S6E4. A: Analyze and interpret data to compare and contrast the composition of Earth’s atmospheric layers (including the ozone layer) and greenhouse gases.

Read each slide, then decide what you need to use for your notes (some slides are just facts others are for the blanks).

Glencoe Earth Science
Ch. 11.1
Atmospheric Composition: What’s it made of?

➔ 99% made up of Nitrogen & Oxygen!

◆ 78% Nitrogen
◆ 21% Oxygen
◆ 0.93% Argon
◆ 0.07% Trace Gases

➔ These gases are permanent & fairly consistent over time.
Atmospheric Composition: The Other 1%

Permanent atmospheric gases: About 99 percent of the atmosphere is composed of nitrogen ($N_2$) and oxygen ($O_2$). The remaining 1 percent consists of argon (Ar), carbon dioxide (CO$_2$), water vapor (H$_2$O), and other trace gases, as shown in Figure 11.1. The amounts of nitrogen and oxygen in the atmosphere are fairly constant over recent time. However, over Earth’s history, the composition of the atmosphere has changed greatly. For example, Earth’s early atmosphere probably contained mostly helium (He), hydrogen (H$_2$), methane (CH$_4$), and ammonia (NH$_3$). Today, oxygen and nitrogen are continually being recycled between the atmosphere, living organisms, the oceans, and Earth’s crust.
Earth's Atmosphere

thermosphere
mesosphere
ozone layer
stratosphere
troposphere
Layers of the Atmosphere but the forth has two parts
Atmospheric Layers

The atmosphere is classified into five different layers, as shown in Table 11.1 and Figure 11.4. These layers are the troposphere, stratosphere, mesosphere, thermosphere, and exosphere. Each layer differs in composition and temperature profile.

**Troposphere**  The layer closest to Earth’s surface, the troposphere, contains most of the mass of the atmosphere. Weather occurs in the troposphere. In the troposphere, air temperature decreases as altitude increases. The altitude at which the temperature stops decreasing is called the tropopause. The height of the tropopause varies from about 16 km above Earth’s surface in the tropics to about 9 km above it at the poles. Temperatures at the tropopause can be as low as −60°C.

**Stratosphere**  Above the tropopause is the stratosphere, a layer in which the air temperature mainly increases with altitude and contains the ozone layer. In the lower stratosphere below the ozone layer, the temperature stays constant with altitude. However, starting at the bottom of the ozone layer, the temperature in the stratosphere increases as altitude increases. This heating is caused by ozone molecules, which absorb ultraviolet radiation from the Sun. At the stratopause, air temperature stops increasing with altitude. The stratopause is about 48 km above Earth’s surface. About 99.9 percent of the mass of Earth’s atmosphere is below the stratopause.
Mesosphere  Above the stratopause is the **mesosphere**, which is about 50 km to 100 km above Earth’s surface. In the mesosphere, air temperature decreases with altitude, as shown in **Figure 11.4**. This temperature decrease occurs because very little solar radiation is absorbed in this layer. The top of the mesosphere, where temperatures stop decreasing with altitude, is called the mesopause.

Thermosphere  The **thermosphere** is the layer between about 100 km and 500 km above Earth’s surface. In this layer, the extremely low density of air causes the temperature to rise. This will be discussed further in Section 11.2. Temperatures in this layer can be more than 1000°C. The ionosphere, which is made of electrically charged particles, is part of the thermosphere.
Layers of the Atmosphere

more facts about Mesosphere

→ Mesosphere (50-85km)

◆ Above stratopause
◆ Coldest layer - As low as -90°C!
◆ Temperature decreases with altitude
◆ Very little solar radiation absorbed here (brrrrr!)
◆ Meteors burn up here!
◆ Mesopause - altitude when temp stops decreasing
Thermosphere has 2 parts:

**Ionosphere**: Lower Thermosphere. Contains electrically charged particles due to absorption of ultraviolet radiation and X-rays that are given off by the sun. **Aurora Borealis** can be seen in this layer. **Radio waves** travel easily in this layer.

**Exosphere**: Upper thermosphere. Air is extremely thin. **Satellites** travel here because there is very little friction with air.
Review /MORE Characteristics of each layer

**Troposphere:** Contains **Convection Currents** created by the sun’s heat which cause most of our **weather**

**Stratosphere:** Contains the **Ozone Layer.** prevents some ultraviolet radiation UV light from reaching Earth’s surface, also where airplanes fly.

