Composition of atmosphere

Introduction to Atmosphere:

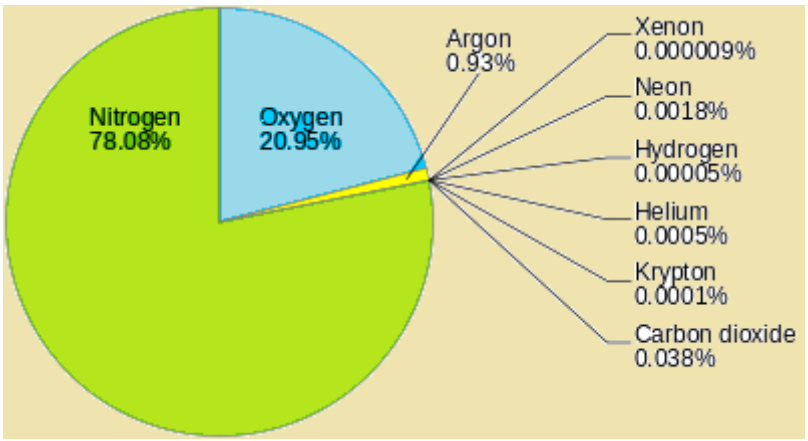
Atmosphere is the huge blanket of gas that circles the entire Earth. Without it, life as we know it could not exist.

This blanket of gas starts at ground level and stretches 600 miles into the sky. However, most of this life-supporting shell is squashed down into a layer only six miles thick. The top of Mount Everest barely peeks above the edge of this layer.

The remaining 594 miles cannot support life. However, these layers do protect us from the dangers of the sun's radiation. They also protect us from drifting rocks, big hunks of metal, and other bits and pieces of space junk that collide with our planet from time to time.

Composition of Atmosphere

The composition of Atmosphere is said to be a mixture of different gases. It envelops around the Earth. 99% of total mas of atmosphere is confined to highest of 32 km from the Earth's surface.



Permanent gases of the Atmosphere

- Atmosphere is consists of various gases, water vapour and dust particles.

- The presence of oxygen becomes negligible at the height of 120 km from the surface of earth with regards to the composition of atmosphere.
- Carbon dioxide and water vapour occur only upto 90 km.
- Carbon dioxide is meteorically very important as it is transparent to incoming solar radiation but opaque to outgoing terrestrial radiation. It is also responsible for greenhouse effect.
- **Ozone gas**: 10-50 km above earth surface and acts as filter, absorbing ultraviolet rays from the sun. Ozone prevents the rays from reaching the surface of earth.
- Water vapour is variable gas, decreases with altitude.
- It also decreases from equator towards the poles.
- Acts like blanket allowing the earth to neither to become too cold nor too hot. Also contributes to the stability and instability in the air.
- **Dust particles:** are in higher concentration in subtropical and temperate regions due to dry winds in comparison to equatorial and polar regions.
- Dust particles act as a hygroscopic nuclei over which water vapour of atmosphere condenses to produce clouds.

- The structure of the atmosphere is classified into the following layers –
    - Troposphere: 0 to 12 km
    - Stratosphere: 12 to 50 km
    - Mesosphere: 50 to 80 km
    - Thermosphere: 80 to 700 km
    - Exosphere: 700 to 10,000 km

Atmospheric division

Layers of Atmosphere

The atmosphere has five distinct layers that are determined by the changes in temperature that happen with increasing altitude. Layers of Earth's atmosphere are divided into five different layers as:

