1.1 STRUCTURE AND COMPOSITION OF ATMOSPHERE

The Atmosphere

The Earth is enveloped by a deep blanket of gases extending several thousands of kilometers (about 9600kms) above its surface. This gaseous cover of the Earth is known as the atmosphere. It is an integral part of the Earth. It is only a very thin layer of gases. Because of force of Gravity it is inseparable from the Earth.

Significance of the Atmosphere:

- All life forms owe their existence to the atmosphere
- Animals need oxygen and plants need carbon dioxide.
- It is the atmosphere that provides oxygen and carbon dioxide.
- The atmosphere maintains the level of water and radiation in the earth system. In the absence of atmosphere there would have been extremes of temperature at about 260^{o}C between day and night.
- The atmosphere maintains the temperature that suits us.
- It shields us from the sun's ultra violet radiation which is injurious to both plants and animals.
- It acts as a protective wall against the bombardment of meteors.
- The currents, motions, and various other activities on the atmosphere combine together to produce weather.

Structure of the Atmosphere:

- The atmosphere consists of zones or layers arranged like spherical shells divided vertically into five layers based on temperature and altitude above the Earth's surface.

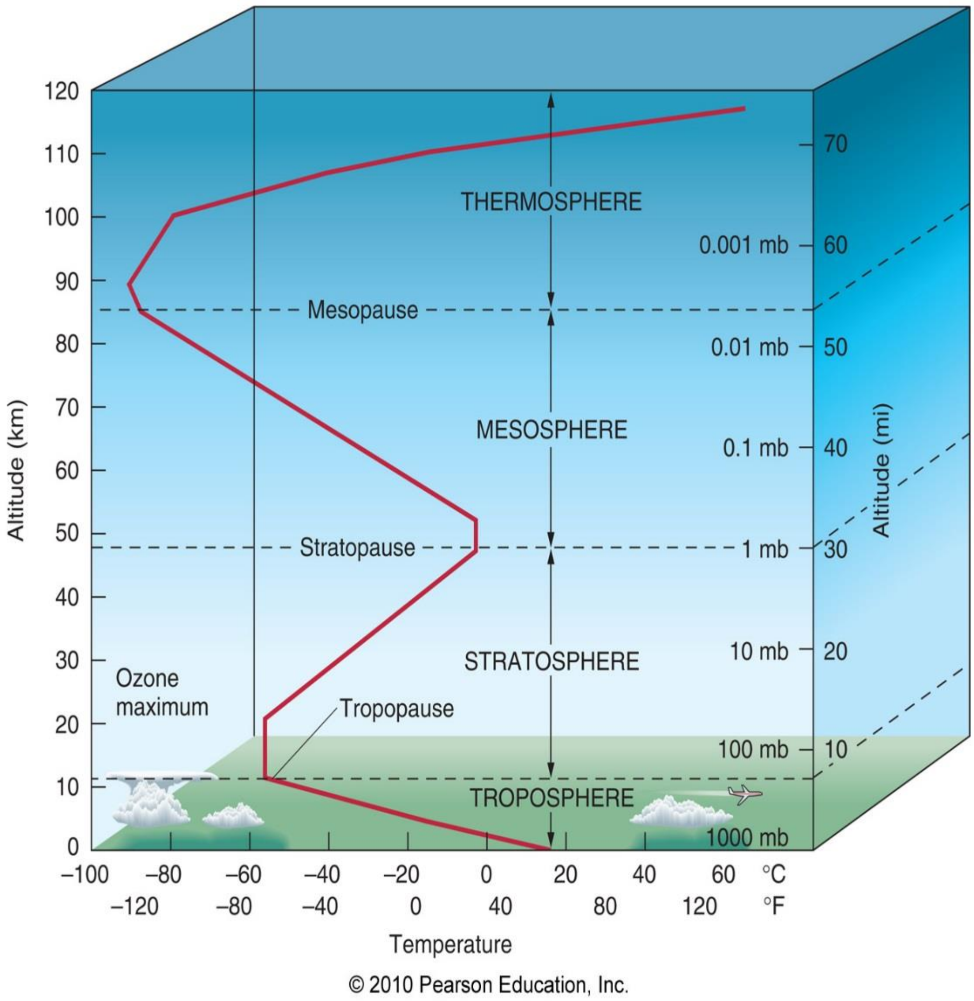

Figure1.1.1 Structure of the atmosphere

[Source: http://unilaggeography2012.blogspot.nl/p/gry-101-introduction-to-physical.html]

Each zone has its own physical and chemical characteristics and properties such as density, pressure, chemical and electrical and temperature properties .The five layers are:

- The Troposphere
- The Stratosphere
- The Mesosphere
- The Thermosphere and Ionosphere
- The Exosphere

