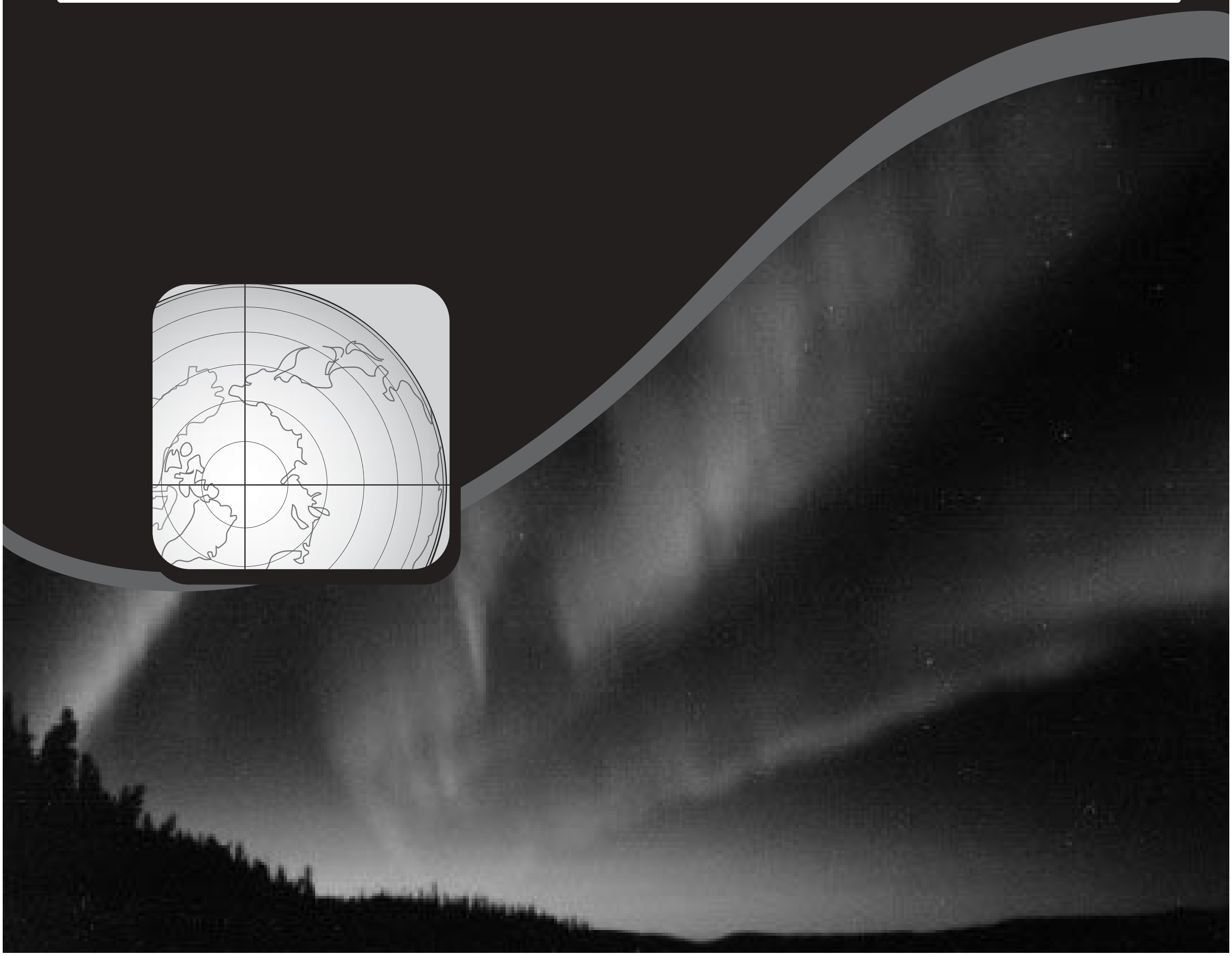
NASA CONNECT™

Data Analysis and Measurement: Dancing in the Night Sky

An Educator Guide with Activities in Mathematics, Science, and Technology



Data Analysis and Measurement: Dancing in the Night Sky is available in electronic format through NASA Spacelink - one of NASA's electronic resources specifically developed for the educational community. This publication and other educational products may be accessed at the following address: **http://spacelink.nasa.gov/products**

A PDF version of the educator guide for NASA CONNECT™ can be found at the NASA CONNECT™ web site: **http://connect.larc.nasa.gov**

NASA CONNECT™ is produced by the NASA Center for Distance Learning, a component of the Office of Education at NASA's Langley Research Center, Hampton, VA. The NASA Center for Distance Learning is operated under cooperative agreement NCC-1-02039 with Christopher Newport University, Newport News, VA.

