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SEC4T (Weather Forecasting) , Topic :- Introduction to atmosphere

❖ Introduction :

The Earth has an atmosphere which we commonly call Air. Air contains oxygen for breathing, nitrogen and small amount of other gases, like the greenhouse gases which keep Earth naturally warm and suitable for life. The air also contains pollution. Some of this is natural, like dust from volcanoes, but a lot is now man-made, and comes from the burning of fuels for energy, electricity, heat and transportation. The air also contains a lot of water in the form of moisture. When it rains we can see it. For the rest of the time, it is present in air in the form of invisible vapour or visible clouds, and is constantly recycled between the Earth and atmosphere by means of the water cycle. Moisture in the atmosphere is a cause of a lot of the world's weather. Most air lies near the Earth's surface in the lowest layer of the atmosphere called the troposphere, pushed down by gravity. Most of the world's weather occurs in the troposphere which is only 10 km thick. The weather is caused by the movement of heat. Heat is exchanged between hot and cold places by moving air or wind, driven by differences in air temperature and pressure. The atmosphere extends a long way out towards space, and is made up of different layers. The stratosphere for example, lying above the troposphere, contains the ozone layer, which protects life on Earth from harmful ultraviolet rays from the Sun. Higher still, meteors burn up in the atmosphere, and can be seen as shooting stars at night.

- **<u>Atomosphere</u> :** An atmosphere (from Ancient Greek ἀτμός (atmos), meaning 'vapour, and σφαῖρα (sphaira), meaning 'ball' or 'sphere') is a layer or a set of layers of gases surrounding a planet or other material body, that is held in place by the gravity of that body. An atmosphere is more likely to be retained if the gravity it is subject to is high and the temperature of the atmosphere is low. The atmosphere of Earth is composed of nitrogen (about 78%), oxygen (about 21%), argon (about 0.9%), carbon dioxide (0.04%) and other gases in trace amounts. Oxygen is used by most organisms for respiration; nitrogen is fixed by bacteria and lightning to produce ammonia used in the construction of nucleotides and amino acids; and carbon dioxide is used by plants, algae and cyanobacteria for photosynthesis. The atmosphere helps to protect living organisms from genetic damage by solar ultraviolet radiation, solar wind and cosmic rays. The current composition of the Earth's atmosphere is the product of billions of years of biochemical modification of the paleo atmosphere by living organisms. The term stellar atmosphere describes the outer region of a star and typically includes the portion above opaque photosphere. Stars with sufficiently low temperatures may have outer atmospheres with compound molecules.
- **Evolution of Atmosphere :** No one knows of any other planet where you can do this simple thing. Other planets and moons in our solar system have atmospheres, but none of them could support life as we know it. They are either too dense (as on Venus) or not dense enough (as on Mars), and none of them have much oxygen, the precious gas that we Earth animals need every minute. So how did our atmosphere get to be so special? Some scientists describe three stages in the evolution of Earth's atmosphere as it is today.

  1) Just formed Earth 2) Young Earth 3) Current Earth

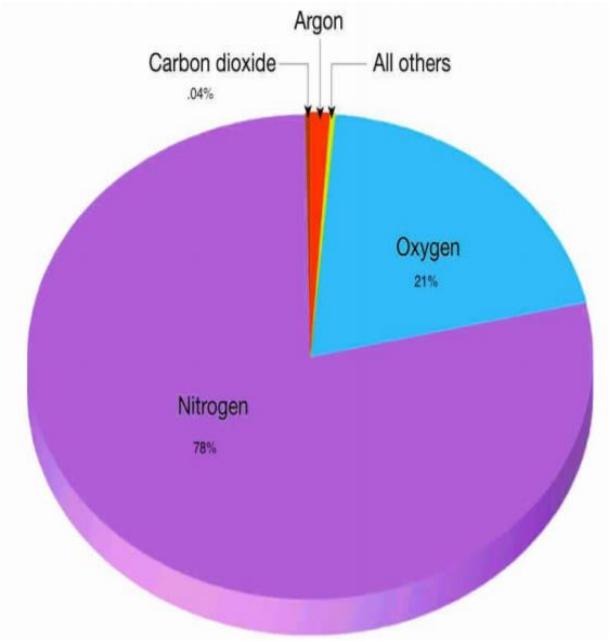
❖ **Composition of the Atmosphere :**

The atmosphere is made up of different gases, water vapour and dust particles. The composition of the atmosphere is not static and it changes according to the time and place.