The layers in the Atmosphere shown in the fig1.1.2

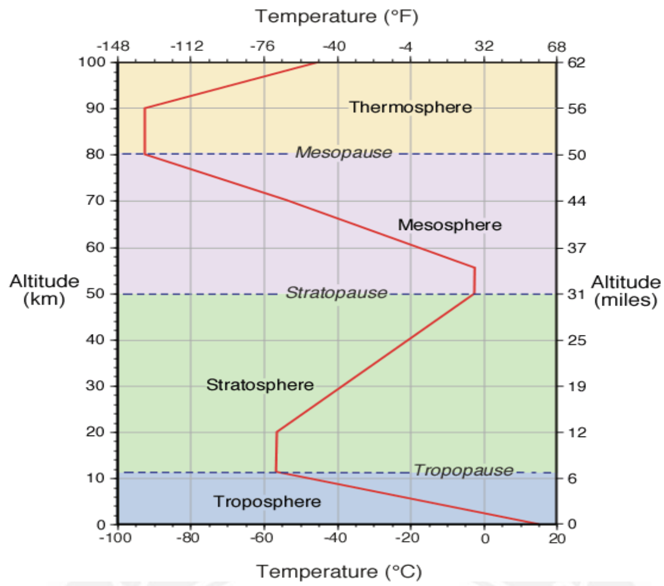

Figure 1.1.2 vertical structure of the atmosphere

[Source:https://www.assignmentpoint.com/wp-content/uploads/2016/09/Vertical-Structure-of-the-Atmosphere.jpg]

Gravity pulls gases toward the Earth's surface, and the whole column of gases exerts a pressure of 1000 hPa at sea level, 1013.25 mb or 29.92 n.Hg. Pressure and Density Decrease with Height.

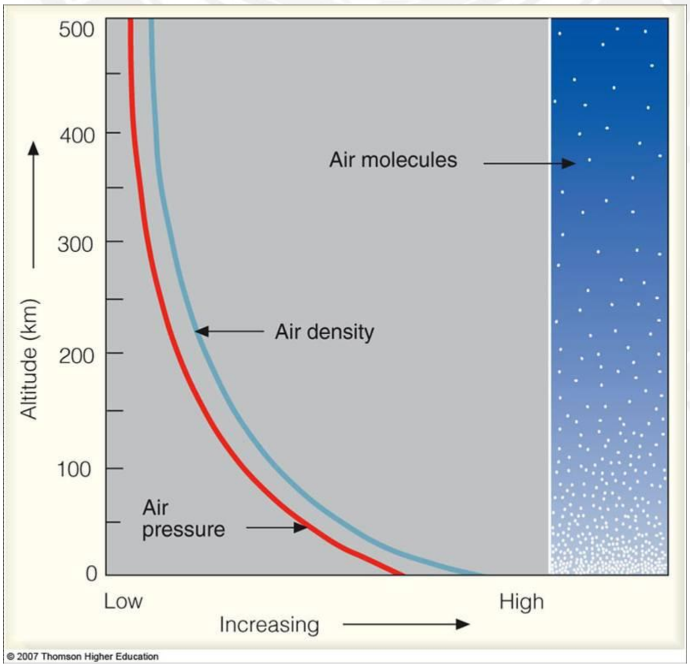

Figure1.1.3 Pressure and Density of Atmosphere

[Source :https://images.app.goo.gl/bYFKZ98YxmDtJv259]

The Troposphere

This is the lowest part of the atmosphere - the part we live in. It contains most of our weather - clouds, rain, snow. In this part of the atmosphere the temperature gets colder as the distance above the earth increases, by about 6.5°C per kilometer. The actual change of temperature with height varies from day to day, depending on the weather.

The troposphere contains about 75% of all of the air in the atmosphere, and almost all of the water vapour (which forms clouds and rain). The decrease in temperature with height is a result of the decreasing pressure. If a parcel of air moves upwards it expands(because of the lower pressure). When air expands it cools. So air higher up is cooler than air lower down.

The lowest part of the troposphere is called the boundary layer. This is where the air motion is determined by the properties of the Earth's surface. Turbulence is generated as the wind blows over the Earth's surface, and by thermals rising from the land as it is heated by the sun. This turbulence redistributes heat and moisture within the boundary layer, as well as pollutants and other constituents of the atmosphere.

The top of the troposphere is called the tropopause. This is lowest at the poles, where it is about 7 - 10 km above the Earth's surface. It is highest (about 17 - 18 km) near the equator.

The Stratosphere

This extends upwards from the tropopause to about 50 km. It contains much of the ozone in the atmosphere. The increase in temperature with height occurs because of absorption of ultraviolet (UV) radiation from the sun by this ozone. Temperatures in the stratosphere are highest over the summer pole, and lowest over the winter pole.