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NASA CONNECT™

Data Analysis and Measurement: Dancing in the Night Sky

An Educator Guide with Activities in Mathematics, Science, and Technology

AIAA FOUNDATION Registered users of NASA CONNECT™ may request an American Institute of Aeronautics and Astronautics (AIAA) classroom mentor. For more information or to request a mentor, e-mail **nasaconnect@aiaa.org**.

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Program Overview

SUMMARY AND OBJECTIVES

In *Data Analysis and Measurement: Dancing in the Night Sky*, students will learn about the Aurora Borealis or Northern Lights. They will learn the many legends and myths that have revolved around the aurora throughout the history of mankind. Students will also discover how NASA scientists and engineers use satellite technology to measure and analyze aurora data. They will see how Norwegian scientists apply the concepts of data analysis and measurement to study the Northern Lights by using ground-based instruments and sounding rockets. By conducting hands-on and web activities, students will make connections between NASA research and the mathematics, science, and technology they learn in their classrooms.

STUDENT INVOLVEMENT

Cue Card Questions

Norbert, NASA CONNECT's™ animated co-host, poses questions throughout the broadcast. These questions direct the instruction and encourage students to think about the concepts being presented. When viewing a videotaped version of NASA CONNECT™, educators have the option to use the Cue Card Review, which gives students an opportunity to reflect and record their answers on the Cue Cards (p.15). NASA CONNECT's™ co-host, Jennifer Pulley, will indicate an appropriate time to pause the videotape and discuss the answers to the questions.

Hands-On Activity

The hands-on activity is teacher created and is aligned with the National Council of Teachers of Mathematics (NCTM) Standards, the National Science (NSE) Standards, and the International Technology Education Association (ITEA) Standards. Students will apply the concepts of data analysis and measurement to plot the auroral oval in the northern hemisphere and determine the height of the northern lights using Carl Stormer's triangulation method.

Free Fall Web Activity

The Aurora Web Activity is aligned with the National Council of Teachers of Mathematics (NCTM) Standards, the National Science (NSE) Standards, and the International Technology Education Association (ITEA) Standards. Using a free, exciting, and object-oriented programming environment called Squeak, students will work collaboratively to investigate the possibility of auroras on other planets. To access the Aurora Web Activity, go to the NASA CONNECT™ web site at <*http://connect.larc.nasa.gov*>.

RESOURCES

Teacher and student resources support, enhance, and extend the NASA CONNECT™ program. Books, periodicals, pamphlets, and web sites provide teachers and students with background information and extensions. In addition to the resources listed in this educator guide, the NASA CONNECT™ web site <http://connect.larc.nasa.gov> offers online resources for teachers, students, and parents.

Hands-On Activity

BACKGROUND

The most spectacular example of the way that the Sun and Earth are invisibly connected is the phenomenon of the Aurora Borealis (northern lights) and the Aurora Australis (southern lights). Auroras are the beautiful curtains of colored light that are commonly seen in the Arctic and Antarctic regions of Earth, which have a long history of sightings by humans for over 3,000 years. For millennia, people have watched them and worried about what ill omens they represented – war, death, or the wrath of God. It wasn't until the mid–1800s that scientists finally began to discover many of their mysteries. Like lightning and earthquakes, they were natural events, not supernatural ones. Thanks to intensive study by research satellites during the Space Age, auroras have been substantially de-mystified, even as their ethereal beauty has remained to dazzle and inspire awe.

Auroral intensity varies from night to night and during a single night, with best viewing usually from late evening through the early morning hours. Strong auroras can be seen in the continental United States, particularly in the north during sunspot maximum years. Although auroras are beautiful to view, they can seriously disrupt radio communications, radio navigation, some defense-related radar systems, and power transmission lines. Current created by changing magnetic fields accompanying an aurora causes corrosion in pipes, including the Trans-Alaskan pipeline.

By the turn of the 20th century, scientists actually created artificial auroras in their laboratories. Once television and the fluorescent lamp were invented, it was obvious how auroras worked. Auroras are similar to color television images. In the picture tube, a beam of electrons controlled by electric and magnetic fields strikes the screen, making it glow in colors. What scientists still didn't understand was what triggered auroras. Some thought it was from direct currents of particles from the Sun itself, an explanation you will still find in current textbooks!

Other scientists thought it was more complicated than that. The current standard explanation follows:

Auroral light is produced by a high-vacuum electrical discharge is powered by interactions between the Sun and Earth. The Sun is a plasma or a gas of charged particles that is so hot its outermost part blows away as solar wind. Consisting of charged particles, this tenuous gas travels to Earth in about three days. Because the Earth's magnetic field prevents the solar wind from penetrating our atmosphere, its solar particles stream around our planet, encasing Earth and its magnetic field within a comet-shaped cavity called the magnetosphere.

