UNIT OVERVIEW

Our atmosphere is an invisible shield that makes life on Earth possible. The Atmosphere and Climate unit acquaints students with the five layers of the atmosphere. Earth's atmosphere traps heat through the greenhouse effect while also protecting the surface of our planet from the Sun's harmful ultraviolet rays. The movement of Earth's air and water creates local weather. The temperature and precipitation in a region over long periods of time make up that region's climate. Earth has three main climate zones: tropical, temperate, and polar. Each zone is made up of multiple climate types. Recently, Earth's overall temperature has risen as CO_2 emissions have increased. Climate change has the potential to cause great changes to Earth's weather patterns, natural places, and inhabitants.

Certain reading resources are provided at three reading levels within the unit to support differentiated instruction. Other resources are provided as a set, with different titles offered at each reading level. Dots on student resources indicate the reading level as follows:

- low reading level
- middle reading level
- high reading level

THE BIG IDEA

Understanding our atmosphere helps students realize the importance of protecting it. Shifts in the mixture of gases in the atmosphere change how well it can keep Earth's surface at a desirable temperature for living things. Maintaining a balance of these gases also determines how well the atmosphere can protect Earth from harmful solar radiation. To reduce the release of excess greenhouse gases, many people conserve energy, use alternative energy resources, reuse and recycle products, and make other changes. They do so in hopes that this planet will always be a good home.

Other topics

This unit also addresses topics such as: auroras, the weight and pressure of air, impacts of volcanic eruptions on climate, the relationship between altitude and air pressure, how scientists predict climate change, and how seasons vary in different climate zones.

SPARK

The spark is designed to get students thinking about the unit's topics and to generate curiosity and discussion.

Materials

- small, clear plastic cup
- sink, bucket, or dishpan to catch water
- index card
- water

Activity

Ask students: *Which is stronger, water or air? How can you tell?* This demonstration will show just how strong air pressure can be. (Practice this demonstration before using it with the class.)

Fill a clear plastic cup to the brim with water. Press an index card to the top of the cup to make a good seal. While holding the cup over the sink or bucket and keeping your hand pressed firmly against the card, slowly turn the cup over. Before removing your hand from the card, ask students what they think will happen when you do so, and why. Ask: *Will the water push the card out of the way and spill out?* Then carefully remove your hand from the card. The water should stay inside!

While holding the cup over the sink or bucket, peel a corner of the card away from the cup slightly. Students will observe that the water spills out.

Below are questions to spark discussion.

When I first removed my hand from the card, why did the water stay in the cup?

Where was there air during the first part of this demonstration, and why was it important to the results?

When I peeled a corner of the card away from the cup, why did the water flow out?

Where was there air during the second part of this demonstration, and why was it important to the results?

Use this activity to begin an introductory discussion about air. Briefly explain that air is made up of small particles, called *molecules,* that move around, creating pressure on all things within Earth's atmosphere. In the first part of this demonstration, the air pressure surrounding the cup was strong enough to hold the card against the cup and keep the water from spilling out. In the second part, air pushed on both sides of the card, so the force of the water allowed it to pour out. Throughout the unit, students will learn more about air, what air is made of, and how air is important to Earth's climate and atmosphere.

Many of the unit's vocabulary terms are related to the spark activity and can be introduced during the spark. For vocabulary work, see the Vocabulary section in this *Unit Guide*.

PRIOR KNOWLEDGE

Invite students to explain their understanding of our atmosphere, what it is, and how it affects us. Discuss what would happen if Earth had no atmosphere.

Probing Questions to Think About

Use the following questions to have students begin thinking of what they know about our atmosphere and climate.

- What is the atmosphere?
- How is the atmosphere important to your life?
- What makes up the air we breathe?
- What is the ozone layer, and why is it important?
- Is the greenhouse effect something natural, or is it something people have caused?
- What is the difference between weather and climate?
- How is climate important to your life?
- How does wind form?
- What is the water cycle, and how is it related to weather?
- How is Earth's climate changing? Can people slow down the changes? If so, how?