- Exosphere
- Thermosphere
- Mesosphere
- Stratosphere
- Troposphere

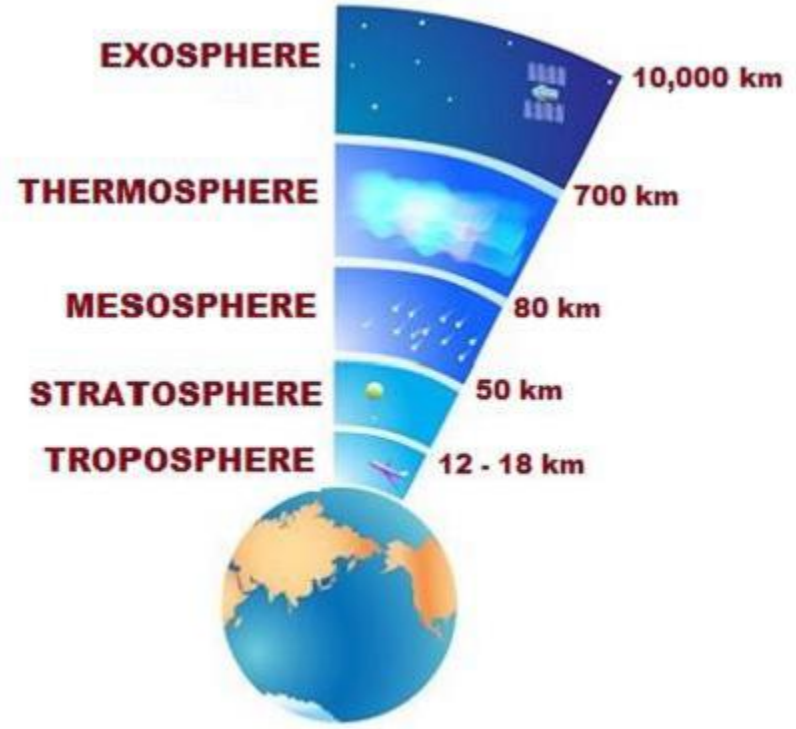
Atmospheric Layer and Ozone Layer

Atmosphere

Earth's atmosphere is held in place by gravity. The atmosphere protects life on the planet by absorbing ultraviolet radiation and by regulating temperature. There is no exact place where Earth's atmosphere ends. Instead, it just gets gradually thinner and thinner (less dense) until it merges with outer space where it consists mostly of interplanetary gases such as hydrogen and helium.

Troposphere

- Troposphere is the closest to the Earth's surface and contains water vapor (clouds), moisture, dust, etc.
- Most of the weather phenomena take place in Troposphere.



- Height of the Troposphere varies i.e. at the equator, it is measured about 18 km and at the poles, it is 12 km.
- **Tropopause** is the transitional zone that separates Troposphere and Stratosphere.

Stratosphere

- Stratosphere is the second-lowest layer of the Earth's Atmosphere that goes up to 50 km.
- Stratosphere contains **Ozone** (O_3) Layer that absorbs the ultraviolet rays (coming through the Sun rays) and protects life on the Earth.
- As the ultraviolet radiation absorbs in Stratosphere, therefore the temperature rises with increasing altitude.
- The **Stratopause** is the transitional zone that separates Stratosphere and Mesosphere.

Mesosphere

- Mesosphere, present above the Stratosphere, extends up to (from 50 km to) 80 km.
- Temperature in the Mesosphere decreases with increasing altitude.
- Mesopause is the transitional zone that separates Mesosphere and Thermosphere.

Exosphere

- Exosphere is the highest or outermost layer of the Earth's atmosphere that extends (starting from 700 km altitude) up to 10,000 km where it ultimately merges into the solar wind.
- Major constituents of the Exosphere are helium, hydrogen, nitrogen, oxygen, and carbon dioxide.
- The phenomena of Aurora Borealis and Aurora Australis can be seen in the lower part of the Exosphere (merged with upper part of the Thermosphere).

Ionosphere

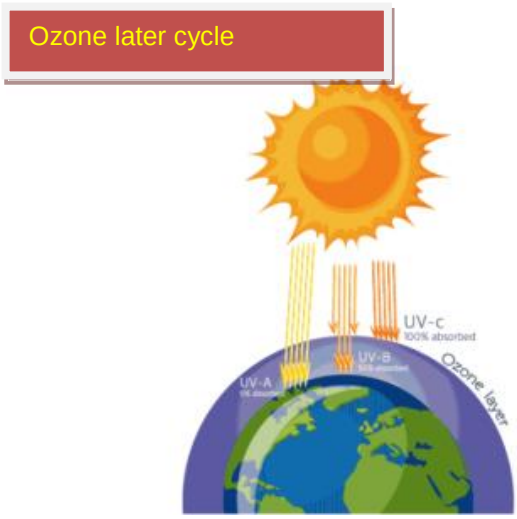
- The lower Thermosphere is called the Ionosphere.
- The ionosphere consists of electrically charged particles known as ions.
- This layer is defined as the layer of the atmosphere of Earth that is ionized by cosmic and solar radiation.
- It is positioned between 80 and 400 km above the Mesopause.

Ozone later cycle

What is the Ozone Layer?

Almost always the ozone has only been correlated with the hole in the ozone layer and the damages it has caused to the environment. The richness of the ozone layer that makes the hole so significant and the science behind the hole is far less popular. Schönbein in the year 1840 confirmed its existence and Jacques-Louis Soret rooted the chemical formula of ozone as O_3 and proved that ozone is an allotropic form of Oxygen.