Energetic electrons colliding with oxygen and nitrogen molecules in the atmosphere cause the delicate colors. The brightest and most common auroral color, a brilliant yellow-green, is produced by oxygen atoms at roughly a 100–km altitude. High altitude oxygen atoms (about 300 km) produce rare, all red auroras. Ionized nitrogen molecules produce blue light; neutral nitrogen molecules create purplish-red lower borders and ripple edges. The atmosphere of oxygen and nitrogen acts as a 3D television screen that displays the awesome dance of charged particles from the Sun as they interact with the Earth's magnetic field.

When a major storm buffets Earth's magnetic field, it causes some parts of this field to rearrange itself, like rubber bands pulled to their breaking point and releasing energy that causes powerful currents of particles to flow from distant parts of the magnetic field into the atmosphere. These particles did not come directly from the Sun, but were already trapped in the magnetic field like flies in a bottle. The particles flow along the magnetic field into the Polar regions and collide with nitrogen and oxygen atoms in the atmosphere. They never reach the ground, although it sometimes seems as though they do!

Many inhabitants of northern regions claim that they can hear the crackling sound of an aurora when it is particularly bright and active. At first scientists dismissed this belief as merely folklore because sound waves cannot travel through the very thin air where the auroras are produced and reach the ground. Modern research, however, has found another explanation that has to do with electric charges near the ground that produce the sound right where you are standing! So the next time you see an aurora, be very quiet and enjoy the celestial dance of light.

Activity 1: Where To See an Aurora

(Recommended for grade level 6-7)

NATIONAL STANDARDS

Mathematics (NCTM) Standards

- Understand and use ratios and proportions to represent quantitative relationships.
- Model and solve contextualized problems using various representations such as graphs, tables, and equations.
- Understand relationships among units and convert from one unit to another within the same system.
- Solve problems involving scale factors using ratios and proportion.
- Build new mathematical knowledge through problem solving.
- Organize and consolidate mathematical thinking through communication.
- Communicate mathematical thinking coherently and clearly to peers, teachers, and others.
- Use representations to model and interpret physical, social, and mathematical phenomena.

Science (NSE) Standards

- Unifying Concepts and Processes
- Physical Science
- Earth and Space Science
- Science in Personal and Social Perspectives

Technology (ITEA) Standards

The Nature of Technology

- Systems thinking involves considering how every part relates to others.

Design

- Design involves a set of steps, which can be performed in different sequences and repeated as needed.

Abilities for a Technological World

- Make two-dimensional and three-dimensional representations of the designed solutions.

Use and maintain products and systems

- Use information provided in manuals, protocols, or by experienced people to see and understand how things work.

Abilities for a technical world

- Design and use instruments to gather data.

The design world

- The use of symbols, measurements, and drawings promotes clear communication by providing a common language to express ideas.

INSTRUCTIONAL OBJECTIVES

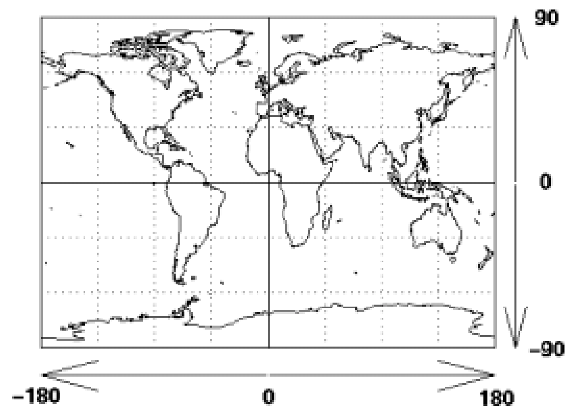
The student will

- find and plot locations on maps using geographic coordinates.
- draw conclusions based on graphical information.
- convert centimeters to kilometers using a given scale.

VOCABULARY

latitude – a geographic coordinate measured from the equator with positive values going north and negative values going south.

longitude – a geographic coordinate measured from the prime meridian (0˚ degrees longitude) that runs through Greenwich, England, with positive values going east and negative values going west



PREPARING FOR THE ACTIVITY

Student Materials

Metric ruler
Colored pencils
Student Activity Sheet 1
Atlas

Teacher Materials

Teacher resource map

Time

Discussing the activity	5 minutes
Preparing the activity	5 minutes
Conducting the activity	30 minutes

Focus Questions

1. What do you know about auroras (northern lights)?
2. Where would you expect to be able to see an aurora?
3. Why are the auroras viewed close to the North and South Poles?

