

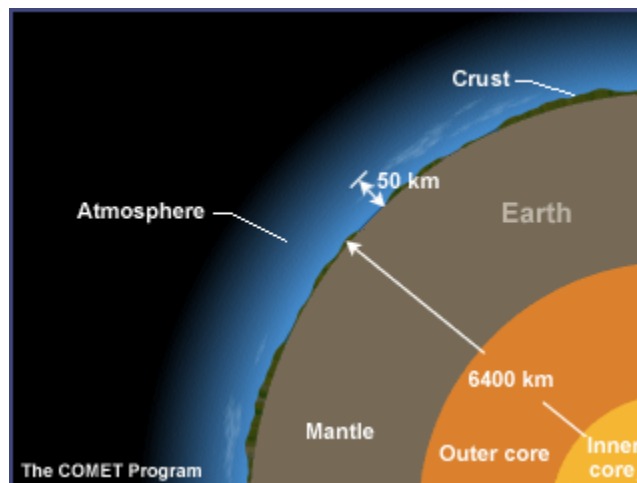
How High Does the Atmosphere Go?

Portions of this activity have been modified from "Global Warming and the Greenhouse Effect," Great Explorations in Math and Science (GEMS) series. (Copyright permission pending)

This two-part activity demonstrates the relative thickness of the thin layer that includes the troposphere and stratosphere. Students will be able to explain how relatively thin the atmosphere is, compared to the size of the planet and will understand the relative extent of the four major atmospheric layers.

Background

While we think of the atmosphere as a vast ocean of air around us, it is very thin relative to the size of the earth. The "thickness" of the atmosphere (the distance between the earth's surface and the "top" of the atmosphere) is not an exact measure. Although air is considered a fluid, it does not have the same well-defined surface as does water. The atmosphere just "fades away" into space with increasing altitude. Compared with the radius of the earth (6,370 km or 3,949 miles), the depth of the atmosphere is quite shallow.



Over 99% of the mass of the earth's atmosphere is contained in two layers: the troposphere and the stratosphere. Most of the earth's atmosphere (80 to 90%) is found in the troposphere, the atmospheric layer where we live. This layer, where the earth's weather occurs, is within about 12 km (7 miles) of the earth's surface. The stratosphere goes up to about 53 km (29 miles). Gravity is the reason the atmosphere is more dense closer to the earth's surface.

This activity demonstrates the relative thickness of the thin layer that includes the troposphere and stratosphere. This layer is essential to all life on earth.

Learning Goals

1. Students will be able to explain how relatively thin the atmosphere is, compared to the size of the planet.
2. Students will understand the relative extent of the four major atmospheric layers.

Alignment to National Standards

National Science Education Standards

- Earth and Space Science, Structure of the Earth System, Grades 5 to 8, pg. 160, Item #8: "The atmosphere has different properties at different elevations."

Benchmarks for Science Literacy, Project 2061, AAAS

- The Physical Setting, The Earth, Grades 6 to 8, pg. 68: "The Earth is mostly rock. Three-fourths of its surface is covered by a relatively thin layer of water (some of it frozen) and the entire planet is surrounded by a relatively thin blanket of air. It is the only body in the solar system that appears able to support life."

Grade Level/Time

- **Grade level:** 6 to 9
- **Time**
 - Part 1: 30 minutes
 - Part 2: 15 minutes to set up the model

Materials

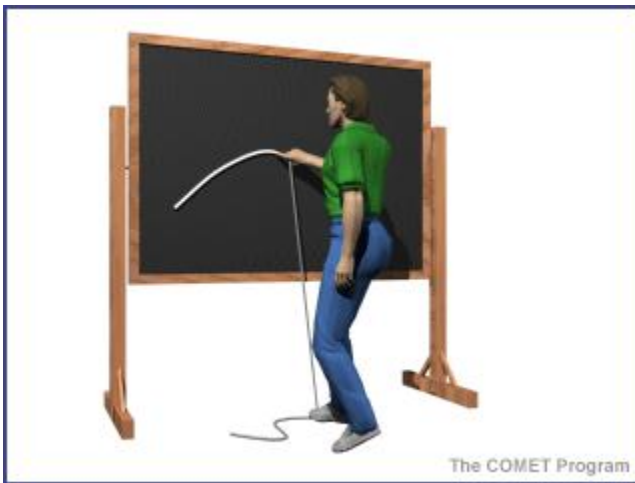
- *Part 1*
 - Chalk board or other drawing surface mounted on a wall
 - Chalk
 - 2-m piece of string
 - An apple
- *Part 2*

