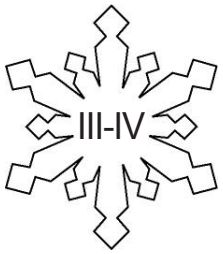
Layering the Air

Levels



Grades 5-8

Overview:

Students learn the composition and layers of the atmosphere through discussion, creation of a scale model, and a written exercise. (NOTE: This lesson may require more than one class period. Students should have a basic understanding of gases prior to this lesson.)

Objectives:

The student will:

- identify the layers of the atmosphere;
- determine how Earth's atmosphere was formed;
- identify the scientists involved in early atmospheric research; and
- create a scale model of the layers of the atmosphere.

GLEs Addressed:

Science

- [5-8] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.
- [5] SA1.2 The student demonstrates an understanding of the processes of science by using quantitative and qualitative observations to create inferences and predictions.
- [5] SG4.1 The student demonstrates an understanding that advancements in science depend on curiosity, creativity, imagination, and a broad knowledge base by investigating that scientists' curiosity led to advancements in science.

Math

- [6] E&C-5 The student accurately solves problems (including real-world situations) by developing or interpreting scale models (scale factors such as 1 in. = 1 ft.).
- [7] E&C-6 The student accurately solves problems (including real-world situations) by solving proportions using a given scale.
- [7] MEA-3 The student demonstrates understanding of measurement techniques by applying a given scale factor to find missing dimensions of similar figures.

Materials:

- Highlighters (one per group)
- Strip of paper, 3.5 meters long (one per group)
- Set of markers: blue, purple, yellow, orange, and green (one set per group)
- Gallant, R. (2003). *Atmosphere: Sea of Air*. Tarrytown, NY: Benchmark Books.
- *Climate Change* Interactive DVD
- OVERHEADS: "Composition", "Solar Energy", and "Layers of the Atmosphere"
- STUDENT WORKSHEET: "Layering the Air"

Activity Preparation:

Copy chapter one (pages 8 – 15) of *Atmosphere: Sea of Air*, so that each student has a copy.

Activity Procedure:

1. Ask students what we breathe (*air, oxygen, etc.*). Ask what we exhale (*carbon dioxide*). Ask what the atmosphere, or air, is composed of. Explain that the atmosphere is composed of a mixture of gases, including oxygen and carbon dioxide.
2. Show OVERHEAD: "Composition." Explain only 21% of the air is oxygen; and only 0.03% is carbon dioxide. The rest is nitrogen, which makes up 78%; argon, which makes up 0.9% (more than carbon dioxide); and other gases, such as methane and water vapor (the remaining 0.07%). (NOTE: This proportion of gases is consistent throughout the atmosphere, except for local variations in water vapor and the ozone layer.)
3. Explain that ancient civilizations did not understand that air was a mixture of gases. It wasn't until the 1700s that air was "discovered." In the mid-1700's Joseph Black discovered carbon dioxide, although at the time he called it "fixed air."
4. Distribute the copies of chapter one of *Atmosphere: Sea of Air* and instruct students to read the chapter. This may be done individually, in small groups, or as a class. To encourage note taking, ask students to highlight one sentence from each paragraph they feel is important.

Teacher Note: Taking notes can aide students in understanding and retention. After each student has read the entire chapter, assign each student (or group of students) a section of the chapter. Ask students to highlight one sentence (if they have not already done so), underline one phrase, and circle one word in each paragraph of their assigned section they feel is important. (NOTE: the phrase and the word should not be in the same sentence as the highlighted sentence.) Ask each student to write their selected words in the order they appear in their assigned section to form a small poem. Write each student's small poem in order as they appear in the text to make a classroom "Atmosphere Poem."