THE ACTIVITY

Step 1: Introducing the Activity

A. Tell the students, "The northern lights are seen most dramatically in only certain places in North America. Today, you will plot the location and boundaries of a typical auroral 'oval' in the Arctic region. You will see its geographic extent and determine its relationship to familiar continents and countries."

B. Distribute student materials.

C. Have students work alone or in pairs.

Step 2: Conducting the Activity

A. Have students label the latitude lines beginning at the center point (Arctic) with 90˚ degrees and marking each circle 10˚ degrees less than the previous circle, ending at 30˚ degrees.

B. Have students label the unmarked longitude lines.

C. Have students plot the points onto the geographic grid for the outer ring.

Outer Ring of Auroral Oval:

Point 1 (90˚,65˚)	Point 7 (0˚, 60˚)
Point 2 (135˚,64˚)	Point 8 (320˚,63˚)
Point 3 (180˚,60˚)	Point 9 (315˚,60˚)
Point 4 (225˚,55˚)	Point 10 (300˚,60˚)
Point 5 (270˚,50˚)	Point 11 (245˚,50˚)
Point 6 (45˚,63˚)	Point 12 (200˚,58˚)

Note: The points are identified as ordered pairs: (longitude, latitude).

D. Have students connect the points in the outer ring.

E. Have students plot the points onto the geographic grid for the inner ring.

Inner Ring of Auroral Oval:

Point 1 (90˚,78˚)	Point 7 (0˚, 75˚)
Point 2 (135˚,72˚)	Point 8 (320˚,72˚)
Point 3 (180˚, 70˚)	Point 9 (315˚,70˚)
Point 4 (225˚,67˚)	Point 10 (300˚,67˚)
Point 5 (270˚,65˚)	Point 11 (245˚,62˚)
Point 6 (45˚,67˚)	Point 12 (200˚,70˚)

Note: The points are identified as ordered pairs: (longitude, latitude).

F. Have students connect the points in the inner ring.

G. Using the grid scale 1 cm = 1400 km, have students measure (in km) the approximate widths of the auroral ring (i.e., the shortest and longest distances between the inner and outer rings) and determine the range.

H. Have students color the rings with their favorite auroral colors.

Step 3: Discussion

1. Where would you travel in North America to see an aurora?
2. About where is the center of the auroral oval located?
3. How far is the center of the auroral oval from the North Pole?
4. What is the range of widths of the auroral oval in kilometers?
5. If you were located at (205˚,65˚) where would you look in the sky for the aurora?
6. If you were located at (290˚,60˚) where would you see the aurora in the sky?

Extensions

1. Go to the following web site and view aurora photos, then write a description of the colors and shapes you see: http://www.northernlights.no/zope/Contest/Gallery/index_html?redir=ok&now=2002_12
2. Go to the following site to study the Earth's magnetic field with a soda bottle magnetometer: http://image.gsfc.nasa.gov/poetry/workbook/magnet.html

Activity 2: How High Up Are Auroras?

(Recommended for grade level 8)

NATIONAL STANDARDS

Mathematics (NCTM) Standards

- Develop an initial conceptual understanding of different uses of variables.
- Build new mathematical knowledge through problem solving.
- Analyze and evaluate the mathematical thinking and strategies of others.
- Select, apply, and translate among mathematical representations to solve problems.
- Draw and construct representations of two- and three- dimensional geometric objects and their compositions.
- Use geometric ideas to solve problems in, and gain insights into, other disciplines and other areas of interest.
- Use trigonometric relationships to determine lengths and angle measures.

Science (NSE) Standards

- Unifying Concepts and Processes
- Earth and Space Science
- Science and Technology

Technology (ITEA) Standards

Relationship Among Technologies and the connections between Technology and other fields

- Knowledge gained from other fields of study has a direct effect on the development of technological products and systems.
- Technological process promotes the advancement of science and mathematics.

Apply design process

- Apply a design process to solve problems in and beyond the laboratory–classroom.
- Use and maintain products and systems.
- Use computers and calculators in various applications.

Abilities for a Technological World

- Design and use instruments to gather data.

The Design World

- The use of symbols, measurements, and drawings promotes clear communication by providing a common language to expression.
- Energy cannot be created or destroyed; however, it can be converted from one form to another.

INSTRUCTIONAL OBJECTIVES

The student will

- use trigonometry to determine the height of triangles.
- make a conjecture based on calculations.
- practice error analysis.
- use a scientific calculator to solve problems involving trigonometry.

VOCABULARY

altitude – the perpendicular distance from a vertex to a line containing that base; also called the height

base – the length of one of the sides of a polygon.

