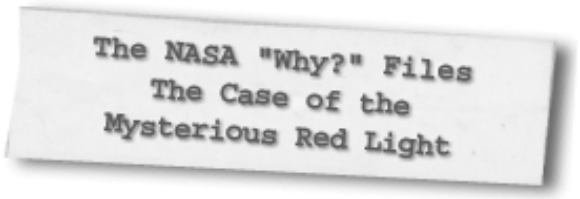


Segment 4

The tree house detectives are certain that the unusually bright red sunrises and sunsets are being caused by a large amount of aerosols in the atmosphere. However, they are puzzled as to what could be causing an influx of aerosols. With Mt. Luminous over 7,000 miles away from Virginia, the tree house detectives rule out its recent eruption of dust and ash, but decide that they had better make certain. They visit with Jennifer Olson of Atmospheric Sciences at NASA Langley Research Center and learn that aerosols can be carried long distances by upper atmospheric winds. It dawns on them that Mt. Luminous just might be the illuminating clue they need to solve the mystery!

After calculating wind speed and distance to determine the length of time it would take for aerosols to travel to Virginia, the tree house detectives once again are afraid they have come to a dead end. After remembering what they learned about the jet stream, the tree house detectives visit Fred Yco, a meteorologist with WAVY News 10 in Norfolk, Virginia. Mr. Yco confirms that the jet stream has been flowing in a pattern that would have brought the aerosols to Virginia in only three days! E-mails from students across the United States confirm their hypothesis, and *The Case of the Mysterious Red Light* is just one more for the files.

With the mystery solved, the tree house detectives visit Dr. D and review their case and the scientific process that they followed. Jacob tries one final magic trick, and suddenly the tree house detectives disappear into the sunset, or was it just an illusion?

Objectives

The students will

- learn that wind vectors represent the speed and direction of wind.
- learn that wind travels in global wind patterns.
- learn that the Earth's atmosphere is divided into layers.
- calculate distance and average wind speed to determine length of time for a particle to travel.
- learn that the jet stream is a river of air in the upper atmosphere.

Vocabulary

CAVE - Cave Automated Virtual Environment. A room with 4 screens (3 walls and a floor) that enables an observer to experience a computer generated projection in a three-dimensional environment.

global wind pattern - Earth's general circulation pattern of wind created by the unequal heating of the Earth's surface and by the rotation of the Earth

jet stream - a narrow belt of strong, high-pressure, fast moving (up to 350 km per hour) air flowing from west to east in the troposphere

stratosphere - A layer of Earth's atmosphere just above the tropopause, extending from about 15 km above Earth to about 50 km. Airplanes travel in this layer and the ozone layer is located here.

wind - horizontal movement of air over the Earth's surface that is created when cool, heavy air moves toward warm, light air

vector - a quantity in which both the magnitude and direction must be stated

Video Component

Implementation Stratey

The NASA "Why?" Files are designed to enhance and enrich the existing curriculum. Full use of the video, resources, activities, and web site usually requires two to three days of class time per segment.

Before Viewing

1. Prior to viewing Segment 4 of *The Case of the Mysterious Red Light*, discuss the previous segment to review the problem and what the tree house detectives have learned thus far. Record on problem board.
2. Review the list of questions and issues that the students revised and/or created prior to viewing Segment 3. Determine which, if any, were answered in the video or in the student's own research.
3. Revise and correct any misconceptions that may have occurred during Segment 3. Use tools located on the web, as previously mentioned in Segment 1.
4. Discuss the hypothesis that the students generated at the end of Segment 3 and decide if information learned supports their hypothesis. If not, discuss why and revise the hypothesis.
5. **Focus Questions** - Print the questions from the web site ahead of time for students to copy into their science journals. Encourage students to take notes during the show to answer the questions.

View Segment 4 of the Video

For optimal educational benefit, view *The Case of the Mysterious Red Light* in 15-minute segments and not in its entirety.

