What's in the Air?

Air? Can't see it. Can't taste it. Can't smell it. If you pay attention, you might feel it as a gentle breeze brushing across your skin. Then again, a strong gust of wind can nearly knock you over. Because we are typically so insensitive to air, it is difficult to understand what it is. Is it one thing, or a mixture of things? And where is it? Is it everywhere, or just in some places?

As we go about our everyday business, we usually travel with our feet on the solid Earth and our heads in the atmosphere. The atmosphere completely surrounds us, pressing firmly on every square centimeter of our top, front, back, and sides. Even if we attempt to get out of the atmosphere by locking ourselves inside a car or hiding in a basement, the atmosphere is there, filling every space we enter.

An atmosphere is the layer of gases that surrounds a planet or **star**. All planets and stars have an atmosphere around them. The Sun's atmosphere is hydrogen. Mars has a thin atmosphere of **carbon dioxide (CO_2)** with a bit of **nitrogen (N_2)** and a trace of water vapor. Mercury has almost no atmosphere at all. Venus, almost the same size as Earth, has an atmosphere composed of carbon dioxide and nitrogen, which would be toxic to a visiting human. Each planet is surrounded by its own mixture of gases.

Earth's atmosphere is composed of a mixture of gases we call **air**. Air is mostly nitrogen (78 percent) and **oxygen (O_2)** (21 percent), with some argon (0.93 percent), carbon dioxide (0.03 percent), **ozone (O_3)**, water vapor, and other gases (less than 0.04 percent together).

Sketch a pie chart in your notebook to represent the percentage of gases in the atmosphere.

Nitrogen is the most abundant gas in our atmosphere. It is a stable gas, which means it doesn't react easily with other substances. When we breathe air, the nitrogen goes into our lungs and then back out unchanged. We don't need nitrogen gas to survive, but it doesn't harm us either.

Oxygen is the second most abundant gas. It takes up about 21 percent of the air's volume, and because the oxygen atom is larger than the nitrogen atom, it accounts for 23 percent of air's **mass**. Oxygen is a colorless, odorless, and tasteless gas. It is the most plentiful element in the rocks of Earth's crust. Oxygen combines with hydrogen to form water.

Gases of the Atmosphere

Gas	Percentage by volume
Nitrogen	78.08
Oxygen	20.95
Argon	0.93
Water vapor*	0.25
Carbon dioxide*	0.039
Ozone*	0.01
Neon	0.002
Helium	0.0005
Krypton	0.0001
Hydrogen	0.00005
Xenon	0.000009

*Variable gas

Oxygen and nitrogen are called **permanent gases**. The amount of oxygen and nitrogen in the atmosphere stays constant. Most of the other gases in this chart are also permanent gases, but are found in much smaller quantities.

Air also contains **variable gases**. The amount of a variable gas changes in response to activities in the environment. Each of the variable gases listed in the table on this page is also considered to be a **greenhouse gas**, which means it traps heat within the atmosphere. The way these gases trap heat will be studied later in this course. Remember that these gases are variable, so if the amount of greenhouse gases increases, the atmosphere may trap more heat. But greenhouse gases are important for life on Earth! If we didn't have greenhouse gases, the Earth would be too hot during the day and too cold during the night to support life.

Water vapor (H_2O) is the most abundant variable gas. It makes up about 0.25 percent of the atmosphere's mass. The amount of water vapor in the atmosphere changes constantly. Water cycles between Earth's surface and the atmosphere through evaporation, condensation, and precipitation. You can get a feeling for the changes in atmospheric water vapor by observing clouds and noting the stickiness you feel on humid days.

Carbon dioxide is another important variable gas. It makes up only about 0.04 percent of the atmosphere. You can't see or feel changes in the amount of carbon dioxide in the atmosphere.

Carbon dioxide plays an important role in the lives of plants and algae. These organisms remove carbon dioxide from the air during **photosynthesis**. Plants and algae convert light energy into chemical energy by making sugar (food) out of carbon dioxide and water. This process releases oxygen into the atmosphere. When living organisms use the energy in food to stay alive, they remove oxygen from the air and return carbon dioxide to the air.

There are other gases that you may have heard about. Ozone (O_3) is a variable gas. It is a form of oxygen that accumulates in the **stratosphere**. Ozone is absolutely essential to life on Earth because it **absorbs** deadly ultraviolet radiation from the Sun. But ozone in high concentration can cause lung damage. In the lower atmosphere, ozone is an air pollutant.

Methane (CH_4) is a variable gas that is increasing in concentration in the atmosphere. Scientists are trying to figure out why this is happening. They suspect several things. Cattle produce methane in their digestive processes. Methane also comes from coal mines, oil wells, and gas pipelines, and is a by-product of rice cultivation. Methane, like other greenhouse gases, absorbs heat coming up from Earth's surface.

These gases and a few other trace gases are all mixed together, so that any sample of air is a mixture of all of them. If you rise higher in the atmosphere, there are fewer particles, but the ratio of each gas to the other is the same. The mixing is caused by the constant movement of the air in the part of the atmosphere near Earth's surface. Above about 90 kilometers (km), there is much less mixing. Very light gases (hydrogen and helium, in particular) are more abundant above that level.

Think Questions

1. What is the difference between permanent gases and variable gases in the atmosphere?
2. During the daylight hours, plants and algae take in carbon dioxide and release oxygen. If humans remove forests, what might happen to the balance between these gases?

Methane is generated through different processes, including the digestive processes of cattle.