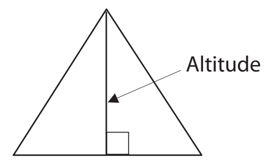
conjecture – a guess based on observations or experimentation

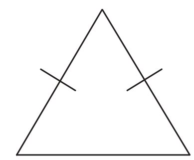
isosceles triangle – a triangle with two congruent or equal sides

magnetosphere – the Earth's protective shield, made up of invisible lines of a magnetic field that radiate out into space from the poles; the magnetosphere deflects the solar wind from directly hitting the Earth, protecting the planet from radiation

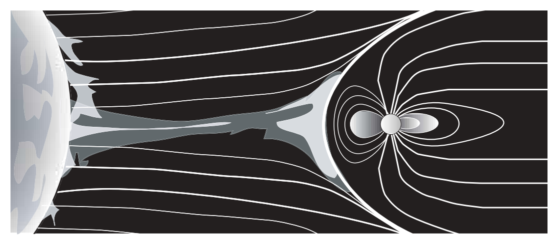
sunspot - a dark, cooler spot on the Sun's surface; charged particles are emitted from these areas. The diameter of an average sunspot is about the same diameter as that of the Earth.

vertex angle – the angle opposite the base

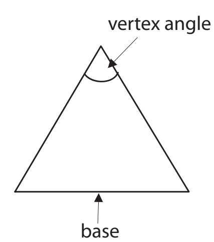




Isosceles Triangle



Magnetosphere



PREPARING FOR THE ACTIVITY

Student Materials
- protractor
- compass
- Student Activity Sheet 2
- scientific calculator

Teacher Materials
- Student activity (problem) sheets – parts 1 and 2
- answer key

Time

Discussing the activity	5 minutes
Preparing the activity	5 minutes
Conducting the activity	30 minutes

Focus Questions

1. What do you know about auroras (northern lights)?
2. Where would you expect to be able to see an aurora?
3. Why are the auroras best viewed close to the North and South Poles?

THE ACTIVITY

Step 1: Introducing The Activity

A. Read the following to the students:
"For thousands of years, people living at northern latitudes had no idea how high up the aurora borealis was located. All you could see from any particular vantage point was a curtain of light. There wasn't much about its shape that gave you any clue to how big it actually was. The aurora could be 1 km or 10,000 km above the ground and there was no real way to tell. Then, in 1910, the Norwegian mathematician, Carl Stormer, found a clever way to find out. He set up stations all over the northern region and equipped each one with specially designed cameras. By taking pictures of the same auroral feature from stations many kilometers apart, he succeeded in triangulating the distance to the aurora. Auroras are most often seen between 90 and 150 km above the ground. We are now going to look at how his technique works!"

B. Distribute student materials and student activity sheet 2 (p. 15).

C. Have students work alone or in pairs.

D. Have students share and discuss conjectures.

Step 2: Conducting the Activity

Part 1

Construct the figure and use trigonometry to solve for the unknown.

1. Construct an isosceles triangle with base angles of 60 degrees and a base length of 115.5 km (21 km = 1 cm). Locate the midpoint and bisect the base. Draw the altitude from the vertex angle. Measure the approximate height (altitude) using a ruler and convert to km using your scale factor. Also use trigonometry to calculate the length of the altitude. Compare the two answers.
2. Sketch (do not construct) the following figures (not to scale):
   a. An isosceles triangle with base angles of 87.15 degrees and base of 10 km. Locate the midpoint of the base and draw the altitude. Calculate the height.
   b. A triangle with base angles of 84.3 degrees and base of 20 km. Draw the altitude and calculate the height.
   c. A triangle with base angles of 80.1 degrees and a base of 35 km. Draw the altitude and calculate the height.
3. What do you notice about the calculated heights? What happens to the base length as the base angle decreases?
   Careful observations of the lowest limits to auroras show that they rarely are less than 90 km above the ground. Some legends report that they can touch the ground, but this is merely an optical illusion. Their tops, however, can sometimes exceed 1,500 km. Auroras require very low density air to produce their light. If the air is too dense, as it is below 90 km, the physical process that produces the light does not work. The atoms in the denser air collide faster than the time it takes for the atom to produce the light, and the collision destroys the light.
4. Suppose each of the four problems above were recorded by four different scientists studying the same aurora feature. Based on your calculations, what is the average height to the nearest unit? What is the range of heights?
5. In problem 1, what other method might be used to calculate the height? Explain how you reached your conclusion.

Part 2 – Mistakes and Omissions

Scientists are human like everyone else and they make errors. They often have to find their mistakes and omissions. Have students complete this exercise alone or in pairs. Be sure they can give reasons for their answers.