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5. Review OVERHEAD: "Composition." Remind students that, in general, the atmosphere is 78% nitrogen, 21% oxygen, 0.9% argon, and 0.03% carbon dioxide.
6. Show OVERHEAD: "Solar Energy." As energy from the sun (solar radiation) passes through Earth's atmosphere, some energy is absorbed and some is reflected. The composition of the atmosphere affects how much solar radiation is absorbed. Some atmospheric gases, such as carbon dioxide, absorb heat, and keep Earth's surface warm. Without these gases, Earth would be very cold and extremely unlikely to support life.
7. Explain that scientists have given names to each of the layers of the atmosphere. Their temperature distinguishes the layers. Display the "Earth's Weather" chapter of the *Global Climate* Interactive DVD. Explain that the layer we live in is called the troposphere. This is the layer in which weather occurs. The troposphere extends up to approximately 16 kilometers (10 miles). (NOTE: The exact height of the layer varies with season and geographical location.)
8. The layer above the troposphere is called the stratosphere. The stratosphere starts at 16 kilometers (10 miles), and extends 32 kilometers (20 miles) upward, ending at 50 kilometers (31 miles). The ozone layer and jet stream exist in this layer.
9. The next layer is the mesosphere, which is much colder than the stratosphere. The mesosphere begins at 50 kilometers (31 miles) and extends up to 80 kilometers (50 miles).
10. The thermosphere is the thickest layer of the atmosphere, extending from 80 – 500 kilometers (50-310 miles). This layer of the atmosphere borders outer space.

Critical Thinking Question: Information Processing Method. Display OVERHEAD: "Layers of the Atmosphere." As a class, discuss the graph; what does it show? (*The graph shows the change of atmospheric temperature with height. The thermosphere is the warmest; the mesosphere is the coolest.*) Ask students to divide into pairs and instruct them to write a few sentences explaining why the troposphere decreases in temperature at higher elevations. Ask students to share their explanation

with the class. If necessary, explain solar radiation is absorbed into Earth, and then radiated back into the atmosphere. Just as one feels less warmth the farther they go from a fire, so the temperature will be cooler the farther one gets from the heat that Earth radiates back into the atmosphere.

Teacher's Note: The temperature rises in the stratosphere and cools in the mesosphere as the elevation increases. This is due to the presence of the ozone layer, which occurs at the boundary between the mesosphere and stratosphere (stratopause). The ozone layer absorbs solar radiation, similar to Earth itself, and radiates the heat back out into the atmosphere warming the atmosphere around it. The thermosphere is warmer than the other layers because of its proximity to space; it receives large amounts of solar radiation.

11. Divide students into groups and distribute the STUDENT WORKSHEET: "Layering the Air" and strips of paper. Explain that a scale drawing is a drawing that represents a real object at the same proportion, but smaller or larger than the actual object. In this activity, students will draw a scale model of the atmosphere at a scale of 1 centimeter to 3 kilometers. Explain the scale indicates that 3 kilometers of real space is equal to 1 centimeter on the model.

12. Ask students how many centimeters the troposphere will be on the model if it is 16 kilometers high on Earth. As a class, solve the problem.

$$\frac{1 \text{ cm}}{3 \text{ km}} = \frac{x}{16 \text{ km}}$$

$$1(16) = 3(x)$$

$$16 \div 3 = 1x$$

$$x = 5.3 \text{ cm}$$

13. Guide groups, as necessary, through the worksheet and creation of a scale drawing.

Extension Idea: Copy and distribute chapter five of *Atmosphere: Sea of Air*. Ask students to read the chapter, take notes, and then write a prediction of what Earth's atmosphere will be like in 50 years. Students may write a short story, poem, or comic strip to explain and/or illustrate their prediction. Make sure students explain the basis for their prediction, citing *Atmosphere: Sea of Air* and/or other sources. ([5-8] SA1.1)

Answers:

1a. 5.3 or 5cm
1b. 16.7 or 17 cm
1c. 26.7 or 27 cm
1d. 166.7 or 167 cm
1e. 100 cm
1f. 4.1 or 4 cm
1g. 0.1 cm

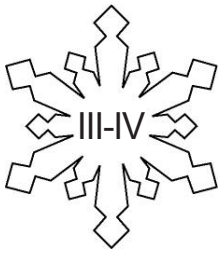
2. The strip of paper should show a line 10 centimeters from one end of the strip, which is labeled "Earth's Surface." The area under the line should be colored purple.

