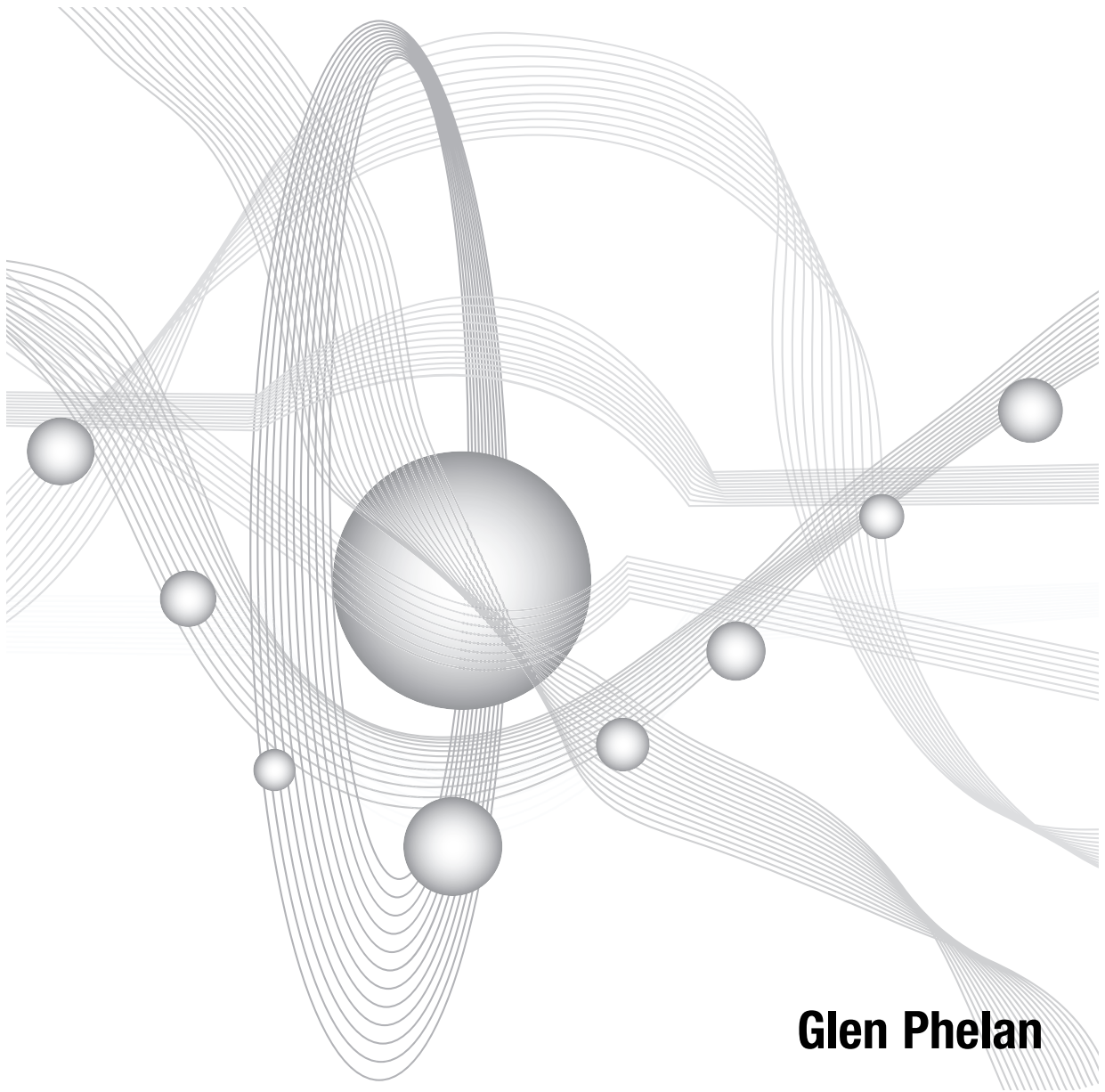


Real-Life Science

EARTH SCIENCE



Glen Phelan

WALCH  PUBLISHING

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Introduction

The *Real-Life Science* series is designed to engage students with topics of high interest that involve places, phenomena, technology, and concepts that they may encounter in their everyday lives. The topics were chosen by professionals in science education, and the National Science Education Standards were used to develop lessons that addressed a number of content standards. Each book in the series has a correlations chart that shows core standards that are addressed by each lesson, as well as other standards that are addressed, but are not the main focus of the lesson.