- 1000 ml (1 liter) graduated cylinder
- Four bags of fish gravel or colored sand (different colors)

Procedure

Part 1

1. Tie a piece of chalk to one end of the string. Standing next to the chalkboard, place your foot on the free end of the string and draw an arc on the board with a radius of about 4 feet. Your foot represents the center of the earth. The arc represents the surface of the earth.

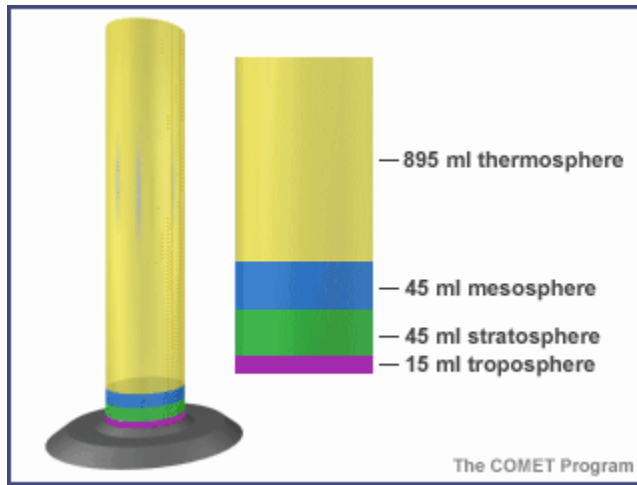


2. Ask students to suggest how far the earth's atmosphere would extend above the surface in this drawing. Mark their suggestions on the board above the chalk line.
3. Tell the students that scientists have found that over 90% of the earth's atmosphere is within about seven miles (12 km) of the earth's surface. The distance from the center of the earth to its surface equals about 4,000 miles. The scale of the chalkboard drawing is about 1 foot = 1,000 miles (1610 km). So, on this scale, seven miles is a little less than 1/8th of an inch (about as thick as the chalk line), and 90% of the earth's atmosphere lies within the thickness of the chalk line used to draw the surface of the earth.
4. Another way of understanding how far out the atmosphere extends is to imagine that the earth has shrunk to the size of an apple. At that scale, the atmosphere is only the thickness of the skin of the apple. Use an apple for a demonstration.

Part 2

Build a model of the structure of the atmospheric layers to show your students the relative extent of the four layers of the atmosphere (troposphere, stratosphere, mesosphere, thermosphere).

Use a 1000 ml graduated cylinder and represent the layers by using the following amounts of fish gravel or colored sand.



Atmospheric Layer	Color Code	Thickness	Top of Layer
Troposphere	Color 1	15 ml	15
Stratosphere	Color 2	45 ml	60
Mesosphere	Color 3	45 ml	105
Thermosphere	Color 4	895 ml	1000

Keep in mind these are relative proportions and not exact points of departure for the different layers.

Observations and Questions

1. What atmospheric layers are represented by the different colors?
2. How much thicker is the stratosphere compared to the troposphere?
3. How much thicker is the thermosphere compared to all the other layers combined?
4. Where in this model would you expect to find clouds?
5. Where in this model would you expect to find Mt. Everest?
6. Where in this model would you expect to find a satellite?
7. Where in this model would you expect to find the space shuttle?

Assessment Ideas

1. Use the apple question suggested in the procedure and have students respond in writing or with a picture instead of simply orally in class.
2. Have students make a labeled diagram on a small notecard illustrating the most important point of the lesson.

3. Ask students to imagine that they're in orbit around a planet one half the size and mass of the earth, but otherwise identical. They should explain how they would expect the atmosphere of the new planet to be different from ours.
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Modifications for Alternative Learners

- None needed; the lesson is fast, clear, visual, and should neither bore advanced students nor pose low readers any difficulties.

When you're finished with the activity, click on Back to Activities List at the top of the page to return to the activity menu.

