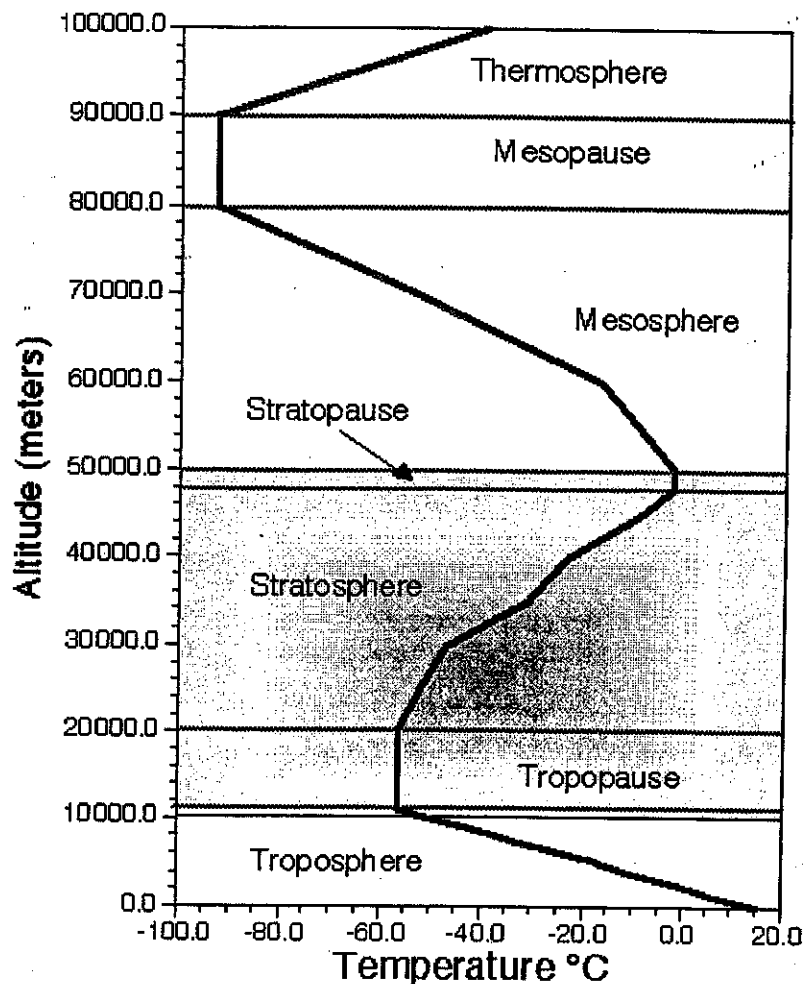


# Atmospheric Layers

The Earth's atmosphere contains several different layers that can be defined according to air temperature or chemical composition. The following diagram displays these layers in an average atmosphere.



According to temperature, the atmosphere contains seven different layers. From the surface of the Earth to approximate 11 kilometers the layer called the **troposphere** exists. This layer contains about 75 % of the total mass of the atmosphere. It is also the layer where the majority of our weather occurs. Maximum air temperature occurs near the Earth's surface in this layer. With increasing altitude air temperature drops rapidly with increasing height, until a temperature of -55 degrees Celsius is reached at the top of the troposphere. The **tropopause**, extending from 11 to 20 kilometers, is an **isothermal** layer in the atmosphere where temperature remains constant over a distance of 9 kilometers.

Above the tropopause, is the **stratosphere** which extends from 20 to 48 kilometers above the Earth's surface. In the stratosphere temperature increases with altitude because ozone gas found in this layer absorbs ultraviolet sunlight creating heat energy. Ozone is primarily found in the atmosphere at varying concentrations between the altitudes of 10 to 50 kilometers. This layer of ozone is also called the **ozone layer** (depicted in yellow in the above Figure). Ozone protects life from the harmful effects of ultraviolet radiation. Without it life could not exist on Earth.

Separating the **mesosphere** from the stratosphere is another isothermal layer called the **stratopause**. In the mesosphere, the atmosphere reaches its coldest temperatures (about -90 degrees Celsius) at a height of approximately 80 kilometers. Above the mesosphere is another isothermal layer called the **mesopause**. The final atmospheric layer has an altitude greater than 90 kilometers and is called the **thermosphere**. The thermosphere is the hottest layer in the atmosphere as oxygen molecules absorb solar radiation.

WORKSHEET

**20.4 ENRICHMENT WORKSHEET**

**INTEGRATING**

**PHYSICS**

# The Tropopause

Read the following paragraphs, and complete the exercises below.

The layer of the atmosphere closest to Earth's surface is called the *troposphere*. Within this layer, the temperature decreases as you go to higher altitudes. At the top of the troposphere, the temperature levels off at a boundary called the *tropopause*.

The tropopause is located about 15 to 20 km above Earth's surface at the equator and about 10 km above the surface at the poles. Why is there such an extreme difference between the altitude of the tropopause at the equator and at the poles?

Much of the movement of air in the troposphere is caused by *convection*. In convection, energy is transferred by the movement of a heated fluid, such as air or water. In this case, the air at the bottom of the troposphere is warmed by Earth's surface. The hot air is less dense than the cool air above it, so it rises.

The air cools as it rises until it reaches an equilibrium altitude at the tropopause. The hotter the air is to begin with, the further it must rise to become completely cooled. At the equator, the tropopause is higher in the atmosphere, because the air is generally warmer and therefore takes longer to cool. At the poles, where the air is not as warm, the tropopause is at a lower altitude.

### Exercises

1. Above what atmospheric layer is the tropopause located?  
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2. Explain, in your own words, how energy is transferred through convection.  
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3. A stove applies heat only to the bottom of a pan, but all of the water in the pan gets warm. Can this be explained through convection? Explain your answer.  
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4. If the average temperature at the equator and the poles increased, what would happen to the position of the tropopause? What would happen if the average temperatures decreased?  
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