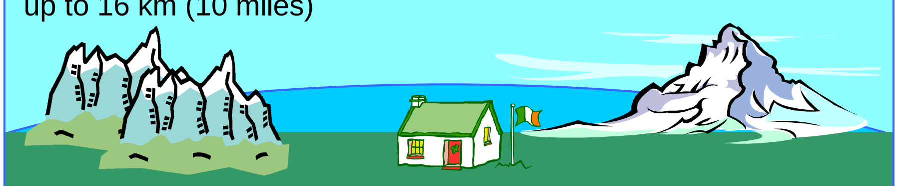
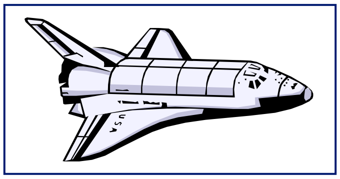
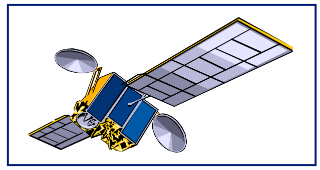
Layers of Earth's Atmosphere

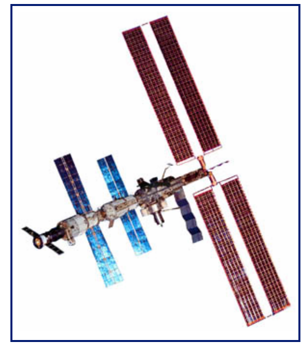
EXOSPHERE up to 10,000 km (6,000 miles)	The atmosphere is extremely thin here. The upper part of this layer is the beginning of true space. Some manmade satellites orbit the Earth within this layer.
THERMOSPHERE up to 600 km (370 miles) or more	The air is very thin here, but very hot – thousands of degrees hot! It is heated by the sun's energy. Both the space shuttle and the International Space Station orbit in the middle-to-upper part of this layer. Also, the Aurora Borealis (northern lights) occurs in this layer.
MESOSPHERE up to 85 km (53 miles)	This is the coldest layer. Temperatures are as low as -90^{o}C (-130^{o}F). Although the air is thin, it is still thick enough to burn up meteoroids.
STRATOSPHERE up to 50 km (30 miles)	Most of the ozone in our atmosphere is found here. Some weather balloons can reach the lower part of this layer.
TROPOSPHERE up to 16 km (10 miles)	This is the layer closest to Earth, where all living things are found. It is also the layer where weather occurs and jets fly.

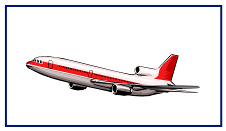


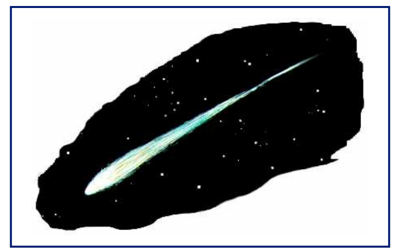
Clip these pictures and paste them into the correct layer of the atmosphere.











Layers of Earth’s Atmosphere

Teachers’ Notes

Objectives: Students will understand that the Earth’s atmosphere is layered and that its properties change with increases in altitude. Students will be able to match various natural phenomena, human activities, and explorations with the layers of the atmosphere in which they take place.

Grade Level: Elementary

NSES: C3, D2, D4, E3

NHSCF: 4b, 6a

Key Concepts

Earth’s atmosphere extends hundreds of kilometers above the surface. It is relatively dense at sea level and becomes increasingly thinner as altitude is gained. In fact, most of the total air mass occurs in the troposphere. The troposphere is where most weather processes take place.

Almost all land-dwelling life forms are found in the bottom 5 kilometers (3 miles) of the atmosphere. At higher altitudes, the thin atmosphere and harsh conditions are inhospitable to most living organisms. Mt. Everest, at almost 9,000 meters (29,000 feet) in elevation, extends about halfway into the troposphere.

The boundaries between layers are not sharply delineated. In particular, there is no well-defined upper limit to the thermosphere – some sources describe it as extending considerably beyond 600 km (370 miles). Above 150 kilometers (90 miles) the air is so thin as to be little more than a vacuum. This altitude is sometimes considered to be the edge of space. However, increasingly small amounts of atmospheric gases are detectable above the mesosphere into the thermosphere and exosphere. Beyond the exosphere lies the magnetosphere, which contains no atmosphere, but where the Van Allen radiation belts are found.

Winged flight is confined to the troposphere because it is the only part of the atmosphere that has sufficient air density to promote lift. High-altitude weather balloons can reach into the lower part of the stratosphere. Much higher, in the upper portions of the thermosphere, atmospheric drag virtually disappears, allowing orbital space flight to occur. Many students may be surprised to learn that the space shuttle orbits so close to Earth. Compare this distance (about 300 km above Earth) to the one-way distance the Apollo astronauts traveled to reach the moon (about 380,000 km).

Temperatures vary between and within layers of the atmosphere. Many students will have experienced the fact that it is cooler on mountaintops than in the valleys. The average temperature gradient through the troposphere (the *environmental lapse rate*) is about –6.5°C per kilometer (-19°F per mile) of elevation gain, causing temperatures to fall below -50 °C (-58 °F) in the upper reaches of the troposphere.

At greater distances above the surface, temperatures can be much colder or much hotter than in the troposphere, depending on the particular physics of the location. In the stratosphere, there is a gradual temperature rise to about -3 °C resulting from the absorption of ultraviolet light by ozone (the "ozone layer"). The hottest region is the thermosphere, where heating of the extremely thin atmosphere is sensitive to solar activity and can produce temperatures up to 1,700°C (3,100°F).

Within the thermosphere is a region known as the ionosphere. The ionosphere is not, technically, a separate layer of the atmosphere. There, the relatively sparse atoms and molecules of the atmosphere are ionized (broken apart into ions and electrons) by solar radiation. The ionized particles make radio communication possible. Auroras (northern and southern lights) also occur in this region. Auroral displays are the visible result of collisions between molecules in the atmosphere and incoming particles in the solar wind trapped by and traveling along magnetic field lines towards Earth's poles.

For additional information, visit these websites:

http://liftoff.msfc.nasa.gov/academy/space/atmosphere.html
http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/ATM_CHEM/atmospheric_structure.html
http://www.windows.ucar.edu/tour/link=/earth/Atmosphere/layers.html
http://www.windows.ucar.edu/tour/link=/earth/Atmosphere/ionosphere.html

Note regarding student activity sheet: All students should be able to access the most basic concepts represented in the diagram, pictures, and text. While younger students are likely to require assistance with reading and vocabulary, older students may enjoy researching the topic and making their own stickers or drawings.

Extension Activity

Although the International Space Station (ISS) orbits at an altitude where the atmosphere is exceedingly thin, atmospheric drag is still sufficient to slow the station and pull it back toward Earth. To overcome this gradual orbital decay, the ISS must be reboosted into proper orbit by the Space Shuttle from time to time. How much altitude does the ISS lose in a day or year? Can the ISS be seen by the naked eye? What is a discoball doing in space? More advanced students, with guidance, may find answers to such questions by exploring these websites:

http://science.nasa.gov/headlines/y2000/ast30may_1m.htm
http://www.hq.nasa.gov/osf/station/viewing/issvis.html
http://voyager.cet.edu/iss/techcheck/techcheck4/discoball.html
http://science.msfc.nasa.gov/headlines/y2001/ast09oct_1.htm