Using “real-life” examples is a technique that is well supported by the National Science Teaching Standards as well. The list below includes some of the standards that suggest that quality instruction can and should include material that does more than just require students to memorize and repeat basic facts.

Teaching Standard A

Teachers of science plan an inquiry-based science program for their students.

- Select science content and adapt and design curricula to meet the interests, knowledge, understanding, abilities, and experiences of students.

Teaching Standard B

Teachers of science guide and facilitate learning.

- Focus and support inquiries while interacting with students.
- Orchestrate discourse among students about scientific ideas.

Teaching Standard E

Teachers of science develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning.

- Structure and facilitate ongoing formal and informal discussion based on a shared understanding of rules of scientific discourse.
- Model and emphasize the skills, attitudes, and values of scientific inquiry.

Each book in the *Real-Life Science* series features lessons you can use in your classroom today. Use these engaging lessons to help your students explore the intriguing ways that science is at work all around them.

National Science Education Standards Correlations

C = Core standard

X = Other or optional skill

Title	Earth and Space Science Content Standard D Grades 9–12: Energy in the earth system	Earth and Space Science Content Standard D Grades 9–12: Geochemical cycles	Earth and Space Science Content Standard D Grades 9–12: Origin and evolution of the earth system	Earth and Space Science Content Standard D Grades 9–12: Origin and evolution of the universe	Science in Personal and Social Perspectives Content Standard F Grades 9–12: Natural resources	Science in Personal and Social Perspectives Content Standard F Grades 9–12: Environmental quality	Science in Personal and Social Perspectives Content Standard F Grades 9–12: Natural and human-induced hazards	Physical Science Content Standard B Grades 9–12: Motions and forces	Physical Science Content Standard B Grades 9–12: Interactions of energy and matter	Science and Technology Content Standard E Grades 9–12: Understandings about science and technology	Science in Personal and Social Perspectives Content Standard F Grades 9–12: Personal and community health	History and Nature of Science Content Standard G Grades 9–12: Historical perspectives
1. How Far Away Is the Horizon?			C							X		
2. How Can You Use a Topographic Map?			C							X		
3. How Did an Ancient Greek Scientist Measure the Size of Earth?			C							X		X
4. How Can You Read the Landscape?		C	C				X					
5. What's So Special About Yellowstone?		C	C		C	X		X				
6. Where Can You Find Moon Milk, Popcorn, and Soda Straws?		C	C			X						
7. How Do Communities Protect Themselves Against Earthquakes?			C			C	X	X	X	X	X	
8. What Is Happening to America's Wetland?					C	C	X	X		X	X	
9. What Lake on Earth Can No One Reach?					C	C						
10. How Do We Know the Temperature of Earth's Interior?	C		C					X	X	X		
11. Why Are Gemstones So Precious?		C	C		X							
12. Why Are Skies Blue, Clouds White, and Sunsets Red?	C					C			X			
13. When Can You See a Rainbow?	C								X			

(continued)

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14. What Do Clouds Tell Us About the Weather?	C					C		X	X			
15. Has It Ever Rained Cats and Dogs?						C	X					
16. Why Are Waves on the West Coast Larger Than on the East Coast?	C						X	X	X			
17. How Do Scientists Measure Sea Level?	C		C				X			X		
18. What Happened to the Giant Mammals of the Pleistocene?			C									
19. What Can Tree Rings Tell Us About the Past?			C			C					X	X
20. What Happened at Easter Island?					C	C	X					X
21. How Close Are We to Making Hydrogen Power a Reality?	C				X	C	X		X	X	X	
22. What Are Green Buildings?	C				X	C	X			X	X	
23. How Many Planets Are There?				C						X		
24. What Was the Purpose of Stonehenge?				C						X		X
25. How Dangerous Is Space Junk?						C	X	X		X	X	

National Research Council. *National Science Education Standards*. Washington, DC: National Academy Press, 1996.