The importance of ozone is defined by the fact that it protects the earth from harmful ultraviolet rays from the sun. The ozone layer is found in the upper regions of the stratosphere where it protects the earth from the harmful ultraviolet rays of the sun. These radiations can cause skin cancer in humans. The ultraviolet rays split the oxygen molecule into free oxygen atoms, these free oxygen atoms combine with the oxygen molecule to form ozone. This salient layer lies at a distance of 12-15 miles beyond the earth surface.



Preparation of ozone

This allotropic form of oxygen is formed by passing dry oxygen through a salient electric current. By doing so a part of the oxygen molecules undergo dissociation and then atomic oxygen gets associated with the oxygen molecule to give 5%-10% of the allotropic form of oxygen. The product obtained is called as ozonized oxygen.

O_2 energy$-\longrightarrow\rightarrow$energy $O+O$
$O_2+O \rightarrow O_3$

$3O_2 \leftrightarrow 2O_3$ - energy (endothermic reaction)

Ozone is unstable and decomposes to molecular oxygen. A dynamic equilibrium is maintained between the formation and decomposition of ozone. It has been found that this protective ozone layer is getting depleted because of the presence of CFC (chlorofluorocarbon) compounds.

When CFC is released into the atmosphere, they mix with atmospheric gases and reach the stratosphere. In the presence of ultraviolet rays, they are broken down to form chlorine radicals. This chlorine radical reacts with ozone to form chlorine monoxide and an oxygen molecule.

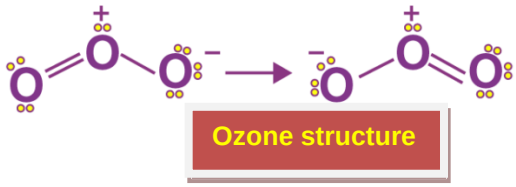
CF_2Cl_2 (g) $\xrightarrow{uv}$ Cl (g) + CF_2Cl (g) (Note: Cl is in the form of radical)
(Note: Cl is in the form of radical)

Cl (g) + O_3 (g) → ClO (g) + O_2 (g)

This reaction breaks down the ozone. CFC compounds are agents which release chlorine radicals in the atmosphere and cause damage to the ozone layer.

Ozone Structure:

Ozone is a polar molecule and to understand this we need to have a look at the structure of Ozone. Ozone resonates between two structures which are shown below:



Ozone structure

The middle Oxygen atom has a formal charge of +1 and the atoms at the edge have a formal charge of -1. Due to the separation of light charges and its bent geometry, it has polarity and is considered a polar molecular.

Properties of ozone:

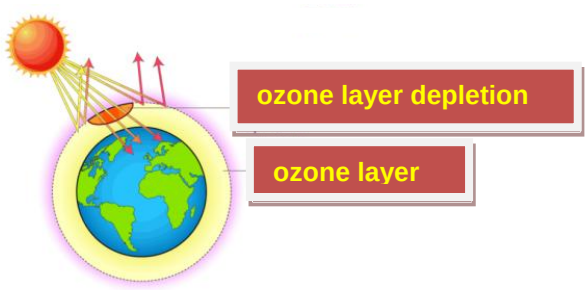
- Ozone in its pure state is blue which has a strong disturbing smell but in a limited proposition, it has a pleasant smell.

- It has the ability to absorb the UV rays which occupy the ultraviolet region which ranges between 220-290 nm of the atmospheric spectrum.
- This form of oxygen boils at 161.2K and forms violet-blue crystals when solidified. It melts at 80.6k.
- This allotrope is a strong oxidizing agent as ozone is an unstable compound under normal conditions and it decomposes quickly in the presence of heat to form nascent oxygen and molecule of oxygen.

Importance of the ozone layer

Ozone is harmful at ground level but high up the atmosphere ozone layer plays a vital role in the protection of all living beings. The sun propagates ultraviolet radiations which as an adverse effect on living beings. This layer absorbs the radiations and prohibits them from entering the outer surface of the earth. The ozone layer resides in the stratospheric layer of the earth's atmosphere. The layers which occupy the lower part of the atmosphere removes the unwanted pollutants from the earth's surface.

Ozone layer depletion:



The reason behind the ozone layer depletion is mainly due to the extensive use of ozone-depleting substances (ODS. Some ozone-depleting substances are:

- **Chlorofluorocarbons (CFC)**: The use of CFC's is one of the main reasons for the depletion of the layer. They are usually used as a coolant in refrigerators and air conditioners used in cars etc. It is also used as an industrial solvent, foam products and as hospital sterilization equipment.
- **Methyl chloroform**: Finds its applications usually in industries for chemical processing etc.
- **Carbon tetrachloride**: Normally used as a solvent.