After Viewing

1. Lead students in a discussion to reflect upon the solution to the mystery.
2. Discuss the hypothesis that the students generated at the end of Segment 3 and determine if their hypothesis was correct. Discuss why the tree house detectives spoke to

an atmospheric researcher at NASA. Why did the tree house detectives need to know about wind patterns? The new "hypothesis" was, "If the zonal winds carried the dust and ash from the volcano to our area, then we would have red sunsets and sunrises." Why did Jason begin to doubt their hypothesis? How did a meteorologist help them to know that they were on the right track? The tree house detectives received E-mails from all across the United States. How did the E-mails help them know they had solved the mystery?

3. Choose activities from the educator guide and web site to enhance and enrich the concepts discussed in the segment. Help students see the correlation between the information learned and the clues that were used to solve the mystery.
4. Complete the problem-based learning activity on the web site.
5. Ask the students to recount the steps the tree house detectives took to solve the mystery. How many times did the tree house detectives revise their hypothesis? Why did they keep revising it?
6. Continue to assess students' performance and thinking as appropriate by reviewing the students' journal writings. Evaluate the final product that was generated to represent the online PBL activity by using the rubric that best fits the products produced. Sample rubrics and other tools can be found at the NASA "Why?" Files web site in the "Tools" section of the educator's area.

Careers

atmospheric scientist
meteorologist
meteorologist technician

Resources

Books

Allaby, Michael: *How the Weather Works.* Reader's Digest Adult, 1999, ISBN: 0762102349

Cosgrove, Brian, Karl Shone, and Keith Percival: *Eyewitness: Weather*. DK Publishing, 2000, ISBN: 0789457822

Farndon, John and John Bendall-Brunello: *Eyewitness Explorers: Weather*. DK Publishing, 1998, ISBN: 0789429853

Moreau, Roger: *Volcano and Earthquake Mazes*. Sterling Publications, 2000, SBN: 0789457806

Onish, Liane: *Wind and Weather: Climates, Clouds, Snow, Tornadoes, and How Weather is Predicted* (Scholastic Voyages of Discovery. Natural History. Scholastic Inc., 1994, ASIN: 0590476467

Watt, Fiona and Francis Wilson: *Weather and Climate (Science and Experiment Series)*. Usborne Publishing Ltd., 1992, ISBN: 0746006837

Web Sites

NASA Langley Research Center/Earth Science
Learn about present and future atmospheric science programs conducted at NASA Langley Research Center.
ttp://www.larc.nasa.gov/research/inside_pages/earthscience.htm

NASA Langley Research Center/Earth Science/Learning Center
Fantastic site for all your atmospheric needs. Learn about the layers of the atmosphere, aerosols, ozone depletion, global warming, radiation budget, volcanoes, and much more. It has a comprehensive glossary of terms, a time conversion chart, and additional links.
http://www-sage3.larc.nasa.gov/solar/learningindex.html

The CERES S'COOL Project
Primary and secondary school teachers and their classes are invited to participate in this ongoing weather data collection project. Your class observations, comparisons, and evaluations will become part of the real data used by researchers at NASA Langley Research Center in Hampton, VA.

The Weather Classroom
The Weather Channel's education site for teachers and students. Learn the weather term for the day, study hurricanes, and learn to forecast the weather.
http://www.weather.com/education/index.html

NOAA (National Oceanic and Atmospheric Administration) Education Resources
An abundance of weather related activities. Teacher, parent, and student sections.
http://www.education.noaa.gov/

"gettech"
A cool place to learn about careers in math and technology. Includes sections for teachers, parents, and students.
http://www.gettech.org

Videos

Eyewitness: Volcano. DK Vision, 1996, ISBN: 0789407213

Activities and Worksheets

How Fast Does She Blow?