National Research Council. "National Science Education Standards."
<http://books.nap.edu/readingroom/books/nse/6e.html#csa912>.

1. How Far Away Is the Horizon?

Topics

studying Earth, mapping, the horizon

Goals

To understand that Earth's curve produces a horizon and to use a formula to determine the distance to the horizon

Context

Most people, at one time or another, have probably gazed out at the horizon. The horizon may seem far away, especially when one is looking out over open water. But it's closer than one might think.

Teaching Notes

- Ask students what the horizon is. Be sure they understand that it is the distant line where the earth and sky seem to meet. Ask how far away they think the horizon is if looking out over an ocean or a wide grassy plain. Record their responses for comparison after they read the Explanation.
- Invite students to share their experiences about seeing different distances to the horizon. For example, after climbing a hill, students may have seen a distant object that they couldn't see at ground level.
- Relate the fact that visitors to the observation deck of the Sears Tower (110 stories) or John Hancock Center (100 stories) in Chicago can see almost 80 kilometers (about 50 miles) across

Lake Michigan to the shores of Michigan. At ground level, however, viewers can see only a few miles out into the lake.

- Ask students how one can use the horizon to tell that Earth's surface is curved. Lead them to recognize that having a distant object come into view as you increase your elevation can only occur if the surface is curved, not flat. Similarly, the highest parts of an approaching ship, such as the smokestack, will be the first to appear over the horizon. They will be the last parts to disappear if the ship is moving away.

Extension Activity

Students can easily model how the distance to the horizon depends on the height of the viewer. Use a large sphere such as a globe, a basketball, or a volleyball. Students can simply hold the ball at shoulder level and notice the horizon where the edge of the ball meets the background. Then students can stand on their tiptoes and notice that they can see slightly farther around the ball.

Answer Key

1. B
2. C
3. The buildings in a city and the tops of a forest would block an unobstructed view, giving a horizon that is not distant enough to be significantly affected by the curvature of Earth.

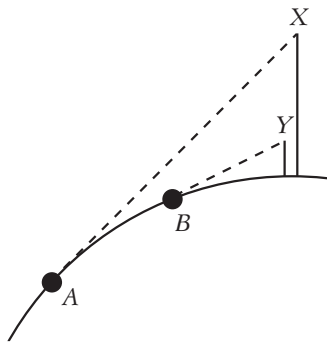
1. How Far Away Is the Horizon?

Explanation

Did you ever stand at the shore and look out over an ocean or a large lake? You see nothing but water all the way to the horizon—that line where Earth and sky seem to meet.

You cannot see beyond the horizon. That's because Earth's surface is curved. You can't see the surface beyond where it curves out of your sight.

So how far can you see before the surface curves out of your sight? It depends on your height above the surface. Look at the diagram. Observer *A* can see as far as point *X*. Observer *B* can see farther, to point *Y*. That's because observer *B* is higher above the surface, maybe in a building or on a hilltop.



You can use the following formula to tell the distance to the horizon:

$$\text{distance to horizon in kilometers} = \sqrt{\frac{\text{height above surface in centimeters}}{6.752}}$$

If you are sitting on the beach, leaning back on your elbows, your eyes might be only 75 centimeters above the water surface. So:

$$\text{distance to horizon} = \sqrt{\frac{75}{6.752}} = \sqrt{(11.11)} =$$

You could see almost 2 miles to the horizon.