1 Dr. Made A. Mistake, a fifth grade scientist, was out of luck. He calculated the height to be 0.765 km. He measured the base angles to be 85 degrees and the length of the base as 17.5 km. Show the correct calculations for the height and determine his error.

2. Dr. Nada Written Down, another aspiring young scientist, did not write down her calculations. She remembered that the height was 100 km and that the base length was 15 km. Determine the missing base angles.

3. Dr. Flipped D. Numbers is having a tough time figuring out where the mistake is in the calculations. The base length was 33.5 km and the base angles were 80.5 degrees. The height that he determined was 191.45 km. How could he have made this mistake?

Step 3: Discussion

1. How can error analysis help students have a better understanding of problem solving?
2. We have used trigonometry to estimate the height of auroras. How else might one apply trigonometric principles to problem solving?

Extensions

1. Apply direct measurement of angles and length to determine height using a clinometer and the tangent ratio. http://www.globe.org.uk/activities/toolkit/toolkit.pdf

Student Worksheets

Activity 1: Where to See an Aurora

Name : ______________________________ Date: ______________

Outer Ring of Auroral Oval:

Point 1 (90,65)	Point 7 (0, 60)
Point 2 (135,64)	Point 8 (320,63)
Point 3 (180,60)	Point 9 (315,60)
Point 4 (225,55)	Point 10 (300,60)
Point 5 (270,50)	Point 11 (245,50)
Point 6 (45,63)	Point 12 (200,58)

Inner Ring of Auroral Oval:

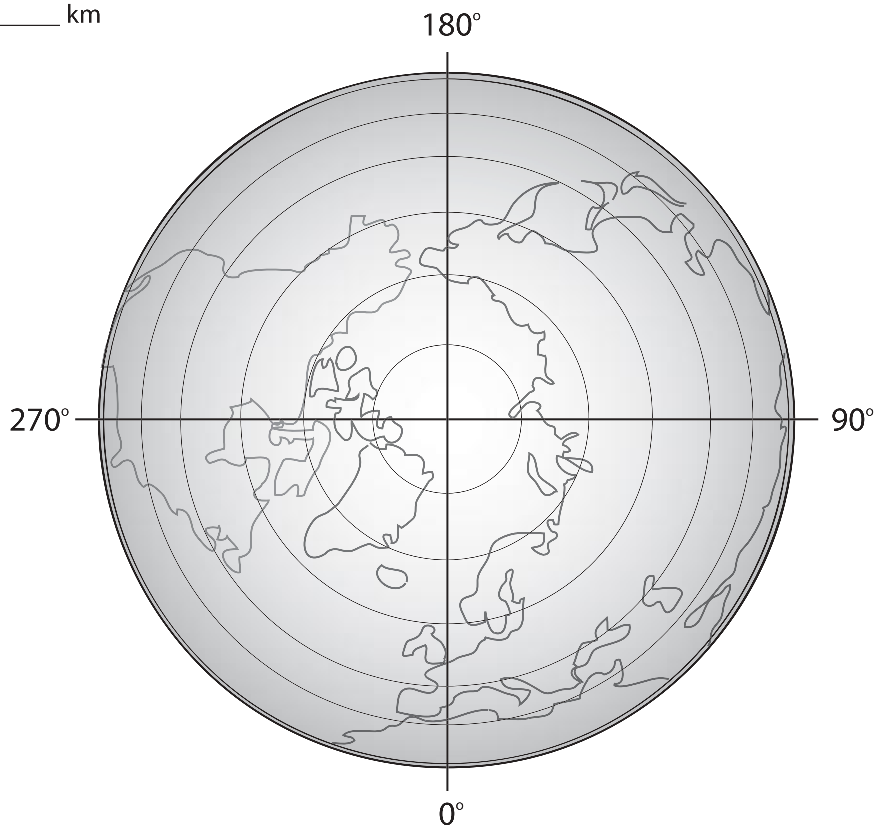
Point 1 (90,78)	Point 7 (0, 75)
Point 2 (135,72)	Point 8 (320,72)
Point 3 (180, 70)	Point 9 (315,70)
Point 4 (225,67)	Point 10 (300,67)
Point 5 (270,65)	Point 11 (245,62)
Point 6 (45,67)	Point 12 (200,70)

Approximate Width:

Shortest distance ____________ km

Longest distance ____________ km

Range ____________ km



Grid Scale: 1 cm = 1400 km

Student Worksheets

Activity 2: How High up are Aurora?

Name : ______________________ Date: ______________

Part 1

Construct the figure and use trigonometry to solve for the given unknown.

