Activity 2: The Earth's Shape and Gravity

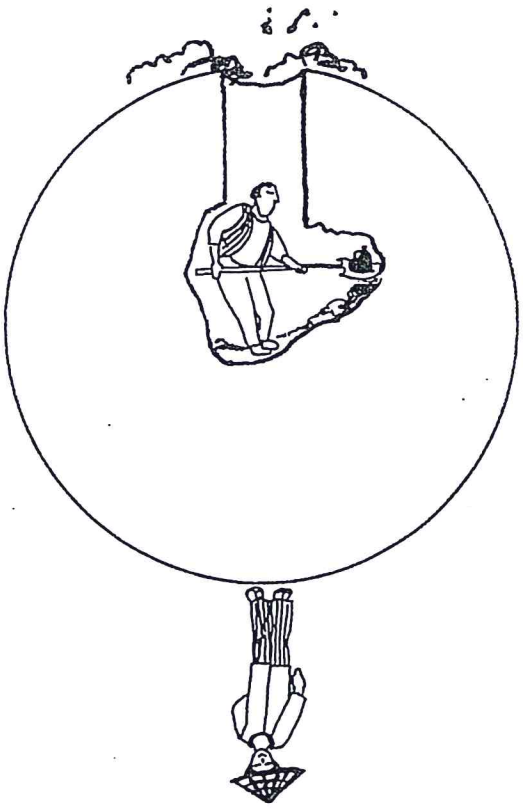
Introduction

Despite the evidence of our senses, we are told as early as the first and second grades that the Earth is really shaped like a ball, that the Earth is round. Perhaps you also remember someone telling you that you could "dig a hole all the way to China," or that people in faraway nations lived "down under your feet, on the other side of the world."

These statements seem unbelievable to us at first, but they are consistent with what we learn in school about the ball-shaped Earth. These early childhood memories provide our first conceptual suggestions about what a ball shaped Earth implies. As such, they are truly significant learning experiences.

In this activity, a questionnaire launches your students on animated discussions about the implications of the ball-shaped Earth model, which in turn helps lead to a deeper understanding of gravity.

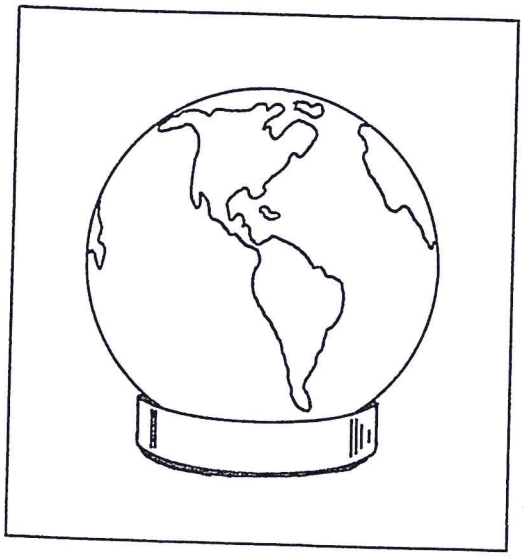
When you lead discussions with your students, please keep in mind that ideas and insights about the Earth's shape and gravity develop gradually. **Getting the "right answer" is not as important as the critical thinking skills that students develop as they struggle to apply their mental models of the Earth to real and imaginary situations.**



Although designed for younger students, the Seeds of Science/Roots of Reading *unit entitled* Gravity and Magnetism *has some excellent activities. You may be interested in the student books for that unit, which can be purchased separately, especially* Gravity Is Everywhere.

Time Frame

Part I: What Are Your Ideas?	30 minutes
Part II: Discussion	40 minutes



What You Need

For the class:

- ❑ 8 copies of the "What Are Your Ideas About Earth?" questionnaire (master included, page 14)
- ❑ 8 Earth globes or other large balls
- ❑ 8 bowls or rolls of tape (to support globes)

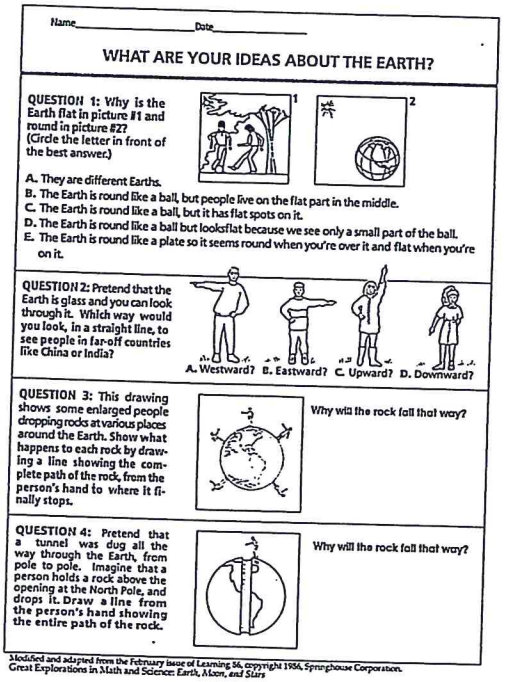
For each student:

