POWER BASICS®

Earth and Space Science

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UNIT 2

The Atmosphere Around Us

LESSON 5: The Atmosphere: Our Life Support System

GOAL: To understand how Earth's atmosphere protects and supports life on Earth

WORDS TO KNOW

altitude	mesopause	stratosphere
contract	mesosphere	thermosphere
energy budget	ozone layer	tropopause
expands	scattered	troposphere
gas	sea level	uniform gases
greenhouse effect	solar energy	vacuum
ionosphere	solid	variable gases
liquid	stratopause	volcanic outgassing

The Origins of the Atmosphere

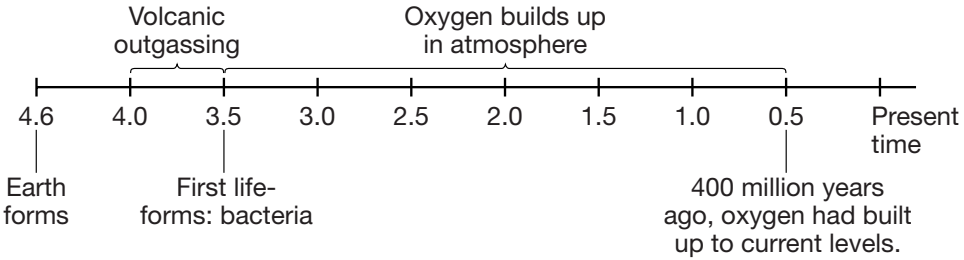
You live on the only planet in the solar system known to support life. Earth is like an oasis in the lifeless solar system. What makes Earth so different? Mainly, it is Earth's protective and supportive atmosphere. Earth's atmosphere is a thin layer of gas about 500 kilometers thick that surrounds the planet. Even though the atmosphere extends for miles above your head, it really is only a thin shell compared to the rest of Earth. This thin shell is the life support system aboard spaceship Earth.

The atmosphere gives Earth the oxygen you need to breathe. It filters out harmful radiation, traps heat, and cycles freshwater in the form of rain. Winds in the atmosphere circulate warmth and moisture around the entire planet.

When Earth formed 4.6 billion years ago, the thin gases that surrounded the planet soon escaped. For millions of years, there was no

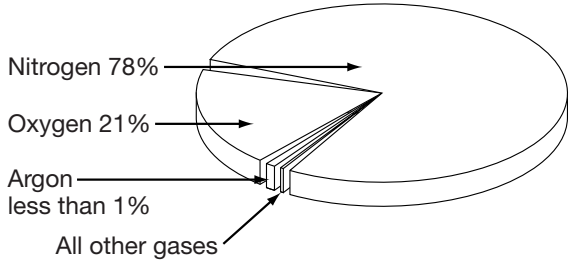
atmosphere on Earth. Between 3.5 and 4 billion years ago, gases trapped inside Earth were released during volcanic eruptions. This process is called **volcanic outgassing.** Volcanic outgassing produced a mixture of carbon dioxide, nitrogen, hydrogen, and water vapor.

In the early stages, Earth's atmosphere had no oxygen. Oxygen did not become part of the atmosphere until the first forms of life appeared about 3.5 billion years ago. These early life-forms were a type of bacteria that produced oxygen as a waste product. Over the next few billion years, oxygen gas built up in the atmosphere. Other life-forms evolved, and the amount of oxygen eventually leveled off about 400 million years ago.



Time Line of Earth's Atmosphere (in billions of years)

Today's atmosphere is made up of air (a mixture of invisible gases). Air is made up of 78% nitrogen, 21% oxygen, less than 1% argon, and trace (very small) amounts of neon, helium, methane, krypton, and hydrogen. These gases appear in the same percentages throughout most of the atmosphere. That is why they are called **uniform gases.**



Composition of Air

Air also contains several variable gases. **Variable gases** are gases whose levels change depending on the location and weather at the time. Variable gases, such as ozone, water vapor, and carbon dioxide, make up a tiny percentage of the atmosphere. Yet, as you will see, they are critical to weather, climate, and life on Earth.

PRACTICE 17: The Origins of the Atmosphere

Circle the answer that correctly completes each of the following statements.

1. The atmosphere on Earth formed _____.
   - **a.** when Earth formed
   - **b.** through volcanic outgassing
   - **c.** when the first forms of life appeared

2. Oxygen became part of the atmosphere about _____.
   - **a.** 3.5 billion years ago
   - **b.** 400 million years ago
   - **c.** 4.6 billion years ago

3. The largest part of the atmosphere is _____.
   - **a.** water vapor
   - **b.** oxygen
   - **c.** nitrogen

4. Gases whose levels change in the atmosphere are called _____.
   - **a.** uniform gases
   - **b.** variable gases
   - **c.** volcanic gases

A Protective Atmosphere

The atmosphere contains four thin shells, or layers. The names given to the layers, from the inside out, are the troposphere, the stratosphere, the mesosphere, and the thermosphere. The height, or **altitude,** of each layer is measured from sea level. **Sea level** is the lowest part of the atmosphere. Sea level is the point midway between the highest seas and the lowest seas. The layers of the atmosphere are separated based on how temperature changes with altitude within each layer.