**Mesosphere:** **Meteors burn up** when they hit this layer.

**Thermosphere:** Divided into Ionosphere and Exosphere. **Satellites** & **Radio waves** travel in this layer. This is the **hottest layer**
# Altitude of Each Layer

Major layers of the atmosphere

<table>
<thead>
<tr>
<th>Region</th>
<th>Altitude range (km)</th>
<th>Temperature range (°C)</th>
<th>Important chemical species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Troposphere</td>
<td>0-20</td>
<td>15 to -56</td>
<td>Nitrogen, oxygen, water vapour, carbon dioxide</td>
</tr>
<tr>
<td>Stratosphere</td>
<td>20-50</td>
<td>-56 to -2</td>
<td>Ozone</td>
</tr>
<tr>
<td>Mesosphere</td>
<td>50-85</td>
<td>-2 to -92</td>
<td>Oxygen, nitric oxide</td>
</tr>
<tr>
<td>Thermosphere</td>
<td>85-500</td>
<td>-92 to 1200</td>
<td>Oxygen + nitric oxide</td>
</tr>
</tbody>
</table>
Basis for Layers/ Extra Facts

Layers are based on **TEMPERATURE CHANGE** within the layer.

As you move up through the troposphere, temperature decreases.

As you move up through stratosphere, temperature increases.

As you move up through the mesosphere, temperature decreases.

As you move up through the thermosphere, temperature increases.
Altitude is the distance above sea level. Air pressure decreases as altitude increases. As air pressure decreases, so does density. The composition of the atmosphere remains the same until the exosphere.
Atmospheric pressure decreases as altitude increases. High altitudes contain less air molecules, resulting in lower air density, decreased temperatures and lower air pressure. High altitudes are typically found above sea level.

Atmospheric pressure is measured as the weight of the air above a surface. Atmospheric pressure is affected by gravity, which is strong at lower altitudes and weak at higher altitudes. Gravity at lower altitudes causes air molecules to be pulled together, increasing the atmospheric pressure as the air becomes more dense. Atmospheric pressure experiences a rapid decrease at 5.5 kilometers above sea level and continues its decrease at a slower rate as altitude increases.
In the troposphere, temperature decreases as altitude increases primarily because Earth's atmosphere is heated upward from the lowest level. Although sunlight passes through the higher altitudes to reach the surface of the Earth, the surface is much better at absorbing the solar heat.
Air Pressure

- As your altitude increases, the air pressure decreases.
- As your altitude decreases, the air pressure increases.
- This is an inverse relationship!
Transfer of Heat through the atmosphere

Heat can move in three ways:

1- Conduction: Heat is transferred through direct contact.

2- Convection: Heat is transferred by a hot fluid (gas or liquid) circulating or moving.

3- Radiation: Heat is transferred by electromagnetic waves.
If a metal cooking fork is left in the fire long enough, eventually the end we are holding will become too hot for us to handle. Heat was transferred from the flames in the campfire to the metal fork, and then from molecule to molecule in the fork until it reaches our fingers via \textit{conduction}.
What is Convection?

→ Density differences in temperatures cause heat to rise and cool to sink, this applies to gasses and liquids

Examples:

Heated water becomes less dense and rises, Boiling water

Hot air expands and is less dense hot air balloon
Imagine standing in front of a camp fire and holding out your hands in front of you...what do you feel?

Warmth as your hands absorb the **radiation** coming from the fire.
How is heat transferred?
There are three ways that heat is transferred from object to the next, conduction, convection, and radiation.

Conduction: transfer of heat between substances that are in direct contact with each other.
Example: grabbing the handle of a hot pan, walking barefoot on concrete during the summer, ironing clothes.

Convection: thermal energy is transferred from hot places (areas of high thermal energy) to cold places (areas of low thermal energy).
Examples: boiling water, heat in a room, the ocean

Radiation: heat is transmitted through empty space, with electromagnetic waves.
Examples: warmth from the sun, a campfire, opening the oven door
Heat moves throughout (within) our atmosphere in **CONVECTION CURRENTS**
Now read OVER your NOTES!

You should be able to analyze and interpret data to compare and contrast the composition of Earth’s atmospheric layers (including the ozone layer) and greenhouse gases.