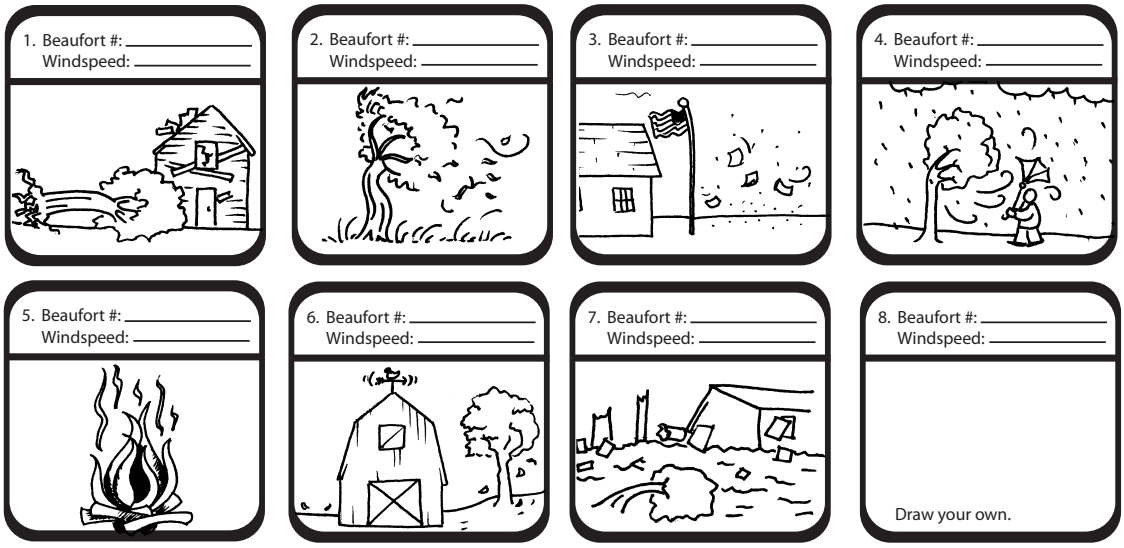
Purpose

Learn to differentiate between wind speeds by using the Beaufort Scale of Wind Force

Beaufort Scale (modified)

Wind Speed Mph	Beaufort Scale	Wind Description	Wind Effects	Wind Vector
1	0	Calm	smoke rises vertically	
4 - 7	2	Light breeze	wind felt on face; leaves rustle; wind vane moves	
13 - 18	4	Moderate breeze	raises dust, loose paper; small branches move	
25 - 31	6	Strong breeze	large branches move; umbrellas used with difficulty	
39 - 46	8	Gale	breaks twigs off of trees	
55 - 63	10	Storm	trees uprooted; damage to coast	
74+	12	Hurricane	widespread damage	

Use the chart above to determine the appropriate Beaufort Scale.



Conclusion

1. The CAVE at NASA Langley Research Center depicted a 3-D model of wind vectors—the longer the vector, the faster the wind. In the last column of the Beaufort Scale, draw wind vectors that might be used in the CAVE.
2. On a normal day, how fast does the wind blow? What would normal be on the Beaufort Scale?