Tell students they will learn more about these topics soon.

UNIT MATERIALS

Each unit provides a wide variety of resources related to the unit topic. Students may read books and other passages, work in groups to complete hands-on experiments and investigations, discuss science ideas as a class, watch videos, complete writing tasks, and take assessments.

Resources are available for printing or projecting, and many student resources are also available for students to access digitally on Kids A–Z.

Selected unit resources are available in more than one language.

For a complete list of materials provided with the unit, see the Atmosphere and Climate unit page on the Science A–Z website.

VOCABULARY

Use the terms below for vocabulary development throughout the unit. They can be found in boldface in the *Nonfiction Book*, the *Quick Reads*, and/or other unit resources. These terms and definitions are available on *Vocabulary Cards* for student practice. Additional vocabulary lists are provided in the teaching tips for *Investigation Packs* and *FOCUS Books*.

Core Science Terms

These terms are crucial to understanding the unit.

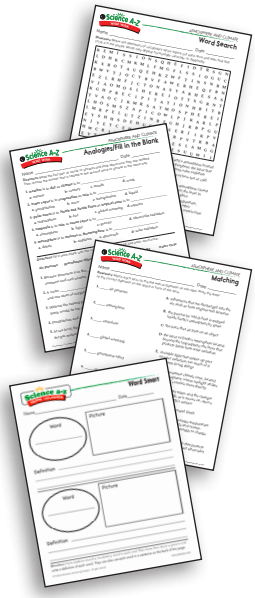
air pressure	the force that air puts on an object
atmosphere	the mass of air around Earth
climate	the weather conditions in an area over a long period of time
emissions	substances that are discharged into the air, such as from engines and factories
gases	matter that can freely change shape and size; often can't be seen
global warming	an increase in the average temperature of Earth's atmosphere and oceans, especially one great enough to change the climate
greenhouse effect	the process by which heat is trapped inside Earth's atmosphere by gases
molecules	the smallest parts of substances that can exist by themselves, made of two or more atoms
ozone layer	a layer of the atmosphere that protects life on Earth by filtering out ultraviolet radiation from the Sun
polar zones	Earth's coolest climate zones, located near the poles, where sunlight strikes the planet's surface least directly
precipitation	water that falls from clouds in the form of rain, snow, sleet, or hail
stratosphere	the layer of Earth's atmosphere located beyond the troposphere; the layer that protects Earth from solar radiation
temperate zones	Earth's climate zones between the tropical and polar zones, where the angle of sunlight causes warmer summers and cooler winters
temperature	the measurement of how hot or cold something is
tropical zone	Earth's warmest climate zone, located near the equator, where sunlight strikes the planet's surface most directly
troposphere	the layer of Earth's atmosphere closest to the planet's surface; the layer in which weather takes place
ultraviolet (UV) rays	invisible light that makes up part of solar radiation; too much of it can harm living things
water cycle	the path water takes, and the changes it goes through, as it moves on, above, and below Earth's surface
weather	a description of the temperature, clouds, rain, wind, and other conditions in the air at a certain time

Other Key Science Terms

The following vocabulary is not essential for comprehending the unit but may enrich students' vocabulary.

aerosols	airborne particles such as volcanic ash, dust, and debris
carbon dioxide (CO_2)	an invisible, odorless gas that plants use during photosynthesis and that animals breathe out as a waste product
condense	to change from a gas to a liquid state
cores	layered sediment samples in the form of long tubes
debris	scattered pieces of something that are left after the rest is gone or has been destroyed
dense	closely packed together
deserts	areas of land that do not receive much rainfall and that have limited vegetation
evaporate	to change from a liquid to a gas state
exosphere	the outermost layer of Earth's atmosphere; the layer in which molecules can escape Earth's gravity
force	the strength or energy that moves an object
gravity	the force that draws objects toward the center of Earth or any other large celestial body
mesosphere	the middle layer of Earth's atmosphere; the layer in which meteors burn up
methane	an invisible, odorless, flammable gas; also called natural gas
nitrogen	a pure natural gas that makes up more than three quarters of Earth's atmosphere
oxygen	a gas that has no color, taste, or smell and that most living things on Earth need to survive
solar radiation	energy that the Sun gives off in the form of rays of light or heat
thermosphere	the layer of Earth's atmosphere beyond the mesosphere; the layer in which the space shuttle orbits
water vapor	the gaseous state of water
weight	how heavy something is, caused by the pull of gravity on the object

