Earth's Atmosphere

Earth's **atmosphere** is a layer of gases surrounding the planet that is held in place by gravity. The atmosphere protects life on Earth by absorbing ultraviolet radiation, warming the surface through heat retention, and reducing temperature extremes between day and night.

The atmosphere has a mass of 5 quintillion kilograms, three quarters of which is within about eleven kilometers of the surface. It gets thinner and thinner with increasing altitude, with no definite boundary between the atmosphere and outer space (though an altitude of 100 km is often regarded as the boundary).

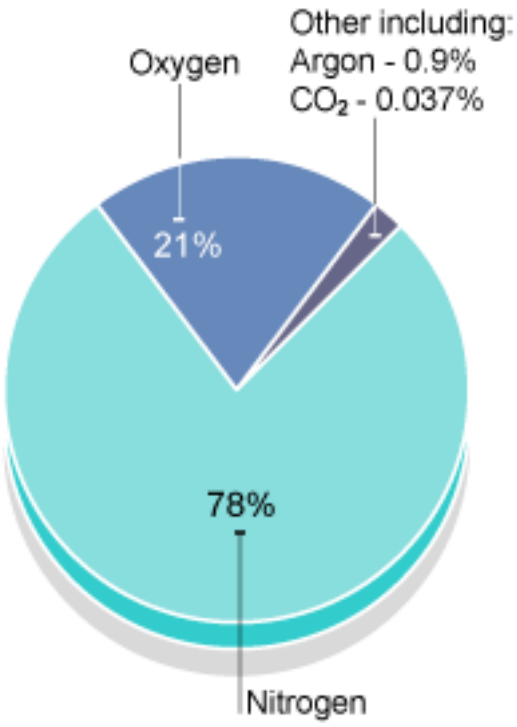
Air is the name given to atmosphere used in breathing and photosynthesis. Air suitable for the survival of plants and animals is only found in the portion of the atmosphere closest to the surface.

Composition

Air is mainly composed of nitrogen (78%), oxygen (21%), and argon (0.9%), which together constitute 99.9% of atmospheric gases. The remaining gases (0.1%) are often referred to as trace gases. Among these are water vapor, carbon dioxide, methane, nitrous oxide, ozone, etc.

Many natural substances may be present in trace amounts in air, including dust, pollen and spores, sea spray, and volcanic ash. In addition, various industrial pollutants may be present, such as chlorine compounds, fluorine compounds, mercury, and sulfur compounds.

The pie chart below illustrates the relative composition of the atmosphere.



Structure

Earth's atmosphere is divided into five main layers. From lowest to highest, these layers are: troposphere, stratosphere, mesosphere, thermosphere, and exosphere.

The **troposphere** is the lowest portion of Earth's atmosphere. It contains about 80% of the atmosphere's mass and 99% of its water vapor. The troposphere extends from Earth's surface to an altitude of 7 km at the poles and 20 km at the equator.

The temperature in the troposphere decreases with altitude, from an average of about $15°C$ at ground level to as low as $-75°C$ at the top of this layer. Similarly, air pressure decreases with altitude, from $101.3\ kPa$ at ground level to $10\ kPa$ at the top.

The troposphere is the layer of the atmosphere where nearly everything that we think of as weather occurs.

The **stratosphere** is the second major layer of Earth's atmosphere. It extends from the top of the troposphere to an altitude of around 50 km.

The temperature in the stratosphere increases with altitude from around $-75°C$ at the bottom to around freezing ($-3°C$) at the top. This is a result of increased absorption of solar radiation by the ozone layer. The **ozone layer**, which is only about 1 cm thick, absorbs 97–99% of the Sun's UV radiation, which would otherwise destroy all life on Earth.

The third layer of Earth's atmosphere, which is located directly above the stratosphere, is known as the **mesosphere**. The exact upper boundary of the mesosphere varies by latitude and season, but is generally considered to be around 100 km above the surface of the Earth.

Within the mesosphere, temperature decreases with altitude. The top of the mesosphere is the coldest part of Earth's atmosphere, with temperatures falling as low as $-100°C$.

Millions of meteors enter the atmosphere each year. Most melt or vaporize within the mesosphere as a result of collisions with the gas particles within the layer.

Directly above the mesosphere is the **thermosphere**. This layer of Earth's atmosphere extends outward to an altitude of around 500 km.

Temperatures in the thermosphere increase with altitude, and can reach as high as $1500°C$. Despite these extremely high temperatures, one would not feel warm in the thermosphere. This is because the air density is so low that there is not enough contact with gas atoms to transfer much heat.

Ultraviolet radiation passing through the thermosphere causes ionization of gas particles. These ionized gas particles are responsible for the glowing lights, called aurora borealis, that we observe in the northern sky.

The International Space Station has a stable orbit within the thermosphere, at an altitude of around 350 km.

The outermost layer of Earth's atmosphere is the **exosphere**. This layer extends from the top of the thermosphere. It's upper boundary is indistinct, but is often defined to be at an altitude of 190000 km (half the distance to the Moon).

The exosphere is mainly composed of hydrogen and helium. The particles are so far apart that they can travel hundreds of kilometers without colliding with each other.

Worksheet

For each of the following questions, fill in the layer(s) of the atmosphere that correctly complete the sentence.

1. Most weather occurs in the _____.

2. The auroras are found in the _____.

3. The ozone layer is found in the _____.

4. Meteors burn up in the _____.

5. Temperatures in the _____ decrease as altitude increases.

6. Temperatures in the _____ can reach as high as $1500°C$.

7. The International Space Station orbits in the _____.

On the back of this page you will find a diagram illustrating the layers of Earth's atmosphere. On this diagram, please label the following layers of the atmosphere: mesosphere, exosphere, troposphere, thermosphere, and stratosphere.

In addition, label (or draw a picture indicating) the location of each of the following on your diagram: the auroras, the International Space Station, the layer where most weather occurs, and the layer where meteors burn up.