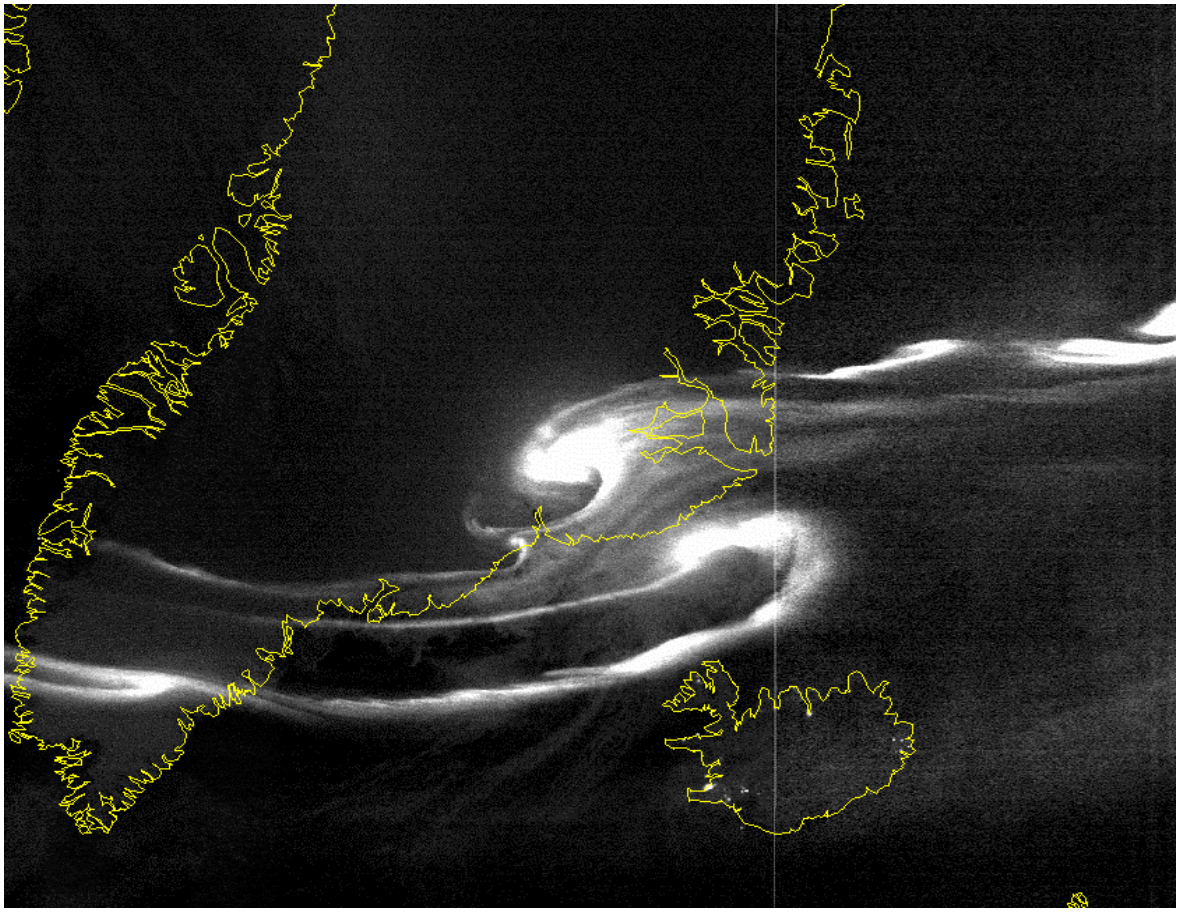
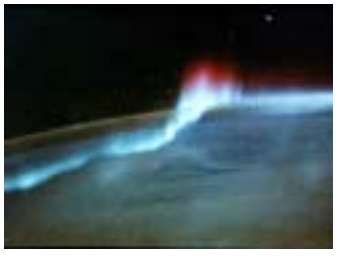
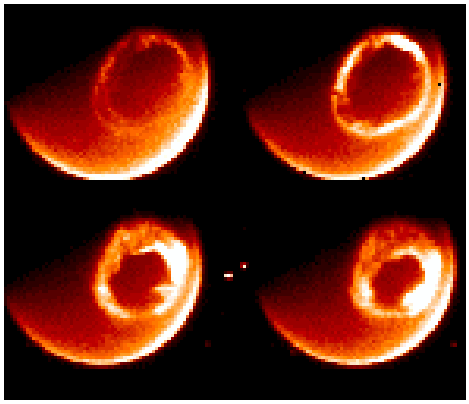
THE NORTHERN LIGHTS







A Grade 7-8 guide to understanding the Aurora Borealis through math, geometry and reading activities.

This series of activities will help students understand how the Northern Lights work, what causes them, and how to observe them.