   _____
3. Wind vectors also show direction. How could you show the direction of the wind? _____

   _____

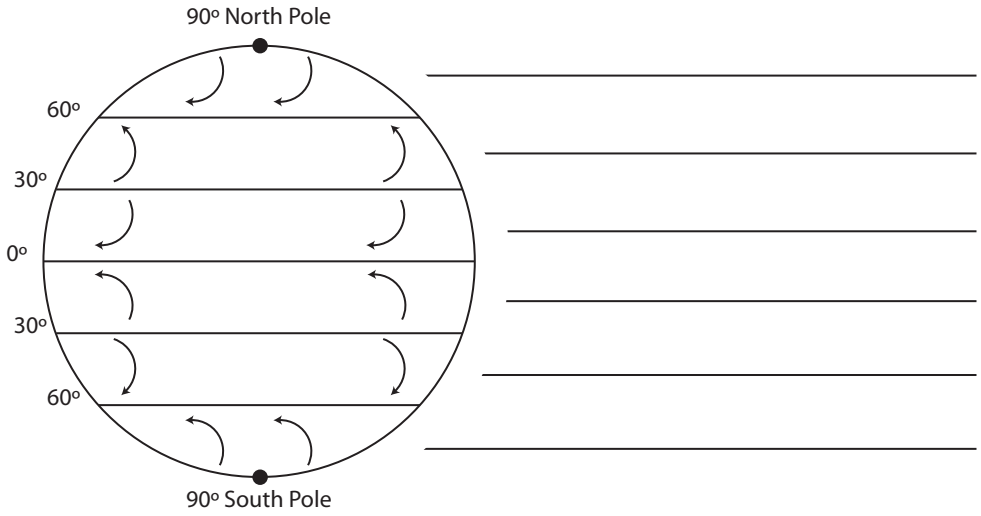
   _____

Global Winds

Wind is the movement of air molecules from an area of high pressure to an area of low pressure. The uneven heating of the Earth's surface by the Sun creates these differences in pressure. The uneven heating is due to the Earth's surface being curved rather than flat. Because of the curved surface, not all areas receive the same amount of radiation from the Sun. Thus, the air above the equator is heated more than at any other place on Earth. The air at the poles is much colder. As the warm air rises from the equator, cold dense air sinks from the poles and moves along the surface of the Earth toward the equator. As the Earth rotates, the Coriolis effect is created. In the northern hemisphere, the Coriolis effect causes air masses to turn westward from their original path. In the southern hemisphere, the air masses deflect eastward. These deflections create wind belts.

Use the clues to correctly label the wind belts on the diagram of the Earth. Color as designated.

1. The Prevailing westerlies are located between 30° and 60° latitude. Color yellow.
2. The Polar easterlies are located above and below 60° latitude. Color blue.
3. The trade winds are located between 0° and 30° latitude. Color orange.
4. The horse latitudes are located at 30° South and North latitudes. Color red.
5. The doldrums are located at 0° latitude. Color black.



Conclusion

1. Within which wind pattern does the United States lie? _____
2. What general direction does the wind blow in the United States? _____
3. How did learning about the global wind patterns help the tree house detectives solve the mystery? _____
4. How do wind patterns affect our weather patterns? _____

Layer Upon Layer

Purpose

To learn the order of the layers of the atmosphere

Materials

disks
markers
scissors
brass fastener
hole punch
journal
glue (optional)