3. The lines should be drawn and labeled at the indicated distance: "troposphere," 5.3 or 5 centimeters; "stratosphere," 16.7 or 17 centimeters; "mesosphere," 26.7 or 27 centimeters; "thermosphere," 166.7 or 167 centimeters; "average orbit of space shuttle," 100 centimeters; "common path of a jet," 4.1 or 4 centimeters, "height of a 110 story building," 0.1 centimeter or 1 millimeter.

4. Each area on the atmosphere model (strip of paper) should be colored as noted: the area between Earth's surface and the troposphere should be blue; the area from the troposphere to the stratosphere should be green; the area from the stratosphere to the mesosphere should be yellow; the area from the mesosphere to the thermosphere should be orange.
5. troposphere
6. thermosphere
7. 128,000
8. Answers will vary.
9. volcanoes
10. ultraviolet energy
11. cyanobacteria
12. 600
13. nitrogen
14. Robert Boyle
15. earth, air, fire, and water
16. John Priestly

Name:_____

Levels



Layering the Air

Student Worksheet

1. Complete the chart below to calculate the scaled distance of each layer of the atmosphere and other objects to Earth's surface using a scale of 1 centimeter to 3 kilometers.

Layer of Atmosphere or Object	Actual Distance (km)	÷3	Scaled Distance (cm)
a. Troposphere	16 km	÷3	
b. Stratosphere	50 km	÷3	
c. Mesosphere	80 km	÷3	
d. Thermosphere	500 km	÷3	
e. Average Orbit of Space Shuttle	300 km	÷3	
f. Common Path of a Jet	12.3 km	÷3	
g. Height of a 110 Story Building	0.3 km	÷3	

2. On a strip of paper, provided by the teacher, measure and draw a line 10 centimeters from one end of the strip of paper. Label this "Earth's Surface." Color this 10-centimeter area, from the line to the bottom of the paper, purple. This represents the area under the surface of Earth.

3. Measure the distance from Earth's surface and draw a line on the strip of paper for each object in the chart in question 1. Label each line.

4. Color each area as described below:
   a. The area between Earth's surface and the troposphere blue.
   b. The area from the troposphere to the stratosphere green.
   c. The area from the stratosphere to the mesosphere yellow.
   d. The area from the mesosphere to the thermosphere orange.

Answer the following questions.

5. In which layer of the atmosphere do you live? _____

6. Which layer of the atmosphere is closest to the sun?_____

7. If the scale of the model is 1 centimeter:3 kilometers, how many centimeters would the moon be from Earth's surface (on the model), if its actual distance is 384,000 kilometers? Show your work.

   _____ cm

8. Why do you think the moon was not included in the model?

   _____

   _____

Name:_____

Layering the Air

Student Worksheet

Fill in the blanks using the words from the word box below.

Word Box

nitrogen		Earth
cyanobacteria	ultraviolet energy	John Priestly
volcanoes	fire	air
water	600	Robert Boyle

9. During the early stages of Earth's history, gases rose from the thousands of _____ that dotted Earth's surface.

10. Many of the complex gases that existed in Earth's early atmosphere were broken down by _____. (HINT: This gives us sunburn.)