- ❑ 1 copy of the "What Are Your Ideas About the Earth?" questionnaire

Getting Ready

1. Copy the questionnaire, making one copy for each student, plus eight additional copies.

2. Borrow eight Earth globes, or obtain beach balls, basketballs, or other large balls to represent the Earth. Remove the globes from their stands, and place them on bowls or rolls of tape, so they will not roll off the tables.



Name_____ Date_____

WHAT ARE YOUR IDEAS ABOUT THE EARTH?

QUESTION 1: Why is the Earth flat in picture #1 and round in picture #2? (Circle the letter in front of the best answer.)

1 2

A. They are different Earths.
B. The Earth is round like a ball, but people live on the flat part in the middle.
C. The Earth is round like a ball, but it has flat spots on it.
D. The Earth is round like a ball but looksflat because we see only a small part of the ball.
E. The Earth is round like a plate so it seems round when you're over it and flat when you're on it.

QUESTION 2: Pretend that the Earth is glass and you can look through it. Which way would you look, in a straight line, to see people in far-off countries like China or India?

A. Westward? B. Eastward? C. Upward? D. Downward?

QUESTION 3: This drawing shows some enlarged people dropping rocks at various places around the Earth. Show what happens to each rock by drawing a line showing the complete path of the rock, from the person's hand to where it finally stops.

Why will the rock fall that way?

QUESTION 4: Pretend that a tunnel was dug all the way through the Earth, from pole to pole. Imagine that a person holds a rock above the opening at the North Pole, and drops it. Draw a line from the person's hand showing the entire path of the rock.

Why will the rock fall that way?

Modified and adapted from the February issue of Learning 84, copyright 1984, Springhouse Corporation. Great Explorations in Math and Science: Earth, Moon, and Stars

Part I: What Are Your Ideas?

1. Hand out copies of the questionnaire. Ask your students to write their names at the top of their papers and to answer the questions. Allow 10 to 15 minutes for the students to finish. Collect the students' papers so you can look over their ideas later.

2. Organize the class into eight discussion groups of three to five students per group. Explain that each team is to discuss the questions and come to an agreement, if possible, on the best responses.

3. Give each group an Earth globe and one blank questionnaire to use for recording their final answers.

4. Circulate among the groups of students, encouraging them to discuss any disagreements fully and to use the globes to demonstrate their ideas. Groups who agree on the answers early should be instructed to make a list of arguments in support of their answers.

Part II: Discussion

1. Lead the class in a discussion about the questionnaire. Play the role of moderator, requiring each group to support their ideas with arguments or to demonstrate using the Earth globes.

2. After discussing one question, poll the students on the alternative answers. Do not announce the correct answers at this time; students should be encouraged to think for themselves.

3. Following is a description of the kinds of answers you can expect from your students and some suggestions for facilitating the discussion:

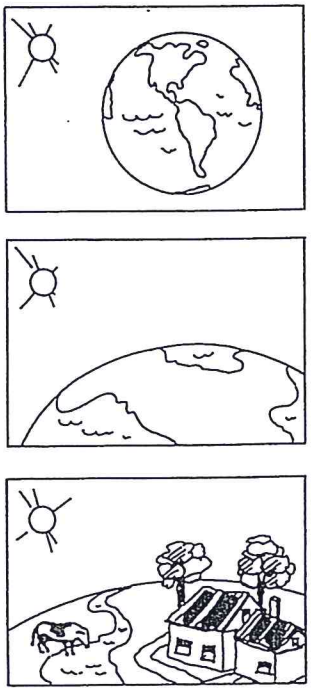
Question 1. The correct answer is: "d. The Earth is round like a ball, but looks flat because we see only a small part of it."

You can expect some variation in your students' ideas on this question, since it requires a correct understanding of the part-to-whole relationship between the "flat ground" of our everyday experience, and the "ball-shaped Earth" that we learn about in school. For example, one student thought that the Earth we live on is really flat, and the ball-shaped Earth is "a planet in the sky, where only astronauts go."