1. Construct an isosceles triangle with base angles of 60 degrees and a base length of 115.5 km (21 km = 1 cm). Locate the midpoint and bisect the base. Draw the altitude from the vertex angle. Measure the approximate height (altitude) using a ruler and convert to km using your scale factor. Also use trigonometry to calculate the length of the altitude. Compare the two answers.

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Careful observations of the lowest limits to aurora show that they rarely are less than 90 km above the ground. Some legends report that they can touch the ground, but this is merely an optical illusion. Their tops, however, can sometimes exceed 1,500 km. Auroras require very low density air in order to produce their light. If the air is too dense, as it is below 90 km, the physical process that produces the light does not work. The atoms in the denser air collide faster than the time it takes for the atom to produce the light, and the collision destroys the light.

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Student Worksheets

Activity 2: How High up are Aurora?

Name : ______________________________ Date: ______________

Part 2 – Mistakes and Omissions

Scientists are human like everyone else and they make errors. They often have to find their mistakes and omissions. Have students complete this exercise alone or in pairs. Be sure they can give reasons for their answers.

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Name: ______________________________
Date: ______________________________

Cue Cards

Professor Alv Egeland, University of Oslo

1. How is a magnetometer used to measure auroral activity?

2. In analyzing the graph, what indicates a great disturbance in the Earth's magnetic field?

3. How are sounding rockets useful to scientists and engineers?

Dr. Nicky Fox, Senior Professional Staff Scientist, Johns Hopkins University/Applied Physics Laboratory

1. Why do scientists use satellite images to monitor the auroras?

2. In analyzing the graph, what determines an increase in auroral activity?

3. What are the phases of an Aurora?

Teacher Materials

Cue Cards

Professor Alv Egeland, University of Oslo

1 How is a magnetometer used to measure auroral activity?

Possible Answer: A magnetometer is an instrument that measures weak, short-term variations in the strength of the Earth's geomagnetic field. These variations are due to electric currents in the upper atmosphere. The electrons and ions of the solar wind, which also produces the aurora, cause these currents; so, a magnetometer measures a quantity that is directly related to the northern lights. The stronger the magnetic variations, the higher the auroral activity.

2 In analyzing the graph, what indicates a great disturbance in the Earth's magnetic field?

Possible Answer: It appears that the greater the deviations from the geomagnetic standard values, the greater the disturbances of the magnetic field, which, in turn, creates greater auroral activity.

3 How are sounding rockets useful to scientists and engineers?

Possible Answer: Sounding rockets provide the only means of carrying scientific instruments directly into the auroral regions. The rockets that are launched at the rocket range are 10 to 20 meters in length and attain altitudes of about 350 km.

Dr. Nicky Fox, Senior Professional Staff Scientist, Johns Hopkins University/Applied Physics Laboratory

1 Why do scientists use satellite images to monitor the auroras?

Possible Answer: Scientists use satellite images to monitor the position of the various auroral features. In particular, the latitudinal location of the equatorward edge of the aurora determines the amount of activity. The chosen the aurora moves towards the equator, the bigger the event.

2 In analyzing the graph, what determines an increase in auroral activity?

Possible Answer: The closer the aurora moves towards the equator, the bigger the event.

3 What are the phases of an Aurora?

Possible Answer: The Quiet Phase, the Growth Phase, the Onset Phase, The Expansion Phase, the Maximum Area Phase, and the Recovery Phase.

Aurora Web Activity

This activity uses a free, exciting, multimedia, object-oriented programming environment called Squeak that runs on 25 different computer platforms. You can download the plug-in for Squeak at www.squeakland.org and then double-click the downloaded icon for easy installation. Once you have the Squeak plug-in installed, you can access the activity at <http://connect.larc.nasa.gov/dansdomain.html> using either IE or Netscape as a browser. Once the activity loads, click on the orange tab at the left, labeled Navigator, to make it pop up and then click on Escape Browser to remove the browser controls so you have more room. Also click the Navigator tab shut for more room. This activity is designed for use by students, teachers, and parents in the school or home setting. Now you are ready to start the activity.

The focus of this activity is for teams of students to work collaboratively to investigate the possibility of auroras on other planets. Auroras have been observed on other planets, and they are believed to exist on still more planets. It is the student team's job to figure this out. They should start by reviewing what they learned about auroras on Earth from the NASA CONNECT™ broadcast and generate a list of conditions that are required for auroras to exist. It would be best for the groups to create a table or matrix of the necessary conditions so they can compare Earth more easily to the other planets. They will find exploration tools waiting for them to discover the conditions on the other planets so they can fill in their table. Through comparison, the teams should be able to determine which other planets could have auroras, and they should be encouraged to present their conclusions to their classmates.