Gases of the atmosphere

Table : Permanent Gases of the Atmosphere

Constituent	*Formula*	*Percentage by Volume*
Nitrogen	N_2	78.08
Oxygen	O_2	20.95
Argon	Ar	0.93
Carbon dioxide	CO_2	0.036
Neon	Ne	0.002
Helium	He	0.0005
Krypto	Kr	0.001
Xenon	Xe	0.00009
Hydrogen	H_2	0.00005

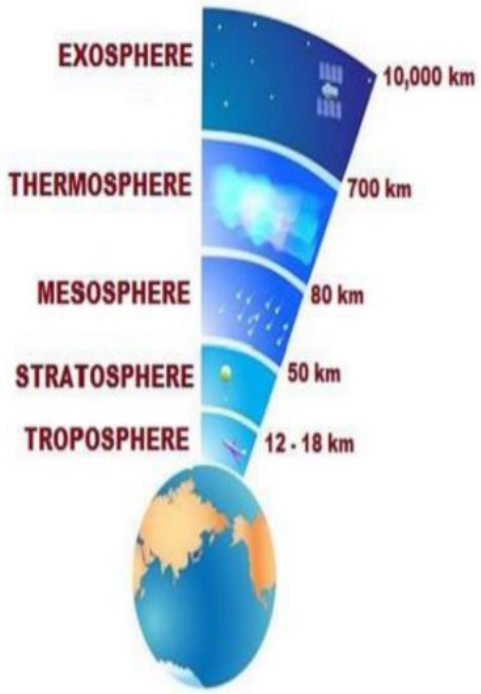


The atmosphere is a mixture of different types of gases. • Nitrogen and oxygen are the two main gases in the atmosphere and 99 percentage of the atmosphere is made up of these two gases. • Other gases like argon, carbon dioxide, neon, helium, hydrogen, etc. form the remaining part of the atmosphere. • The portion of the gases changes in the higher layers of the atmosphere in such a way that oxygen will be almost negligible quantity at the heights of 120 km. • Similarly, carbon dioxide (and water vapour) is found only up to 90 km from the surface of the earth.

Structure of the atmosphere

The atmosphere can be divided into five layers according to the diversity of temperature and density. They are:

1) Troposphere
2) Stratosphere
3) Mesosphere
4) Thermosphere (Ionosphere)
5) Exosphere