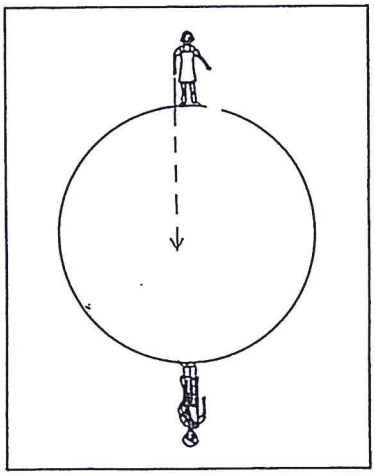
Question 2. The correct answer is: "d. Downward."

When first confronted with this question, most people try to imagine which direction they would fly in a plane to get to Australia, and will answer, "eastward" or "westward." Ask your students to imagine that the Earth is made out of glass and that they can look straight through it. You might also use a globe and a ruler to show what happens if you look due east or west: the ruler (representing the way you would look) points off into space.

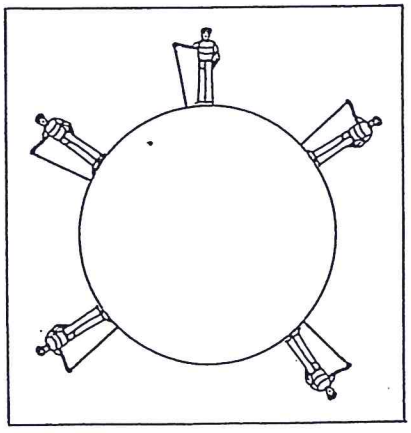
Question 3. The correct answer shows each rock falling straight down, landing next to the person's feet. It is common for students to show the rocks falling off the Earth, to an absolute down direction in space, or to compromise the two views by showing the rocks falling at an angle.



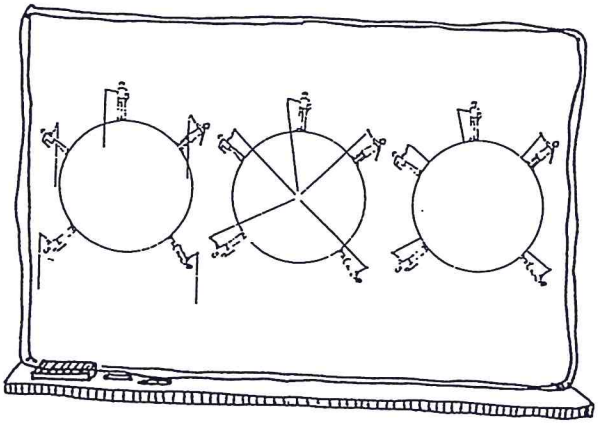
Question 1.



Question 2.



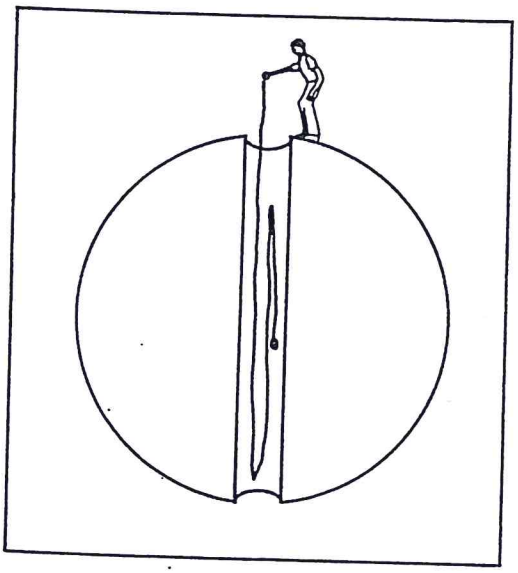
Question 3.



To help the students discuss their answers to this question, draw three or four large circles on the board, each with figures holding rocks as shown on the questionnaire. Invite students to come up to the board to draw their answers. The pictures of three or four alternative views will help you focus the discussion on which answer is best.