If you are standing on the shore, your eyes might be 170 centimeters above the water. In that case:

$$\text{distance to horizon} = \sqrt{\frac{170}{6.752}} = \sqrt{(25.18)} = 5.018 \text{ kilometers (3.118 miles)}$$

You could see about 5 kilometers to the horizon.

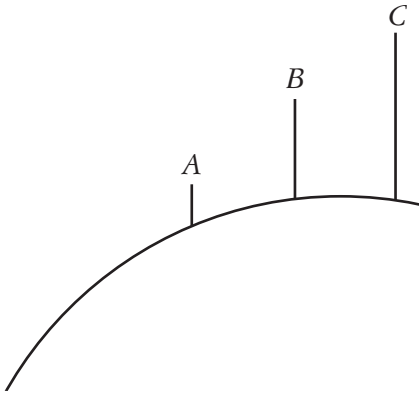
Either way, the horizon might be closer than you think. And it's all because of Earth's curve.

assessment page

1. How Far Away Is the Horizon?

Circle the letter of the best answer.

- The horizon is the _____.
 - highest point in the sky
 - line where Earth and sky seem to meet
 - part of Earth that you cannot see
 - center of Earth
- For which observer is the horizon the farthest away?



- A
 - B
 - C
 - The horizon is the same distance for all observers.
- What might the distance to the horizon be to a person standing near the ocean looking out to sea?
 - 1 kilometer
 - 5 kilometers
 - 10 kilometers
 - 300 kilometers

(continued)

assessment page

1. How Far Away Is the Horizon?

4. Suppose you are standing on a small sand dune near the shore looking out to sea. Your eyes are 4.3 meters (430 centimeters) above sea level. How far can you see to the horizon?
- a. 8 kilometers
 - b. 10 kilometers
 - c. 12 kilometers
 - d. 4.3 kilometers

Answer the following question.

5. Why would the formula for determining distance to the horizon probably not work in a city or a forest?

12. Why Are Skies Blue, Clouds White, and Sunsets Red?

Topics

meteorology, scattering light

Goal

To explain how the wavelengths of light in sunlight cause the variety of colors we see in the sky

Context

Most are familiar with the changing colors of the sky—from the deep blues of a clear day to the fiery oranges and reds of a sunset. Yet, most people take this spectacular display of light for granted. Few realize how the interaction of sunlight and air particles create the colors of the sky.

Teaching Notes

- Ask students to look out the window and describe the sky's appearance in terms of sunlight and wavelengths. If there are gray clouds, challenge students to explain the color. (The thicker the clouds are, the darker their bottoms will appear because less and less sunlight is able to get through.)
- The sky appears various shades of blue from day to day. Sometimes it looks almost white. Discuss possible explanations for these differences. Explain that bluer skies mean that there are fewer large particles in the air to scatter other

colors of light. Cold, dry air has fewer large particles of water vapor, so these conditions often bring the deepest blue skies. Humid days, on the other hand, often have skies that are very faint blue because the larger water vapor particles scatter light of all wavelengths.

- Point out that there is no air on the moon. Then ask what color the moon's sky is. (The moon's sky is black because there are no air particles to scatter the sunlight before it strikes the moon's surface.)
- Explain that huge volcanic eruptions can affect the color of the sky around the world. When Mount Pinatubo erupted in the Philippines in 1991, it belched clouds of dust and gas high in the atmosphere that circulated around the world for 18 months. During that time, the extra particles in the air produced amazing sunsets of orange and red.

Extension Activity

Demonstrate the scattering of light. Stir a few drops of milk into a large jar of water. Then shine a flashlight through the jar. The liquid will appear blue and the light exiting the jar will look slightly reddish. Ask students to explain these observations. (The milk helps to scatter the blue wavelengths, leaving light of longer wavelengths, such as red, to exit the jar.)