THINK ABOUT IT

All of the following words end with the suffix *–sphere*: Atmo*sphere*, tropo*sphere*, strato*sphere*, meso*sphere*, thermo*sphere*. Can you explain why? Write your answer on a separate sheet of paper.

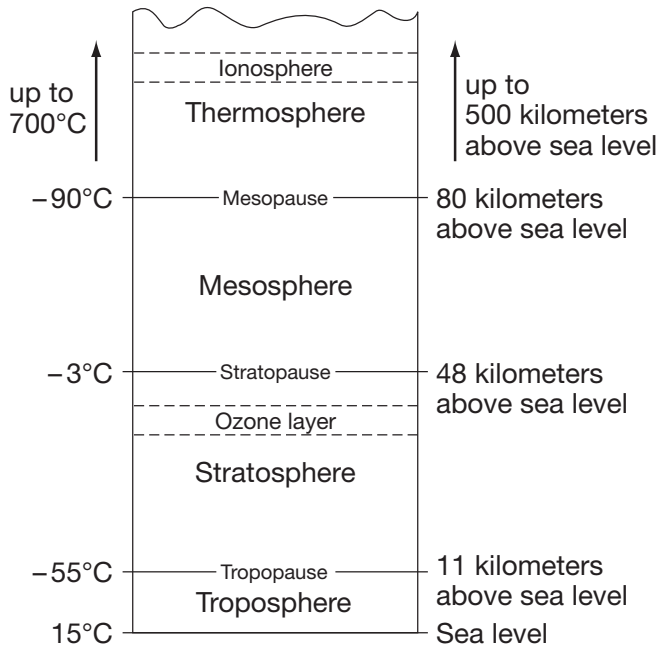
The tops of each of the lower three layers are called the **tropopause, stratopause,** and **mesopause.** These locations are the boundaries between each layer. At these boundaries, temperatures begin reversing direction. Temperatures *pause,* or stop increasing (or decreasing), with altitude and begin decreasing (or increasing) with altitude.

The Troposphere

You live in the troposphere. The **troposphere** is the bottom layer of the atmosphere. Temperatures in the troposphere decrease with altitude. Temperatures vary from 15°C at Earth's surface (sea level) to –55°C at the tropopause. On average, the troposphere extends to about 11 kilometers above sea level. It extends higher over the warm equator and lower over the poles. Only in the troposphere is the air "thick" enough to sustain most animal life. Also, most water vapor stays in the troposphere, along with all of Earth's weather systems.

The Stratosphere

The **stratosphere** lies above the troposphere and extends to an altitude of about 48 kilometers above sea level. Strong, steady winds blow through the stratosphere. In the stratosphere, air temperatures increase with altitude. The temperatures vary between –55°C at the beginning of the stratosphere to –3°C at the stratopause.



Layers of the Atmosphere

This increase in temperature occurs partly because of the energy absorbed by the ozone layer. The **ozone layer** is a protective layer of the variable gas called ozone. You and many other forms of life could not survive the intensity of the Sun's energy without the ozone layer. Ozone absorbs the Sun's harmful ultraviolet waves that can cause sunburn, skin cancer, and damage to crops.

Scientists are concerned about a thinning of the ozone layer in locations over Antarctica and the Arctic. This thinning, also called the ozone hole, constantly changes. Measurements have shown that each year the hole gets a little larger. The ozone hole is caused by pollutants called chlorofluorocarbons, or CFCs, which are widely used as coolants in refrigerators and air conditioners. Life on Earth depends on the protection offered by the ozone layer. Countries all over the world have agreed to reduce the use of CFCs.

The Mesosphere

The **mesosphere** lies between 48 and 80 kilometers above sea level. In the mesosphere, temperatures decrease with altitude. At the mesopause, air temperatures drop to –90°C, which is the lowest temperature in the entire atmosphere.

The Thermosphere

The **thermosphere** begins at an altitude of 80 kilometers and extends to about 500 kilometers above sea level. Here, the air is no longer the same mixture of uniform gases as in the lower atmosphere. Instead, the gas particles are so spread out that each gas settles into its own layer. The particles of gas within the thermosphere absorb solar energy. The result is that temperatures rise within the thermosphere to about 700°C. Most meteors burn up on their way through the thermosphere.

Within the thermosphere, there is a layer called the **ionosphere.** The atmospheric gases of the ionosphere are ionized, or electrically charged. This allows the ionosphere to reflect short-wavelength radio waves, making long distance radio communication possible.