Layers of the Atmosphere

By Jack Fearing, Lincoln Junior High School, Hibbing, Minnesota

Teacher's Page
Objective: To discover how the atmosphere can be divided into layers based on temperature changes at different heights, by making a graph. Students must read the background material, plot data points, and determine where layers begin and end from their comprehension of the reading material.

Grade Level: 6-10

Time Required: 35 - 45 minutes

Materials: No additional materials are needed.

Background: Students should know how to plot data on a graph with negative numbers. Go over the instructions carefully, reading the background paragraph aloud. Watch them carefully during the activity, making sure graphing is correct. They may need help understanding that they find the layer divisions based on what they read in the text.

Evaluation: Students should be graded on the correct plotting of the points in the table onto the graph. They should also label eight items on the graph: troposphere, tropopause, stratosphere, stratopause, mesosphere, mesopause, thermosphere and ozone layer.
Questions:
1. The variations in temperature changes.
2. troposphere: decrease
   stratosphere: increase
   mesosphere: decrease
   thermosphere: increase
3. tropopause: about 12-18 km about –60
   stratopause: about 46-54 km about –2 to 0
   mesopause: about 85-90 km about –90
4. The temperature increases in the stratosphere due to ozone layer capturing ultraviolet radiation. The temperature decreases in the mesosphere since there is no ozone and the amount of air is decreasing.
5. As solar energy hits the earth's surface, it is converted into heat. That heat radiates upward from the earth's surface. The farther away from the warm earth's surface we go, the less heat we feel until we hit the ozone layer in the stratosphere. The temperature of the troposphere therefore decreases steadily until the stratosphere.

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Student's Pages follow:

Name _____

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OBJECTIVE: To discover how the atmosphere can be divided into layers based on temperature changes at different heights, by making a graph.

This is misleading - because this is really virtually no data for the thermosphere - only the VERY lowest portion and NO explanation for the temperature trends in the mesosphere in any of the background information. Students are only really learning about the two lower layers here.

BACKGROUND:
The atmosphere can be divided into four layers based on tempe
layer closest to the Earth is called the troposphere. Above this e,
followed by the mesosphere, then the thermosphere. The upper hese
layers are known as the tropopause, the stratopause, and the me

Temperature variations in the four layers are due to the way sol as it
moves downward through the atmosphere. The Earth's surface r of
solar energy. Some of this energy is reradiated by the Earth as heat, which warms the overlying troposphere. The global average temperature in the troposphere rapidly decreases with altitude until the tropopause, the boundary between the troposphere and the stratosphere.

The temperature begins to increase with altitude in the stratosphere. This warming is caused by a form of oxygen called ozone (O_3) absorbing ultraviolet radiation from the sun. Ozone protects us from most of the sun's ultraviolet radiation, which can cause cancer, genetic mutations, and sunburn. Scientists are concerned that human activity is contributing to a decrease in stratospheric ozone. Nitric oxide, which is the exhaust of high-flying jets, and chlorofluorocarbons (CFCs), which are used as refrigerants, may contribute to ozone depletion.

At the stratopause, the temperature stops increasing with altitude. The overlying mesosphere does not absorb solar radiation, so the temperature decreases with altitude. At the mesopause, the temperature begins to increase with altitude, and this trend continues in the thermosphere. Here solar radiation first hits the Earth's atmosphere and heats it. Because the atmosphere is so thin, a thermometer cannot measure the temperature accurately and special instruments are needed.

DIRECTIONS:
1. Table 1 contains the average temperature readings at various altitudes in the Earth's atmosphere. Plot this data on the graph on the worksheet, and connect adjacent points with a smooth curve. Be careful to plot the negative temperature numbers correctly. This profile provides a general picture of temperature at any given time and place; however, the actual temperature may deviate from the average values, particularly in the lower atmosphere.

TABLE 1
Average Temperature Readings at Various Altitudes

Altitude (km)	Temp (^{o}C)	Altitude (km)	Temp (^{o}C)
0	15	52	-2
5	-18	55	-7
10	-49	60	-17
12	-56	65	-33
20	-56	70	-54
25	-51	75	-65
30	-46	80	-79
35	-37	84	-86
40	-22	92	-86
45	-8	95	-81
48	-2	100	-72

2. Label the different layers of the atmosphere and the separating boundaries between each layer.

3. Mark the general location of the ozone layer. You should place eight words on your graph in the correct locations: troposphere, tropopause, stratosphere, stratopause, mesosphere, mesopause, thermosphere and ozone layer.

QUESTIONS:

1. What is the basis for dividing the atmosphere into f

The problem I have with this question is that there is not enough data for the thermosphere and no background info is given on why the trends in those layers exist.

2. Does the temperature increase or decrease with alti

troposphere? _____ st_____

mesosphere? _____ thermosphere? _____

3. What is the approximate height and temperature of the:

reword - this is a "layer" - so are we asking for the "top" of each layer? I assume so but students may think we want the average.

tropopause: _____ _____

stratopause: _____ _____

mesopause: _____ _____

4. What causes the temperature to increase with decrease with height through the mesosphere?

not enough information given for them to answer this PLUS - formating issue - IF we are giving them spaces for their answers to some questions (for example 2 and 3 above) we can't expect them to answer this question in the space provided!!

5. What causes the temperature to decrease with height in the troposphere?

aren't they going to be a bit curious when they discover (in our powerpoint) that the temp in the thermosphere is VERY HIGH - rising dramatically beyond 100 km (which is conveniently omitted here) - we need to provide the data and explanation here otherwise this is "half" a lesson. The data table should go until at least 120 km.

Graph of Temperature at Various Altitudes

ALTITUDE (km above sea level – Y-axis)