11. The appearance of oxygen was most likely triggered by the appearance of organisms called _____.

12. Oxygen reached the level it is today, 21%, _____ million years ago.

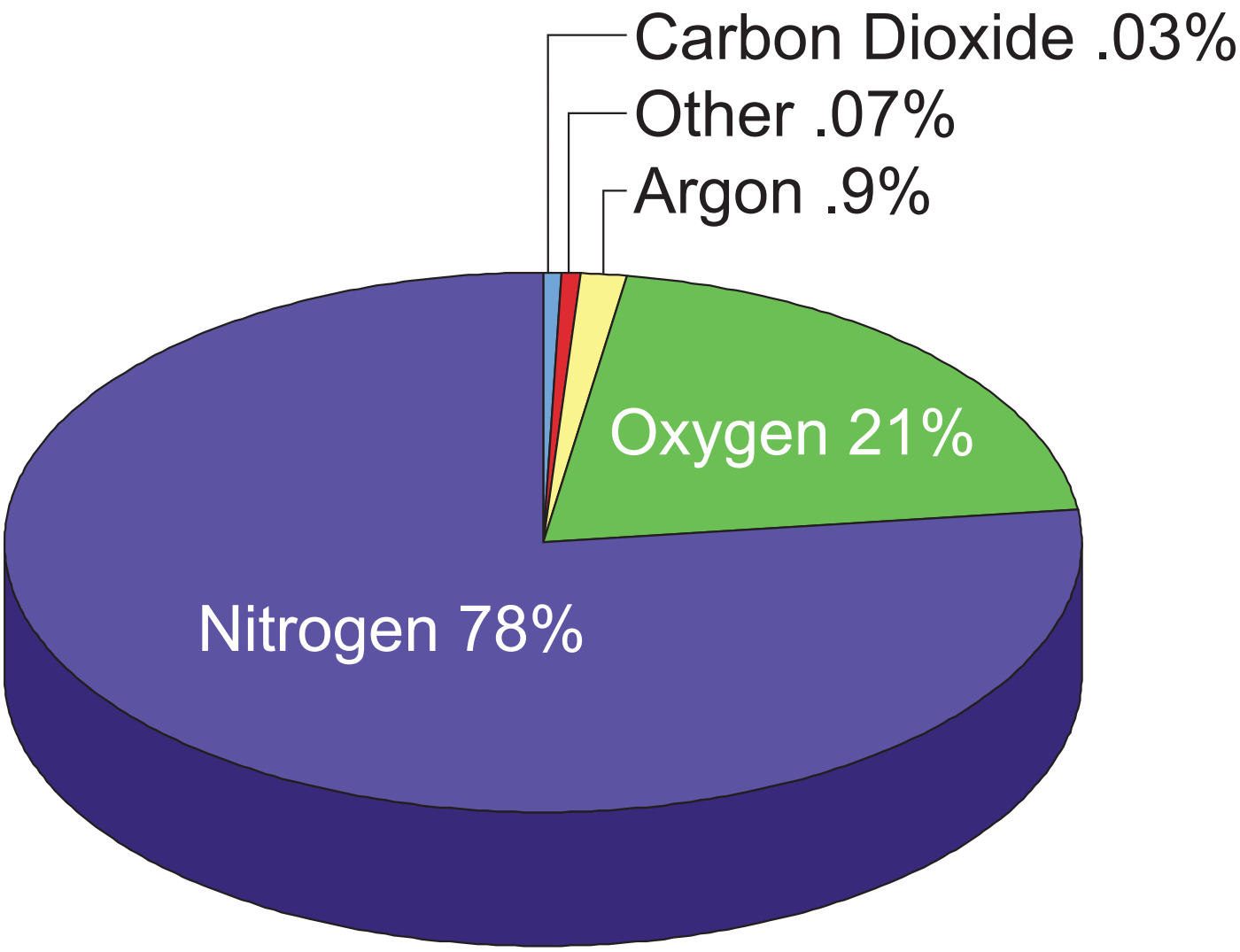
13. Today's atmosphere is made up of many gases, including carbon dioxide, ozone, methane, and many other gases. Most of the atmosphere, however, is made up of _____.