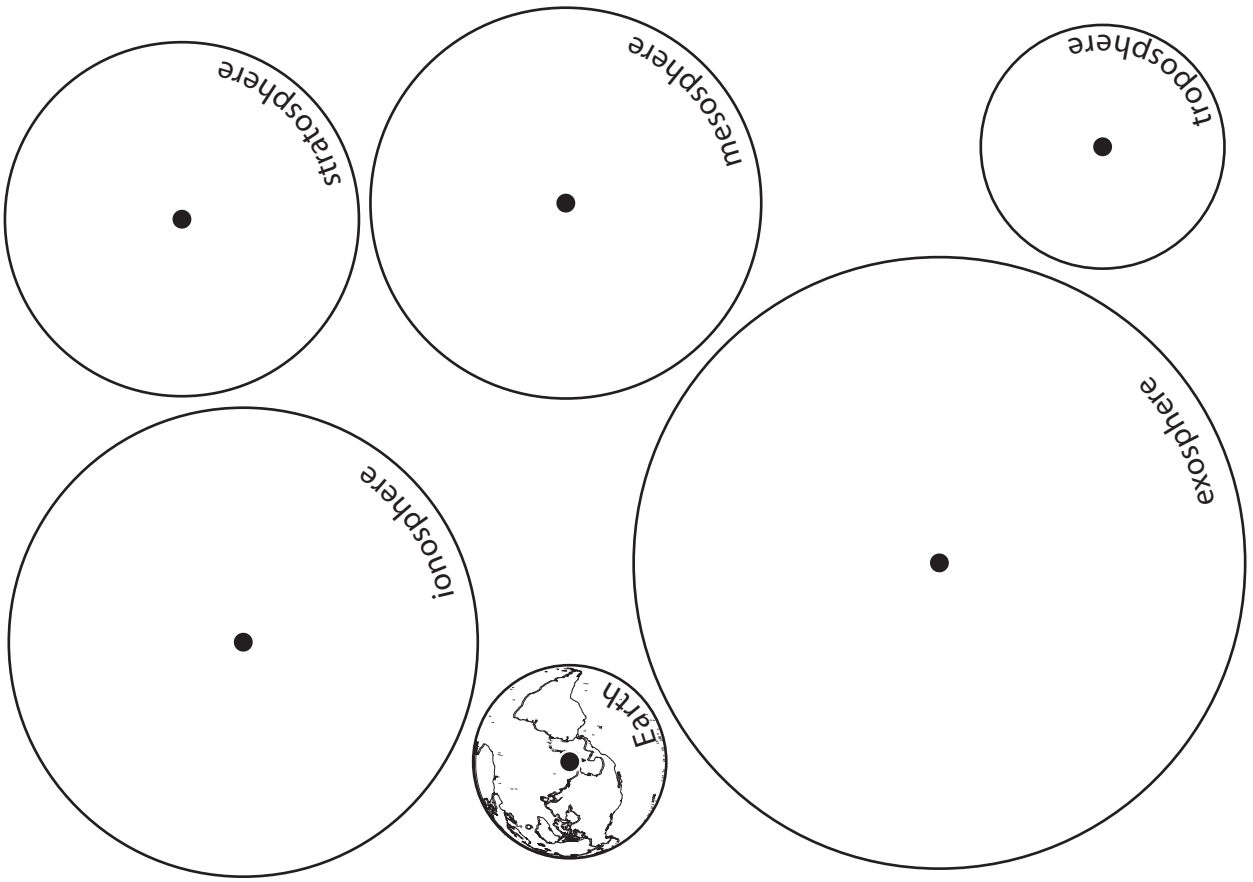
Procedure

1. On the Earth disk, color the water blue and the land brown.
2. Color the troposphere blue, the stratosphere yellow, the mesosphere orange, the thermosphere pink, and the exosphere purple.
3. Cut out the circles.
4. Punch a hole in each layer at the center mark. Optional: If glue is used, do not punch holes. Place a drop of glue at the center mark of each circle and follow the directions in Step 5.
5. Using the holes (center marks) as a guide, center the layers in a graduated order from largest to smallest (the exosphere on the bottom and the Earth on the top).
6. Use a brass fastener to fasten all layers together.

Conclusion

1. Which layer is closest to the Earth? _____
2. Which layer is farthest from the Earth? _____
3. Along which layer of the atmosphere did the volcanic ash from Mt. Luminous travel? _____

_____



Layers of the Atmosphere

Purpose

To identify the boundaries of the different layers of the atmosphere

Materials

grid sheet
pencil
colored pencils
research resources for the layers of the atmosphere

Procedure

1. Use internet or book resources to locate information on the layers of the atmosphere. Be sure to include each layer's boundary, location of the ozone layer, and what you might find in each layer.
2. Identify the boundary of the troposphere, stratosphere, mesosphere, thermosphere, and exosphere on the grid.
3. On the left-hand side of the grid, label each layer.
4. Use different color pencils to shade in the area of the grid represented by each layer.
5. Identify the location of the ozone layer and label.
6. Create a key for each of the following and place them in the correct atmospheric layer: aurora, airplane, ionosphere, magnetosphere, space satellites, living things, meteor, and weather.