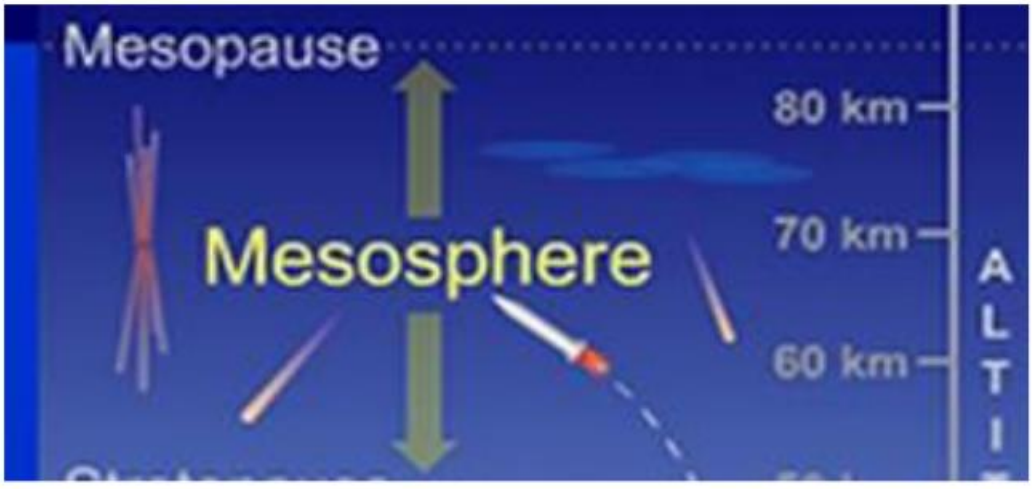


1. **Troposphere :** It is the lowermost layer of the atmosphere. • The height of this layer is about 11 km on the equator and 8 km on the poles. • The thickness of the troposphere is greatest at the equator because heat us transported to great heights by strong convectional currents. • Troposphere contains dust particles and water vapour. • This is the most important layer of the atmosphere because all kinds of weather changes take place only in this layer. • The air never remains static in this layer. Therefore this layer is called 'changing sphere' or troposphere. • The environmental temperature decreases with increasing height of the atmosphere. It decreases at the rate of 1 degree Celsius for every 165 m of height. This is called Normal Lapse Rate.

   Tropopause : The zone separating troposphere from the stratosphere is known as tropopause. • The air temperature at the tropopause is about – 80 degree Celsius

over the equator and about – 45 degree Celsius over the poles. The temperature here is nearly constant, and hence, it is called tropopause.

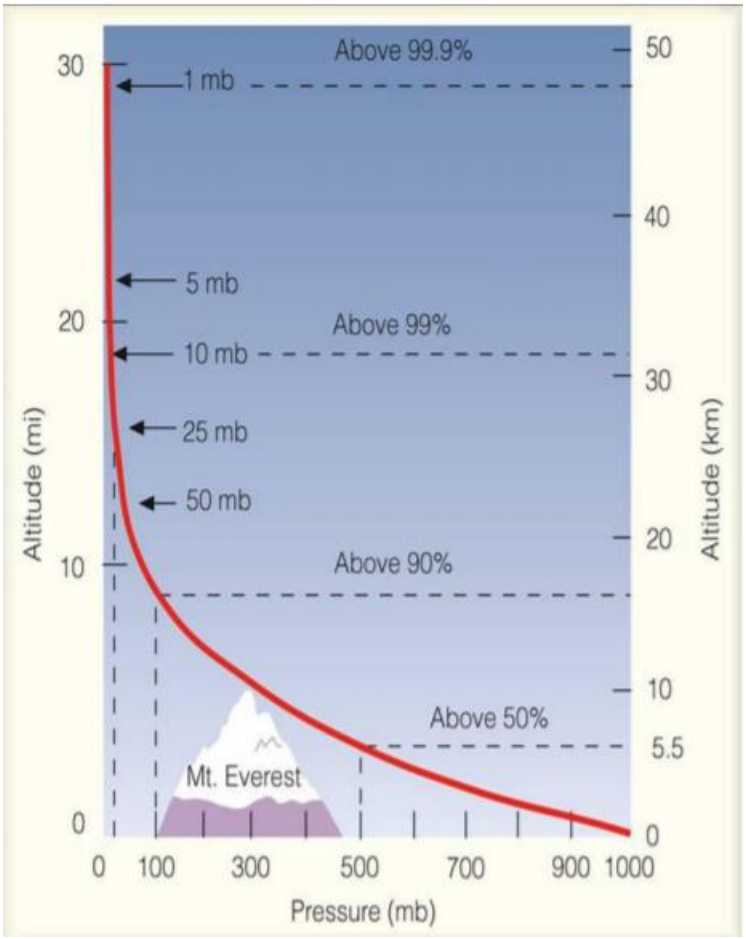
2. **Stratosphere:** Stratosphere is found just above the troposphere. • It extends up to a height of 50 km. • The temperature remains almost the same in the lower part of this layer up to the height of 20 km. After this, the temperature increases slowly with the increase in the height. The temperature increases due to the presence of ozone gas in the upper part of this layer. • Weather related incidents do not take place in this layer. The air blows horizontally here. Therefore this layer is considered ideal for flying of aircraft. • One important feature of stratosphere is that it contains a layer of ozone gas. • The relative thickness of the ozone layer is measured in Dobson Units. • It is mainly found in the lower portion of the stratosphere, from approximately 20 to 30 km above the earth's surface. • It contains a high concentration of ozone (O3) in relation to other parts of the atmosphere. • It is the region of the stratosphere that absorbs most of the sun's ultra-violet radiations.
   Stratopause : The upper limit of the stratosphere is known as stratopause.
3. **Mesosphere** : It is the third layer of the atmosphere spreading over the stratosphere. • It extends up to a height of 80 km. • In this layer, the temperature starts decreasing with increasing altitude and reaches up to – 100 degree Celsius at the height of 80 km. • Meteors or falling stars occur in this layer.
   Mesopause : The upper limit of the mesosphere is known as mesopause.