14. The word "element" was given the meaning it has today by the English scientist _____ in 1661.

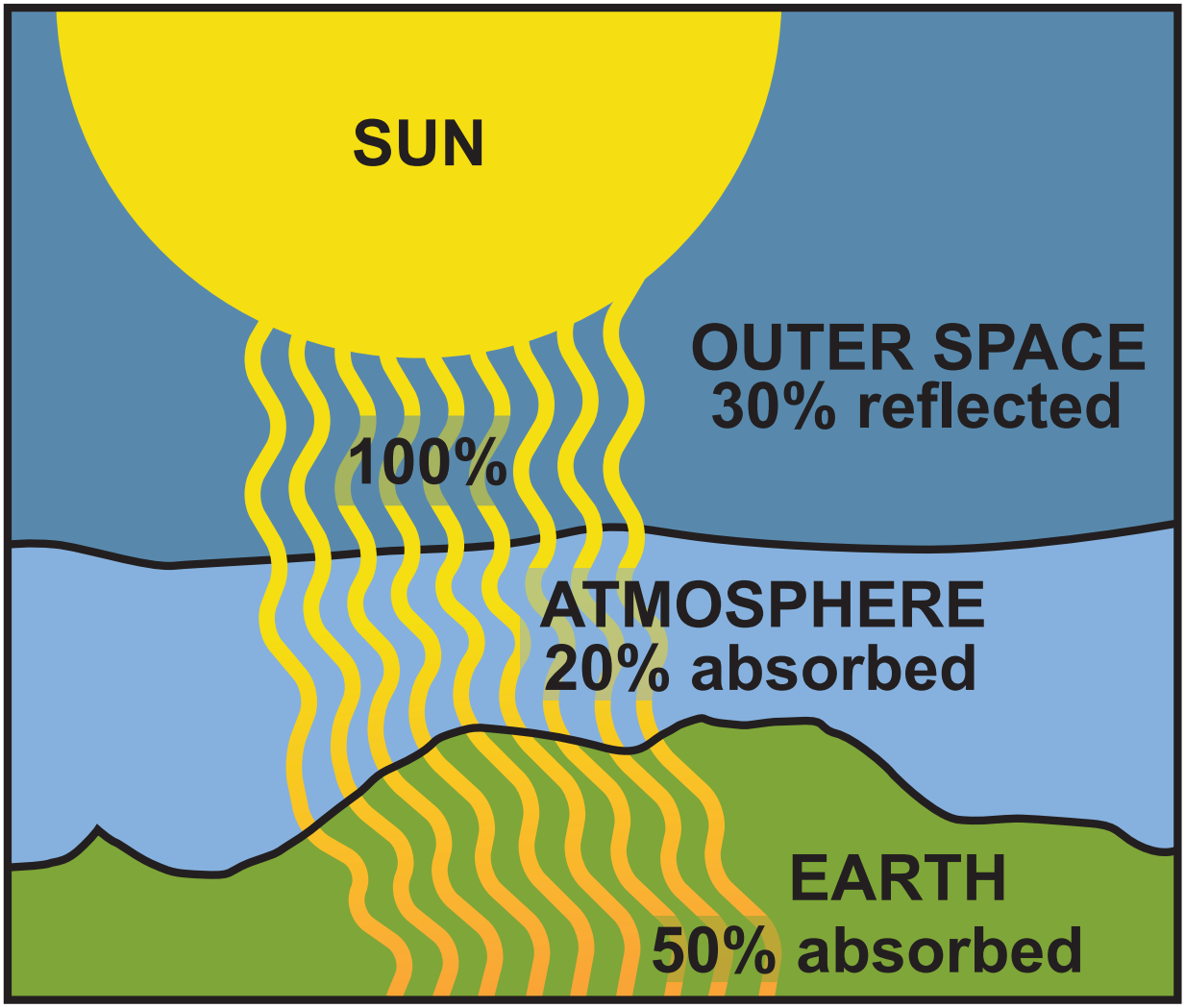
15. The early Greeks believed that all matter was made of four root substances: _____, _____, _____, and _____.

16. In 1774, _____ discovered that oxygen was necessary for both fire and life.

Composition
Overhead



Solar Energy
Overhead



Layers of the Atmosphere
Overhead