Vocabulary Activities



You may choose to introduce all the terms that will be encountered in the unit before assigning any of the reading components. *Vocabulary Cards* with the key science terms and definitions are provided. Dots on the cards indicate the reading levels of the *Nonfiction Book* or the *Quick Reads* in which each term can be found. If all level dots appear, the term may come from another resource in the unit. Students can use these cards to review and practice the terms in small groups or pairs. The cards can also be used for center activity games such as Concentration.

The *Word Work* activity sheets offer fun puzzles and practice with key vocabulary terms from the unit. For further vocabulary practice and reinforcement, you can choose from the vocabulary *Graphic Organizers*. To build customized vocabulary lessons with terms related to the topic, see Vocabulary A-Z.

Students can use the *Word Smart* vocabulary *Graphic Organizer* to organize information on the science terms. You may want to assign each student one to three words to share his or her *Word Smart* knowledge with classmates. Students who have the same word should first compare their *Word Smart* sheets with each other and then report to the larger group.

The science terms can be used in oral practice. Have students use each term in a spoken sentence.

As students read, encourage them to create a science dictionary by recording new vocabulary terms and definitions in their *SAZ Journal*.

BACKGROUND AND MISCONCEPTIONS

Use this section as a resource for more background knowledge on unit content and to clarify the content for students if misconceptions arise. Refer to Using the Internet below for more ways to extend the learning.

Q: *Are air and oxygen the same thing?*

A: No. Oxygen is a component of natural air, but it is not air by itself. Earth's air is made up of about 21% oxygen. Nitrogen, at 78%, is actually a far greater component.

Q: *Is air the same everywhere? Is air in a container different from air in a room or outside?*

A: Air is composed of several gases. The predominant ones are nitrogen and oxygen, with smaller amounts of argon, carbon dioxide, methane, and other gases. Air in different locations may have different proportions of these gases, but air remains similar everywhere on Earth. The air in most containers and closed rooms was once outside air, so it is composed of the same mixture of gases as the outside air, even once it is trapped inside a space.

Q: *Why is air pressure different at different altitudes?*

A: Generally, the greater the altitude, the lower the air pressure. This is because at the surface, a column of air extends all the way up to the edge of the atmosphere. Gravity causes many more molecules to accumulate near the surface than higher in the atmosphere. Also, each higher layer in the atmosphere provides more space for air molecules to spread out, thus lowering the air pressure (and air density) at higher altitudes.

Q: *Are the greenhouse effect, global warming, and climate change all the same thing?*

A: No. These terms are often mentioned together in the media. As a result, many people think they are interchangeable, but they are different. When the Sun's energy reaches Earth's surface, it is absorbed and converted into infrared radiation. Some of that energy radiates into the atmosphere, where gases such as carbon dioxide, water vapor, and methane prevent some of the heat from escaping into space, keeping Earth warm and inhabitable. This natural process is called the *greenhouse effect.*

Global warming is an increase in the average temperature of the atmosphere, especially a sustained increase sufficient to cause climatic change. If the greenhouse effect becomes stronger, more heat is trapped in the atmosphere. This increase in temperature can lead to global warming, which is a type of climate change.

Q: *Why is global warming such a controversial issue?*

A: The issue of climate change, specifically global warming, has received so much attention in recent years that it can be difficult for policymakers and the general population to separate facts from fiction. Many individuals and companies have a vested interest in persuading the public to agree with their position. At the heart of the debate is whether human activities are responsible for some or all of the recently observed changes in Earth's atmosphere as well as changes on the surface of the planet.