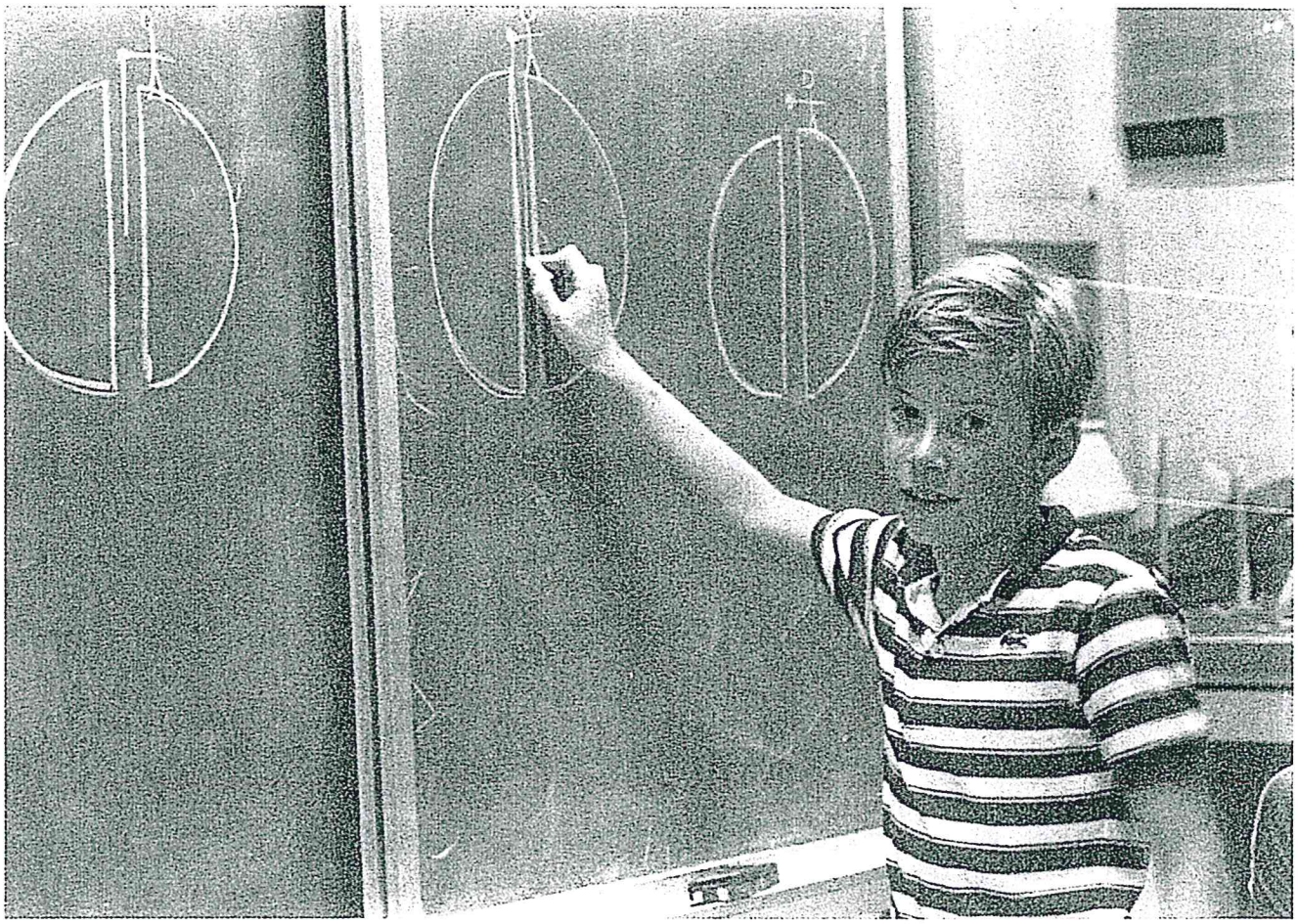
At some point in the discussion, you may need to explain why "down" is always toward the center of the Earth. Ask your students to think about the people who live all around the ball-shaped Earth. The only way to explain why these people do not fall off is to imagine that "down" is toward the center of the Earth. To demonstrate this idea, turn an Earth globe so that the South Pole is "up" and ask the students to imagine being there. People on the South Pole must think that people in the Northern Hemisphere live upside-down!

Question 4. This one stumps many adults! The best way to explain what occurs is to explain the history of the concept of *gravity* in this way:



When the ancient Greeks came up with the idea of a ball-shaped Earth, they had to explain why people who lived on the other side of the world didn't fall off. Aristotle, who lived about 2,300 years ago, thought that everything went to its "natural resting place" in the center of the universe, which he believed to be at the center of the Earth. If Aristotle had filled out the questionnaire, he would have drawn a line to the center and stopped there.