(continued)

12. Why Are Skies Blue, Clouds White, and Sunsets Red?

Answer Key

1. d
2. a
3. b
4. c
5. The water droplets and ice crystals that make up clouds are large enough to scatter all wavelengths of light, which combine to form white.
6. The longer journey means the more red and orange light gets scattered away before reaching our eyes, leaving the longer wavelengths of yellow, orange, and red.
7. Because of Rayleigh scattering, slightly longer or moderate wavelengths scatter the light of longer wavelengths than blue. In the sky, light appears green or yellow.

12. Why Are Skies Blue, Clouds White, and Sunsets Red?

Explanation

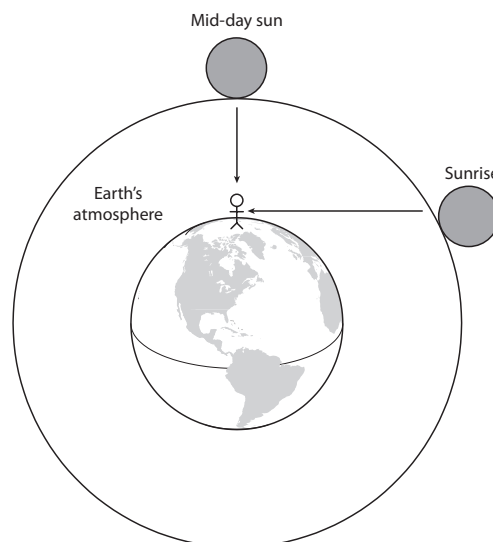
From sunrise to sunset, the daytime sky shows a range of spectacular colors. The source of these colors is the sun. So to understand the colors of the sky, you have to know something about sunlight.

Sunlight is a mixture of seven colors: red, orange, yellow, green, blue, indigo, and violet. When combined, these colors of light become white. Therefore, sunlight traveling through outer space is white, or colorless.

Another property of sunlight is that it travels in waves. Each color in sunlight has its own wavelength. In space, nothing interferes with the sunlight, and the wavelengths stay together forming white light. When sunlight enters Earth's atmosphere, however, it encounters molecules of various gases. Some of the light bounces off these molecules in all directions and becomes scattered in the sky. The tiny air molecules are the right size to scatter the shorter wavelengths of light, mostly blue. Longer wavelengths of light, such as red, pass through the air unscattered. Therefore, a sunlit sky looks blue.

Sunlight passing through the air also strikes clouds. The water droplets and ice crystals that make up the clouds are clear. Why, then, do clouds look white? The water droplets and ice crystals are much larger than air molecules. In fact, they are large enough to scatter light of all wavelengths, not just blue. The scattered light of all colors mixes and makes the clouds look white.

At sunrise and sunset, the sun is low in the sky. Its light passes through more air than it does during the day, as the drawing shows. The longer path means that more and more blue light gets scattered away before reaching our eyes. That leaves the longer wavelengths of yellow, orange, and red—the colors of sunrise and sunset.



assessment page

12. Why Are Skies Blue, Clouds White, and Sunsets Red?

Circle the letter of the best answer.

1. All the colors of sunlight combine to form _____ light.
 - a. black
 - b. blue
 - c. red
 - d. white

2. Which color of light has the shortest wavelength?
 - a. blue
 - b. orange
 - c. red
 - d. yellow

3. When light waves scatter, the light
 - a. gets absorbed by particles.
 - b. bounces off particles.
 - c. stops shining.
 - d. turns to black.

4. A sunlit sky looks blue because
 - a. clouds scatter all wavelengths of light.
 - b. clouds reflect all wavelengths of light.
 - c. air molecules scatter the shorter wavelengths of light.
 - d. air molecules scatter the longer wavelengths of light.