There is widespread agreement among scientists that the emission of heat-trapping gases, primarily due to the burning of fossil fuels, makes a significant contribution to global warming. However, other people insist that this climate change can be explained entirely by natural factors such as changes in the output of energy from the Sun or historical climate cycles. You might discuss causation versus correlation with students.

In spite of tremendous efforts by the mainstream scientific community to educate the public, many people still believe that global warming is unrelated to human activity. The challenge for the scientific community is to present enough compelling evidence that human activity matters to convince governments and citizens to change laws and behaviors in the interest of protecting the planet.

Q: *Is ozone good or bad?*

A: Ozone can be both beneficial and harmful, depending on where it is located in the atmosphere. Ozone in the upper atmosphere blocks out damaging UV radiation. Depletion of the ozone layer exposes organisms and ecosystems to more risk. Ozone in the lower atmosphere (near Earth's surface) is a form of pollution and is a major constituent of smog. It can cause breathing difficulties and other health problems in people and other animals. Ground-level ozone can also be harmful to plants. Ozone warnings in the news refer to surface ozone.

Q: *Is a hole in the ozone layer causing global warming?*

A: No. Global warming is due to an increase in greenhouse gases (such as carbon dioxide) in the atmosphere. A depletion of ozone allows more UV light from the Sun to reach Earth's surface but is not known to be an important factor in increased temperatures on Earth.

EXTENSION ACTIVITIES

Using the Internet

Most search engines will yield many results when the term *atmosphere* or *climate* is entered. You can also perform a more specific search, such as *What if Earth had no atmosphere?* Be aware that some sites may not be educational or intended for the elementary classroom. More specific inquiries are recommended, such as:

- What is the ozone layer?
- weather versus climate
- climate zone maps
- greenhouse gases
- global warming for kids
- What causes wind?
- interactive water cycle model
- Why don't we feel atmospheric pressure?

Projects and Activities

- **Project:** Have students create a model of the atmosphere using different colors of construction paper. Students can cut the paper into strips of different widths, each proportional to the thickness of the layer it represents (may require research). Then, on the paper strips, they can write short descriptions of the atmospheric layers.
- **Project:** Invite students to create a color-coded climate map to illustrate the world's different climate zones and climate types within each zone.
- **Math:** Obtain an anemometer (a gauge to measure wind speed). Have students calculate the velocity at which it spins on a windy day. To do so, they should: (1) count the number of revolutions per minute (RPM); (2) calculate (in meters or feet) the circumference of the circle made by the rotating cups; (3) multiply the RPM value by the circumference. The result will be an approximation of the wind velocity (in meters or feet per minute).

- **Guest:** Invite a meteorologist to speak with students about his or her career and to explain how understanding weather can help students in their daily lives. If possible, ask the meteorologist to bring weather instruments to demonstrate how to use them.
- **Field Trip:** Bring students to a local television station to observe how the weather forecast and report are produced, including the technology used to research weather and present it to the public.
- **Project/Home Connection:** Have students identify ways to reduce, reuse, and recycle materials at home. Ask them discuss with their families ideas such as using reusable drink bottles, using reusable shopping bags, buying in bulk to reduce packaging, removing their names from unwanted mailing lists, planting trees, and starting a compost pile from household garbage. Have students share what they are doing or would like to do. Then ask them to explain how reducing, reusing, and recycling can help protect Earth's atmosphere and climate.
- **Writing:** Ask students to bring in a current events article or cartoon concerning weather, the atmosphere, or climate change. Then have them write a summary of the main ideas presented.
- **Research:** Have each student monitor the weather in a different global location for several weeks. When done, ask them to draw conclusions about the climate in that location and then compare their conclusions with research about that region's climate.
- **Research/Home Connection:** Students can conduct research as a family/home project or in the library/media center to extend the learning about a topic in one of the *Quick Reads* or other unit resources.