There is an active book in the middle of the screen to help you understand what the tool measures and the technology involved in making the measurements. The students should read the active book for important information regarding the investigation. Included in the active book are mathematics problems to solve which require the students to work with numbers and units and understand ratios. Have fun and explore.

NATIONAL STANDARDS

Mathematics (NCTM) Standards

- Work flexibly with fractions, decimals, and percents to solve problems.
- Understand and use ratios and proportions to represent quantitative relationships.
- Understand the meaning and effects of arithmetic operations with fractions, decimals, and integers.
- Represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic rules.
- Understand both metric and customary systems of measurement.
- Understand relationships among units and convert from one unit to another within the system.
- Solve problems involving scale factors, using ratio and proportion.
- Formulate questions, design studies, and collect data about a characteristic shared by two populations or different characteristics within one population.
- Apply and adapt a variety of appropriate strategies to solve problems.
- Communicate mathematical thinking coherently and clearly to peers, teachers, and others.
- Analyze and evaluate the mathematical thinking and strategies of others.

Science (NSE) Standards

- Abilities necessary to do scientific inquiry
- Structure of the Earth System
- Earth and the Solar System

Technology (ITEA) Standards

The Nature of Technology

- New products and systems can be developed to solve problems or to help do things that could not be done without the help of technology.

Abilities for a Technological World

- Use computers and calculators in various applications.

INSTRUCTIONAL OBJECTIVES

The students will

- review and solidify their understanding of auroras on Earth from the NASA CONNECT™ program, "Dancing in the Night Sky".
- work collaboratively in groups based on their review to develop a list of the essential conditions that lead to auroras on Earth.
- work collaboratively in groups to determine which other planets in our solar system could have auroras, by–
- exploring properties of other planets using the Squeak project available at the NASA CONNECT™ website
- using their list of essential conditions to solve the task.
- working with numbers and ratios to solve problems which compare various properties of the planets.
- reporting the results of their investigation to their colleagues.

Resources

BOOKS, PAMPHLETS, AND PERIODICALS

Hall, Calvin; Pederson, Daryl; *Northern Lights: The Science,* Myth and Wonder of Aurora, Sasquatch Books, 2001.

Jago, Lucy; *The Northern Lights: The True Story of the Man Who Unlocked the Secrets of the Aurora Borealis*, Knopf, 2001.

Savage, Candace; Aurora: *The Mysterious Northern Lights*, Firefly, 2001.

Syun-Ichi, Akasofu; Aurora Borealis: *The Amazing Northern Lights*, Alaska Geographic Society, 1979.

Todd, Flip; *Aurora Borealis; A Photo Memory*, Todd Communications, 1999.

WEB SITES

Exploratorium "Auroras:Paintings in the Sky"

http://www.exploratorium.edu/learning_studio/auroras/

Archive of aurora photos by Jan Curtis:

http://www.geo.mtu.edu/weather/aurora/images/aurora/jan.curtis/

Archive of aurora photos by Dick Hutchinson:

http://www.ptialaska.net/~hutch/aurora.html

Space Weather Today:

http://www.spaceweather.com/

IMAGE real-time aurora images from space:

http://image.gsfc.nasa.gov/poetry/today/intro.html

http://www.sec.noaa.gov/IMAGE/

http://sprg.ssl.berkeley.edu/image/

NOAA Auroral Activity monitor:

http://www.sec.noaa.gov/pmap/index.html

CANOPUS real-time auroral monitor:

http://www.dan.spagency.ca/www/rtoval.htm#TOPOFPAGE

Current solar activity report:

http://www.dxlc.com/solar/

Alaska Science Aurora page for kids:

http://www.alaskascience.com/aurora.htm

Human Impacts of Space Weather:

http://image.gsfc.nasa.gov/poetry/weather01.html

Ask the Space Scientist:

http://image.gsfc.nasa.gov/poetry/ask/askmag.html

More classroom activities:

http://image.gsfc.nasa.gov/poetry/activities.html

The Northern Lights Essay Competition:

http://image.gsfc.nasa.gov/poetry/alaska/alaska.html

Figure This!

Offers Mathematics Challenges that middle school students can do at home with their families to emphasize the importance of a high-quality mathematics education for all.

http://www.figurethis.org

Engineer Girl

Part of the National Academy of Engineering's Celebration of Women in the Engineering project. The project brings national attention to the opportunity that engineering represents to people of all ages, but particularly to women and girls.

http://www.engineergirl.org

NCTM – National Council Teachers of Mathematics

http://www.nctm.org