(continued)

22. What Are Green Buildings?

Topics

environmental science, cogeneration, energy efficiency, green roofs, energy conservation, alternate energy sources

Goal

To explain some of the characteristics of environmentally friendly green buildings

Context

More and more, people are talking about green cars, green development, and green buildings. One might reasonably guess that the adjective *green* has something to do with being environmentally friendly. In general, that's correct. But there are some specific characteristics that make buildings "green."

Teaching Notes

- Ask students which of the topics in the Explanation interests them the most. Encourage them to find out more about that topic. They should begin by generating a list of questions. Model this process by developing questions as a class about one of the topics, such as energy efficiency.
- Discuss how green roofs cool the surrounding area. Ask students if they have ever noticed a sudden drop in temperature as they walked, biked, or drove past a wooded area from a non-wooded area. Explain that the cooler

temperatures are caused largely by the evaporation of water from the leaves—a process called transpiration. This process pulls energy from the atmosphere, cooling it. The vegetation on green roofs does the same thing. It also lessens the number of tar-covered or other dark, heat-absorbing roofs that are more typical in a city.

- Emphasize that making buildings green is not only good for the environment, it makes good economic sense, too. For example, Chicago recently retrofitted all 105 of its fire stations with energy-efficient lighting. This effort saves the city \$250,000 annually in electricity bills.

Extension Activity

Demonstrate the energy efficiency of fluorescent lights over incandescent lights. Obtain a compact fluorescent bulb and an incandescent bulb with the same light output in lumens (written on the package). Place a thermometer about a foot from each bulb. Turn on both bulbs. After five or ten minutes, have students read the temperatures. The temperature from the incandescent bulb will be significantly higher than that of the fluorescent bulb. Ask a student to explain why. (The incandescent bulb converts most of the electricity to heat. The fluorescent bulb converts most of the electricity to light, which is the purpose of the bulb.)

(continued)

22. What Are Green Buildings?

Answer Key

1. Biomass
2. wind
3. solar
4. wind
5. Cogeneration is the production of two useful forms of energy from the same source. For example, after steam has turned turbines to produce electricity in a power plant, it can be directed to heat water in nearby buildings.
6. Energy efficiency means getting more use of the energy we use. Energy conservation means reducing the amount of energy we use in the first place.

22. What Are Green Buildings?

Explanation

A green building has nothing to do with what color it's painted. It has everything to do with how the building is designed, constructed, operated, and maintained. Simply put, a green building is one that is environmentally friendly. That could mean many things. Green buildings usually have at least some of the characteristics described below.

Energy efficiency

Green buildings try to get the most out of the energy they use. For example, typical incandescent lightbulbs are only about 5% efficient; most of their energy is given off as heat, not as light. Fluorescent lightbulbs, on the other hand, are about 22% efficient. In addition to lighting, green buildings use high-efficiency heating and cooling equipment.

Cogeneration

Some buildings use a process called cogeneration to produce two useful forms of energy from the same source. For example, the steam produced at a power plant is usually wasted once it does its main job of turning turbines to produce electricity. But this steam can be channeled to heat water in nearby buildings or even to produce more electricity to run machines at the plant.

Energy conservation

Green buildings are designed to use only the amount of energy that's needed. Green building engineers and maintenance crews know the importance of keeping air ducts clean, weather-stripping doors and windows, and controlling the level of heating and air conditioning.

Alternative energy sources

Green buildings use energy sources other than fossil fuels to provide heating and electricity. Large south-facing windows take advantage of sunlight to warm the building and provide natural light. More citizens, companies, and local governments are installing solar panels to heat water and even provide electricity. In Chicago, a project is underway to install wind turbines on one of the city's largest downtown civic buildings to generate some of the building's electricity.

Green roofs

From the air, some buildings really do look green. But they're more than just rooftop gardens. Green roofs are almost totally covered with grass and other plants. The green roofs help keep a city cooler. They also reduce the amount of storm water that would runoff into the sewers, thereby decreasing the burden on the sewer system.

These are just some of the many ways that people are choosing to make buildings that use resources more wisely.