By absorbing dangerous UV radiation, the ozone in the stratosphere protects us from skin cancer and other health damage. However chemicals (called CFCs or freons, and halons) which were once used in refrigerators, spray cans and fire extinguishers have reduced the amount of ozone in the stratosphere, particularly at polar latitudes, leading to the so-called "Antarctic ozone hole".

Now humans have stopped making most of the harmful CFCs we expect the ozone hole will eventually recover over the 21st century, but this is a slow process.

The Mesosphere

The region above the stratosphere is called the mesosphere. Here the temperature again decreases with height, reaching a minimum of about -90°C at the "mesopause".

The Thermosphere and Ionosphere

The thermosphere lies above the mesopause, and is a region in which temperatures again increase with height. This temperature increase is caused by the absorption of energetic ultraviolet and X-Ray radiation from the sun.

The region of the atmosphere above about 80 km is also caused the "ionosphere", since the energetic solar radiation knocks electrons off molecules and atoms, turning them into "ions" with a positive charge. The temperature of the thermosphere varies between night and day and between the seasons, as do the numbers of ions and electrons which are present. The ionosphere reflects and absorbs radio waves, allowing us to receive shortwave radio broadcasts in New Zealand from other parts of the world.

The Exosphere

The region above about 500 km is called the exosphere. It contains mainly oxygen and hydrogen atoms, but there are so few of them that they rarely collide - they follow "ballistic" trajectories under the influence of gravity, and some of them escape right out into space.

COMPOSITION OF ATMOSPHERE:

The three major constituents of Earth's atmosphere are nitrogen, oxygen, and argon.

- Water vapour accounts for roughly 0.25% of the atmosphere by mass.

- The concentration of water vapor (a greenhouse gas) varies significantly from around 10 ppm by volume in the coldest portions of the atmosphere to as much as 5% by volume in hot, humid air masses, and concentrations of other atmospheric gases are typically quoted in terms of dry air (without water vapor).
- The remaining gases are often referred to as trace gases, among which are the greenhouse gases principally carbon dioxide, methane, nitrous oxide, and ozone.
- Besides argon, already mentioned, other noble gases, neon, helium, krypton, and xenon are also present.
- Filtered air includes trace amounts of many other chemical compounds.
- Many substances of natural origin may be present in locally and seasonally variable small amounts as aerosols in an unfiltered air sample, including dust of mineral and organic composition, pollen and spores, sea spray, and volcanic ash.
- Various industrial pollutants also may be present as gases or aerosols, such as chlorine , fluorine compounds and elemental mercury vapor.
- Sulfur compounds such as hydrogen sulfide and sulfur dioxide (SO_2) may be derived from natural sources or from industrial air pollution.
- The atmosphere is composed of
  - Gases
  - Vapor
  - Particulates

The atmosphere is a mixture of many gases. In addition, it contains huge numbers of solid and liquid particles, collectively called aerosols.

The gases in the atmosphere are composed of neutral, uncharged particles. Except for the noble gases, atoms in the gas phase share electrons with other atoms in chemical bonds so that their electron count can approach the more stable filled-shell configuration. The Earth's atmosphere consists of a mixture of noble gas atoms and many kinds of molecules.

Major constituents of dry air, by volume			
Gas		**Volume**	
Name	**Formula**	**in ppm**	**in %**
Nitrogen	N_2	780,840	78.084
Oxygen	O_2	209,460	20.946
Argon	Ar	9,340	0.9340
Carbon dioxide (December, 2020)	CO2	415.00	0.041500
Neon	Ne	18.18	0.001818
Helium	He	5.24	0.000524
Methane	CH_4	1.87	0.000187
Krypton	Kr	1.14	0.000114
Not included in above dry atmosphere:			
Water vapor[(D)]	H_2O	0–30,000[(D)]	0–3%[(E)]

Changes in Composition:

Earth's primordial atmosphere was probably similar to the gas cloud that created the sun and planets. It consisted of hydrogen and helium, along with methane, ammonia, and water. This was a reducing atmosphere. There was no molecular oxygen or other reactive oxides. Over time, some of this first atmosphere, particularly the lighter gases, out gassed and was lost. More water may have arrived with comets colliding on the surface of the planet. Volcanic activity in the early, Earth created major changes with release of water vapor, carbon dioxide, and ammonia along with small quantities of SO_2, H_2S, HCl, N_2, NO_2, He, Ar, and other noble gases.

This produced the second atmosphere. Comet impacts may have increased the amount of water. Water vapor formed clouds. These produced rain. Over a period of thousands of years, the liquid water accumulated as rivers, lakes, and oceans on the Earth's surface. Bodies of liquid water acted as sinks for carbon dioxide. Chemical and biological processes transformed CO_2 gas to carbonate rocks. The nitrogen and argon accumulated in the atmosphere. They do not react with water or other atmospheric components. Oxygen existed in only trace quantities before life began.