Research

1. In which layer of the atmosphere is the jet stream located? _____
2. How fast does the jet stream flow? _____
3. What force holds the layers of the atmosphere to the Earth? _____
4. What is the most common gas in the atmosphere? _____
5. Why is the ozone layer important? _____

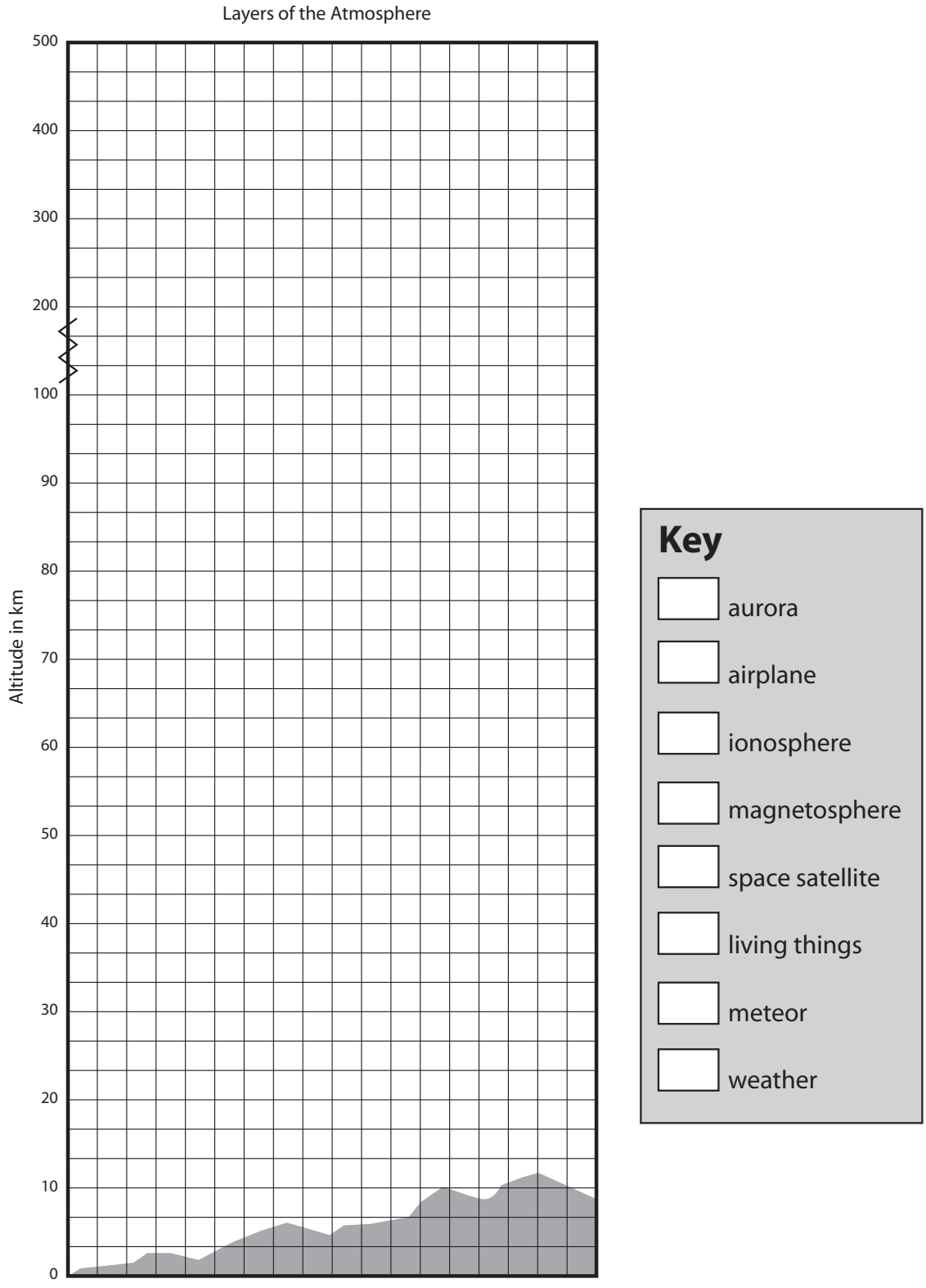
   _____

   _____
6. Why is the atmosphere important? _____

   _____

   _____

Layers of the Atmosphere



Riding the Jet Stream

Watch a weather forecast on your local news channel. Observe the position of the jet stream(s) and draw the jet stream(s) on the map below using green marker or pencil.