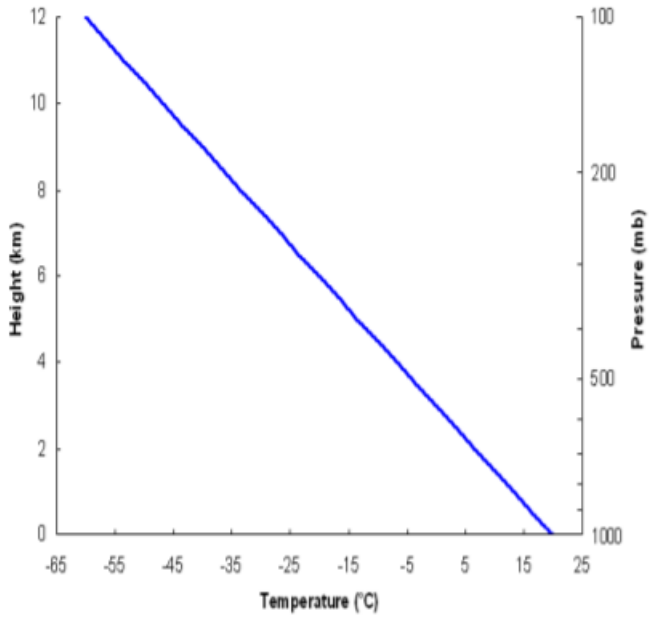
4. **Thermosphere**: This layer is located between 80 and 400 km above the mesopause. • It contains electrically charged particles known as ions, and hence, it is known as the ionosphere. • Radio waves transmitted from the earth are reflected back to the earth by this layer and due to this, radio broadcasting has become possible. • The temperature here starts increasing with heights.
5. **Exosphere**: The exosphere is the uppermost layer of the atmosphere. • Gases are very sparse in this sphere due to the lack of gravitational force. Therefore, the density of air is very less here.

❖ **Why Do Temperature and Pressure Decrease with Height?**

The molecules that make up the atmosphere are pulled close to the earth's surface by gravity. This causes the atmosphere to be concentrated at the Earth's surface and thin rapidly with height. Air pressure is a measure of the weight of the molecules above you. As you move up in the atmosphere there are fewer molecules above you, so the air pressure is lower. Figure shows how pressure decreases with height. The black Dotted lines show how much of the atmosphere is below you at a certain level. For example, at 10 miles up, 90% of the atmosphere is below you. At the peak of Mount Everest, as shown, the air pressure is 70% lower than it is at sea level. This means when mountain climbers breathe air on top of the mountain, they are only inhaling 30% of the oxygen they would get at sea level. It is no surprise that most climbers use oxygen tanks when they climb Mt. Everest. • Temperature decreases with height in the troposphere. This is true for a couple different reasons. First, even though the sun's energy comes down from the sky, it is mostly absorbed by the ground. The ground is constantly releasing this energy, as heat in infrared light, so the troposphere is actually heated from the ground up, causing it to be warmer near the surface and cooler higher up.



Another reason is the decreasing air pressure with height. If the warm air at the surface gets blown upward into the cooler air above it, the surface air will continue to rise. As air rises into areas of lower pressure it expands because there are less molecules around it to compress it. The molecules in the air use some of their energy to move apart from each other, causing the air temperature to decrease. The constantly decreasing air pressure in conjunction with the ground-up heating keeps the temperature in the troposphere decreasing with height.



In the real atmosphere, the actual vertical temperature structure depends on air masses with specific properties of temperature and humidity being blown into the area as well as effects of daytime heating. If you have a layer of air with warm temperatures above the surface, we call that an "inversion". That layer can act as a cap which prevents clouds and sometimes severe weather from forming.