The idea was revised "only" about 300 years ago by Isaac Newton, who believed that the rock falls because of a pulling force between every particle within the Earth and every particle within the rock. He named the force *gravity.* From the rock's point of view, "down" is always toward the greater mass of the Earth. Before it reaches the center of the Earth, the rock keeps going faster and faster because it is still falling "down." It only starts slowing after it passes the center, because then the greater mass of the Earth is behind it. If Isaac Newton were to fill out the questionnaire, he would draw the rock falling back and forth between the two poles of the Earth, until air resistance finally slowed it down. Eventually, it would settle in the exact center of the Earth, suspended in the middle of the tunnel.



Again, it is helpful to draw several circles on the board, showing the figure and tunnel in each one. Invite students to come up and draw their answers until several different ideas are represented. Then lead a discussion debating the merits of each idea.

4. After the discussion, give the correct answers, as outlined above, as "the opinion of most scientists."

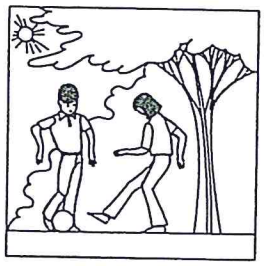
5. To evaluate this activity, have your students complete the questionnaire again, two or three weeks later.

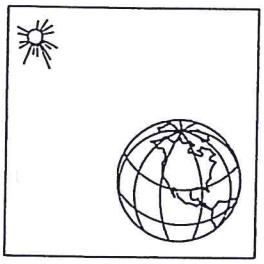
Research on how students gain understanding of the Earth's shape indicates that the learning process is a gradual one. The questionnaire can be used to construct a class "profile" and determine levels of understanding to help guide appropriate Going Further activities. See pages 53–54 of this guide for suggestions on how to do this.

Name_____ Date_____

WHAT ARE YOUR IDEAS ABOUT THE EARTH?

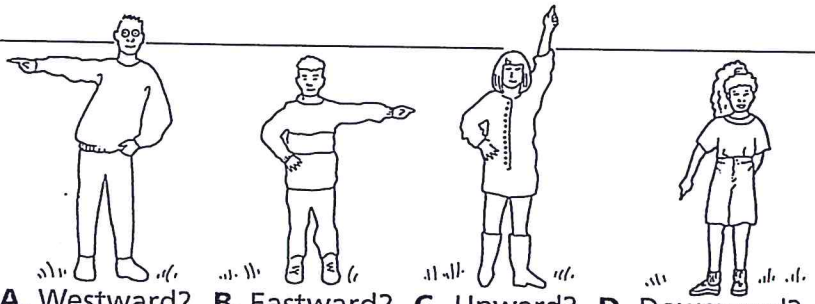
QUESTION 1: Why is the Earth flat in picture #1 and round in picture #2?
(Circle the letter in front of the best answer.)


1


2

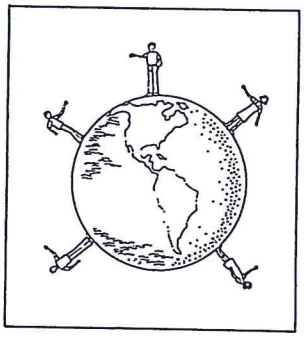
A. They are different Earths.
B. The Earth is round like a ball, but people live on the flat part in the middle.
C. The Earth is round like a ball, but it has flat spots on it.
D. The Earth is round like a ball but looks flat because we see only a small part of the ball.
E. The Earth is round like a plate, so it seems round when you're over it and flat when you're on it.

QUESTION 2: Pretend that the Earth is glass and you can look through it. **Which way would you look, in a straight line, to see people in far-off countries like China or India?**



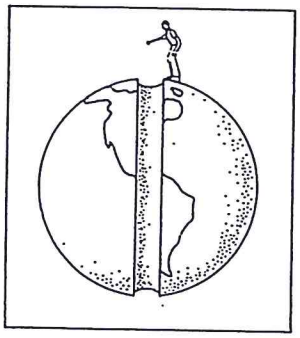
A. Westward? **B.** Eastward? **C.** Upward? **D.** Downward?

QUESTION 3: This drawing shows some enlarged people dropping rocks at various places around the Earth. **Show what happens to each rock by drawing a line showing the complete path of the rock, from the person's hand to where it finally stops.**



Why will the rock fall that way?

QUESTION 4: Pretend that a tunnel was dug all the way through the Earth, from pole to pole. Imagine that a person holds a rock above the opening at the North Pole, and drops it. **Draw a line from the person's hand showing the entire path of the rock.**



Why will the rock fall that way?