Name_____ Date _____ Period_____

Part 2: How High is Space?

You will compare the heights of layers of Earth's atmosphere to the top of the mesosphere, which is "**astronaut altitude**," the distance from the Earth at which one officially becomes an astronaut. Although still within the atmosphere the astronaut altitude is considered to be the beginning of "space". Above this altitude, planes cannot fly because there is not enough air to provide the lift necessary to allow planes to operate.

1. Compare distances listed in the table below to your scale model of the atmosphere with your predictions.

Table 1: How high is it?

	Altitude Above Sea Level (km)
Peak of Mt. Everest	9 km
Typical Clouds	1 – 10 km
Airplanes	8.5 –11 km
Top of Thunderheads*	12 –15 km
Astronaut Altitude	80 km (50 miles)
Space Shuttle (no longer active)	320-390 km
International Space Station	390 km
Lowest CINDI (C/NOFS) altitude	375 km
Average CINDI (C/NOFS) altitude	563 km
Highest CINDI (C/NOFS) altitude	750 km

*Thunderheads can "dent" stratosphere.

2. Move the pictures to their proper locations, and tape or glue them to your scale model atmosphere.

3. Using the information from Layers of the Atmosphere, draw a line across the chart to indicate the top of each atmospheric layer. Draw an arrow from the bottom to the top of each layer. Label each layer.

Layers of the Atmosphere

Our Atmosphere: is a mixture of gases that surround our planet Earth. The atmosphere contains the gases that we need to breathe. It blankets the planet, holding in heat to keep the planet warm and hospitable for life and absorbing harmful ultraviolet radiation from the Sun.

Mercury and our own moon, as well as many other objects in the solar system do not have enough gravity to keep an atmosphere. Earth does have enough gravitational pull to keep most of the atmosphere from escaping into space.

The Earth's atmosphere is made up of a mixture of gases. The main atmospheric gases are 78 percent nitrogen, 21 percent oxygen, and 1 percent argon. The atmosphere also contains small amounts of water vapor, with concentrations varying with latitude and seasons, and a number of trace gases, including carbon dioxide, methane, carbon monoxide, oxides of nitrogen, and ozone. Scientists defined five atmospheric regions or layers based on properties such as whether the temperature is increasing or decreasing within the layer. **Note:** Temperatures and conditions in the atmosphere vary over the course of years, months, and even days. So, the extent of layers varies with time.

Troposphere (from 0 km to between 12 and 15 km)

The lowest layer of the atmosphere is the layer in which we live. Temperature decreases with height in the troposphere. Weather systems and clouds are found in this layer. The bulk (about 85 percent) of the total mass of the atmosphere is found in the troposphere.

In this layer, a strong, high-altitude wind called the **jet stream** blows eastward, horizontally in the northern hemisphere. The **jet stream** has a large impact on the weather at the Earth's surfaces. The top of the troposphere (tropopause) can reach temperatures as low as 200 K (-73 °C). The flat shape of the tops of thunderheads occur at the tropopause.

Stratosphere (~12 – ~15 to ~50 km)

The second layer of the atmosphere is the Stratosphere. Temperature increases with altitude in this layer. The Stratosphere contains about 15 percent of the total mass of the atmosphere, but it contains 90 percent of the ozone in the atmosphere. Ozone is an important trace gas that acts as a shield for the Earth's surface by absorbing harmful ultraviolet radiation from the Sun. This energy absorption heats the Stratosphere. At the top of the stratosphere (stratopause), temperature can reach about 300 K.

Mesosphere (~50 to ~80 km)

The temperature decreases again with altitude in the third layer, with the upper part of the mesosphere being the **coldest** region in the atmosphere. Most meteors burn up in the mesosphere due to atmospheric friction. The temperature at the mesopause, the upper boundary of the mesosphere, is about 180 K (–93 °C).

Thermosphere (~80 to ~750 km)

Temperatures increases and soars to over 2,000 degrees Celsius in the fourth layer of the atmosphere. Air pressure is very low here, about one ten-millionth of that at Earth's surface. The thermosphere is contained within another layer known as the **ionosphere**.

Exosphere (~750+ km)

Gas molecules begin to escape the atmosphere of the Earth when they reach the exosphere. There is no absolute upper boundary to this layer in which the gas becomes more and more thin with increasing altitude, but most scientists adopt a value of about 2000 km.

Ionosphere (~50 km to around 2,000 km)

The ionosphere is a region in the atmosphere in which enough of the atmospheric gas is *ionized* (ionized atoms or molecules have lost or gained electrons) that free electrons can interfere with radio communications. Radio waves are used by communications satellites and by navigations satellites such as GPS (Global Positioning System). This region has multiple atmospheric layers within it. The Coupled Ion Neutral Detection Investigation (CINDI) flies on an Air Force Spacecraft called C/NOFS to study weather in the ionosphere (space weather) to help predict when changes in the ionosphere may interfere with radio communications.