1. How many jet streams were there? _____
2. Why does the jet stream curve and bend? _____

_____

_____

3. Explain how the jet stream could carry dust and ash more quickly to Virginia from the Pacific Ocean. _____

_____

_____

_____

Tracking an Ash Cloud

Volcanic ash can be a serious hazard to jet airplanes when they are flying. Because pilots may not see volcanic ash clouds, they can fly into them. When ash is sucked into a jet engine, it can cause the engine to stall. Fortunately, when stalls have occurred, the pilots have been able to restart their engines, but only after losing many thousands of meters in altitude.

Procedure

You are an air traffic controller (teacher will assign you a location), and you have just received a warning that there was a major eruption of Mount St. Helens this morning. The air space you monitor is in the path of an ash cloud. Your job is to calculate approximately how many hours it will take the ash cloud to move into the air space you monitor. The warning notice states that the ash cloud is moving at a rate of 96 km/h (60 mph).

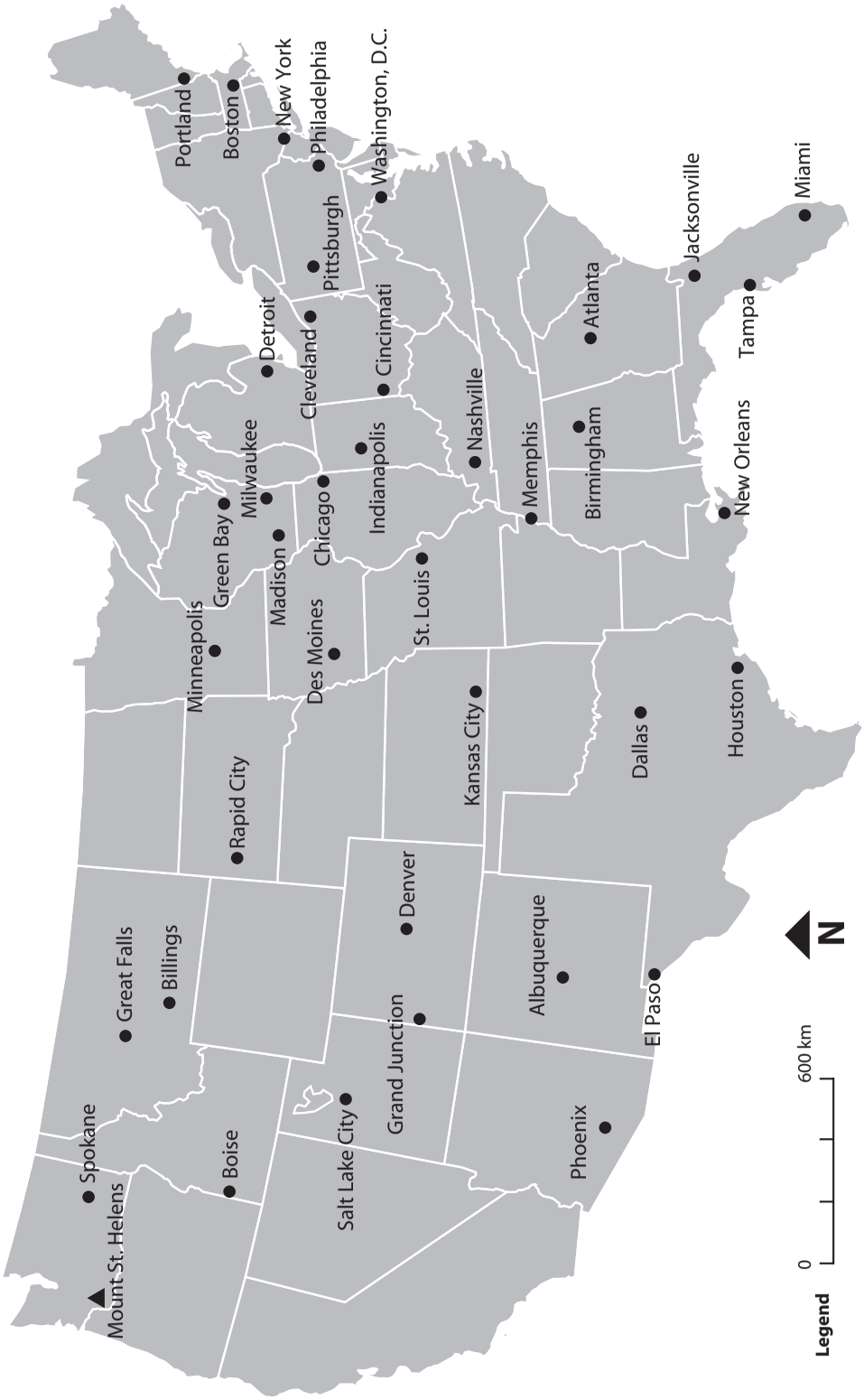
Knowing how fast the ash cloud is moving, your job is to calculate approximately how many hours (the time) it will take the ash cloud to reach your air traffic control tower.

