Earth's atmosphere

A gravitationally held envelope of gases surrounds Earth. Start with what air contains, then connect composition to the processes that make the planet habitable.

1. DRY AIR: APPROXIMATE PERCENTAGES BY VOLUME



78%	**Nitrogen**	The largest share of dry air.
21%	**Oxygen**	Essential for aerobic respiration.
1%	**Other gases**	Mostly argon; also carbon dioxide and other trace gases.

Rounded proportions for well-mixed lower air. Argon alone is about 0.9%.

2. WATER VAPOR IS VARIABLE

Dry air excludes water vapor. Near the surface, water vapor can range from almost 0% to about 4%, depending on conditions. Adding water vapor changes the percentages of the other gases in the total moist-air mixture. Clouds are tiny liquid droplets or ice crystals, not visible water vapor.

3. SMALL AMOUNTS CAN HAVE LARGE EFFECTS

Nitrogen and oxygen dominate air by volume but contribute little directly to the greenhouse effect. Water vapor, carbon dioxide, methane and other greenhouse gases absorb and emit infrared radiation. A gas can be scarce yet environmentally important; abundance alone does not measure its effect.

Composition check: in 100 L of dry air, roughly 78 L is nitrogen and 21 L is oxygen, compared at the same temperature and pressure.

Composition and variable water vapor: NOAA GML, Earth's Atmosphere.
Trace gases and radiation: NOAA GML, The Greenhouse Effect.

Scope: College Board AP Environmental Science CED, Topic 4.4, p. 83.

Five layers, changing temperature

Read from the ground upward. Temperature gradients distinguish the main thermal layers. Their boundaries are transitions, not solid lids; heights vary with location and solar conditions.

1. A VERTICAL MAP OF THE ATMOSPHERE

LAYER / APPROXIMATE HEIGHT	WHAT CHANGES AS YOU GO UP?
5. Exosphere Above roughly 700 km	Extremely sparse gas gradually merges with space.
4. Thermosphere Roughly 80-700 km	Temperature rises as high-energy solar radiation is absorbed; auroras occur here.
3. Mesosphere Roughly 50-80 km	Temperature falls; most incoming meteors burn up here.
2. Stratosphere Roughly 11-50 km	Temperature rises. Ozone absorbs ultraviolet radiation.
1. Troposphere Surface to roughly 11 km	Temperature usually falls. Most weather and clouds occur here.

Not to scale. Heights vary; focus on the layer order and temperature trends.

2. NAME THE BOUNDARIES

Tropopause: top of the troposphere. Stratopause: top of the stratosphere. Mesopause: top of the mesosphere, near the coldest part of the atmosphere. A change in the direction of the temperature trend helps identify each boundary.

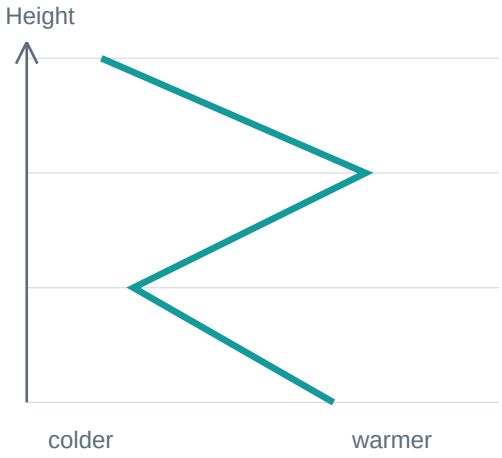
Layer order, characteristics and approximate heights: NOAA NESDIS, Layers of the Atmosphere.
Layer boundaries and temperature changes: UCAR, Layers of Earth's Atmosphere.

Scope: College Board AP Environmental Science CED, Topic 4.4, p. 83.

Separate the patterns

Temperature, pressure and gas composition answer different questions. Identify the variable before explaining what changes with height.

1. TEMPERATURE DOES NOT SIMPLY FALL FOREVER



Mesosphere: decreases

Stratosphere: increases

Troposphere: decreases

Qualitative, not to scale. In the thermosphere above, temperature rises again.

2. PRESSURE DECREASES WITH ALTITUDE

Higher places have less overlying air, so atmospheric pressure is lower. Air also generally becomes less dense. This is not the alternating temperature pattern shown above. In the lower atmosphere, oxygen can remain about 21% of dry air even while its partial pressure decreases.

3. TWO DIFFERENT RADIATION PROCESSES

Ozone protection	Stratospheric ozone absorbs incoming ultraviolet radiation, reducing harmful UV exposure at the surface.
Greenhouse effect	Earth emits infrared radiation. Greenhouse gases absorb and emit some of it, including back toward the surface, helping warm the lower atmosphere and surface.

Do not describe ozone protection as the same process as greenhouse warming.

Temperature and pressure profiles: UCAR, Change in the Atmosphere with Altitude.
Infrared absorption and emission: NOAA GML, The Greenhouse Effect.

Scope: College Board AP Environmental Science CED, Topic 4.4, p. 83.