Through a series of math and reading activities, students will learn:

- How aurora are described by scientists and by other students (Reading)
- The geographic locations of aurora based on satellite data (Geography)
- How aurora appear in the sky at different geographic latitudes (Geometry)
- The height of aurora above the ground (Geometry - parallax)
- How to predict when they will appear (Mathematics)
- What Norse Mythology had to say about aurora (symbolic code translation)

This booklet was created by the NASA, IMAGE satellite program's Education and Public Outreach Project.

Writers:
Dr. Sten Odenwald *(NASA/IMAGE)*
Ms. Susan Higley *(Cherry Hill School)*
Mr. Bill Pine *(Chaffey High School)*

Students:
Emily Clermont *(Holy Redeemer School)*
Denali Foldager *(Seward Elementary School)*
Sonta Hamilton *(Mt. Edgecumbe High School)*

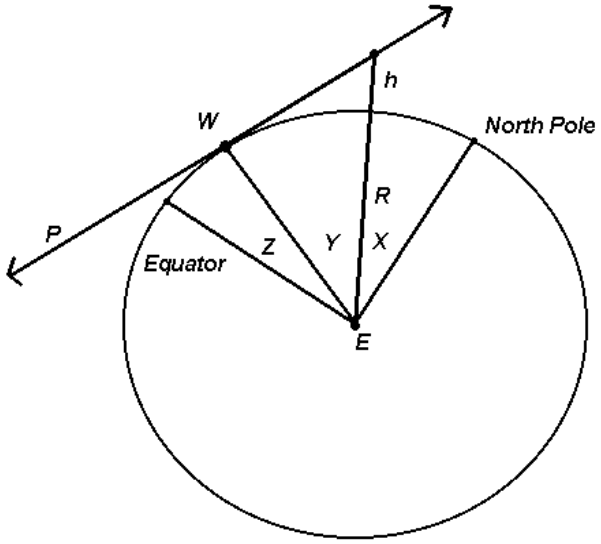
For more classroom activities about aurora and space weather, visit the IMAGE website at:

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

The cover shows a view from the NPOESS satellite looking down at an aurora over Greenland. *(http://npoesslib.ipo.noaa.gov/S_sess.htm).* Viking rune inscription (http://www.commersen.se/vikingar/vardag/runor.html). The three smaller images at the bottom of the page are: (Left) an aurora borealis viewed from the Space Shuttle; (middle) portion of the auroral oval over North America viewed by the DMSP satellite showing city lights; (right) the auroral oval viewed over the Arctic region on July 15, 2000 by the IMAGE satellite.

Activity 3 Aurora Viewing from the Ground

Although the best viewing for the Aurora Borealis is near a latitude of +68° , because these curtains of light extend over 1,000 kilometers above the ground, they can be seen at other latitudes as well.



Key: This is the final construction.

Objectives:

Students will read to perform a task.
Students will construct a drawing to determine the optimum viewing angle of an aurora.

Benchmarks:

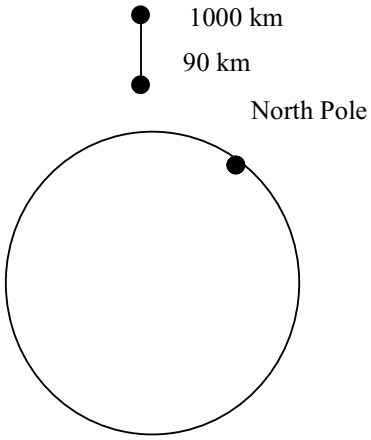
Mathematical ideas can be represented concretely, graphically, and symbolically.
Understand that writing incorporates circle charts, bar graphs, line graphs, tables, diagrams, and symbols.

Teacher Key (sample answers):

1. The directions are used to construct a diagram (shown above) to help students determine an optimal viewing latitude of an aurora.
2. The diagrams allow a visual image of the directions and help to clarify the directions by showing the desired results.
3. The word perpendicular means that the tangent line P meets at a 90 degree angle. This provides a right triangle.
4. The center of the Earth, E, can be located by constructing the perpendicular bisector of any two chords. Another method is to fold the circle creating two diameters and where the two diameters intersect is the center of the circle, or Earth in this case.
5. The top of the aurora is located at R+h = 6378 km + 1000 km = 7378 km
6. Cosine Y = (Earth's radius) divided by the height in number five.
   Make sure that the calculator is in the degree mode. Next, use inverse cosine (6378 divided by 7378). The resulting angle should be 30 degrees, rounded to the nearest degree. This is the measure of angle Y.
   When determining angle Z, use 65 – 30. The measure of angle Z is 35 degrees.