1. On the map (Tracking an Ash Cloud), find the location of your assigned tower and circle it on the map.
2. Find Mount St. Helens and circle it on the map.
3. Look at the map legend. Calculate the number of kilometers (distance) your tower is from Mount St. Helens and record it here _____.
4. Use this formula to find how many hours (time) it will take the ash cloud to reach your tower.

$$\frac{\text{Distance (D)}}{\text{Rate (R)}} \quad X \quad \text{Time (T)}$$

5. The ash cloud will reach your air traffic control tower in_____hours.
6. A second plume of dust and ash has erupted and it is moving at 110 kilometers per hour. Calculate how many hours it will take this ash cloud to reach your tower.
7. How would the jet stream affect the time it takes for the ash cloud to reach your tower.

Tracking an Ash Cloud



Answer Key

How Fast Does She Blow?

1. 10
2. 8
3. 4
4. 6
5. 0
6. 2
7. 12

1. Vectors should graduate from short to longer.
2. 0-2
3. Draw the vector in the direction that the wind is blowing. If it were a northeast wind, you would point the vector NE.

Global Winds

1. The U. S. is in the Northern Hemisphere and lies within the prevailing westerlies.
2. The wind blows generally from the East to the West.
3. By learning that the prevailing westerlies blow from East to West, the tree house detectives realized that the ash and dust from Mt. Luminous would blow toward Virginia.
4. Wind helps move weather systems in the general direction of the wind pattern. Weather systems in the U.S. generally move from east to west.

As the World Turns

1. No, the line was not straight. The line curved inward because the disk was spinning.
2. The Earth is spinning, causing the wind to deflect to the right in the Northern Hemisphere. This deflection is called the Coriolis Effect. Wind in the Northern Hemisphere flows to the right as shown by the line on the disk.

Layer Upon Layer

1. troposphere
2. exosphere
3. troposphere and stratosphere

Layers of the Atmosphere

troposphere

up to 350 km per hour

gravity

nitrogen

The ozone layer protects us from harmful UV radiation.

The atmosphere is important because without it we could not sustain life. Oxygen in the atmosphere is necessary for us to breathe. The ozone layer protects us from UV rays that could cause skin cancer and even death, and the atmosphere provides us with weather that maintains the water cycle.

Tracking an Ash Cloud

7. The jet stream would be moving at a faster speed; therefore, the ash cloud would arrive much sooner.