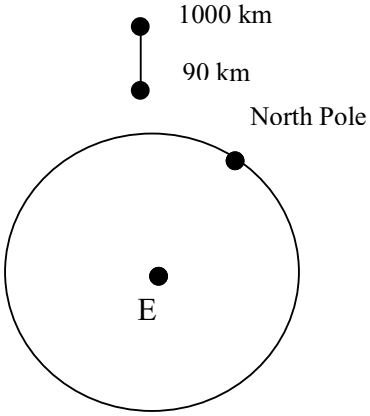
Student Name _____ Date _____

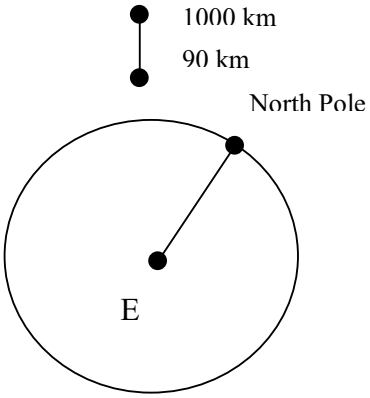
The following steps are used to create a drawing that depicts the optimum viewing angle for an aurora. First, read the steps. Next look at the given diagram and then answer the questions at the end of the reading.



The figure at the left is the Earth . The aurora are 90 to 1000 km above the Earth.

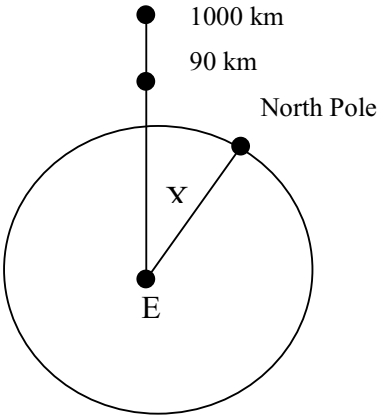
Step 1. Locate the center of the Earth. Label this point E.

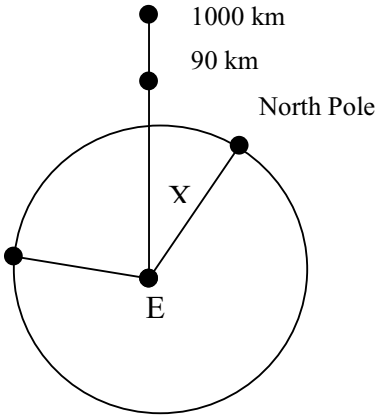




Step 2. Draw a radius from the center of the Earth to the North Pole.

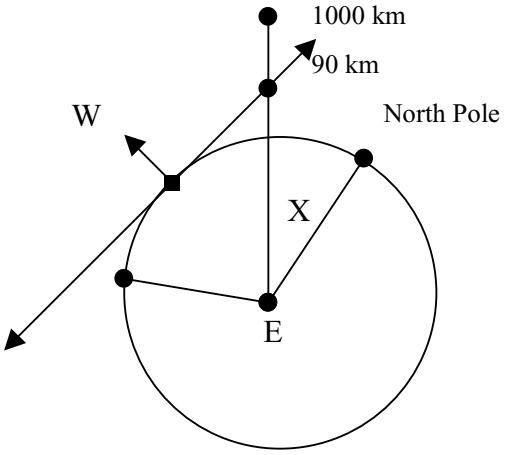
Step 3: Draw a line segment to connect the center E with the point at 90 km. The total length of the line segment will be the height. Label the angle X degrees.

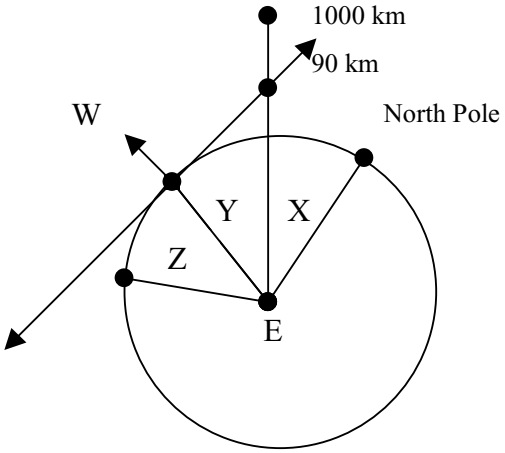




Step 4. Using the height as a side, draw a 65 degree angle counterclockwise.

Step 5. Draw a tangent through the circle and the point at 90 km in the aurora region. Label the point that it intersects the circle as point W (Note: this tangent line is perpendicular to the edge of the circle).





Step 6. Draw a radius connecting point W to the center. This divides the 65 degree angle into two new angles. Label one angle Y and the other angle Z (note: the two angles are not congruent).

Problems and Questions:

1. What are the directions used to determine?
2. How do the diagrams help to clarify the directions for each step?
3. What does the word perpendicular in step five indicate?
4. In step 1, how can the center of the Earth be located?
5. If the Earth's radius is 6378, and the aurora region is 90 to 1000 km, what is the total height from the center of the Earth to the top of the aurora region?
6. Radius EW is perpendicular at point W. Find angle Y and angle Z.
7. Using the directions, construct the geometric figure.

Useful Web Resources

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.sp-agency.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