Layers of the atmosphere

Like anything else in the universe, in general, the deeper you venture into a planet, the denser (and hotter) it gets. In the case of our home planet called Earth, the outermost portion of the planet is its atmosphere. As we move towards earth's surface, the atmosphere grows denser, and the behavior of the atmosphere changes. Each distinct region has its own characteristics, and can be seen as a separate layer.

The outermost layer of our atmosphere is the exosphere. The "air" up here is so thin that individual atoms of hydrogen and helium bounce around almost independently. Each atom is moving very fast and almost never encounters any other particles. In many ways, the exosphere is nearly identical to "outer space." In fact, where the exosphere ends and outer space begins is really a matter of opinion, and of how you choose to define outer space.

Below the exosphere sits the somewhat denser thermosphere. The thermosphere is a somewhat perplexing place. The air is still very thin: it is even possible for atoms to travel large distances (up to a kilometer!) without running into another particle. The thermosphere is so named because the atoms in it are moving at extremely high speeds because of the energy they've absorbed from solar electromagnetic radiation. The thermosphere therefore has a very high temperature. Oddly, because there are so few particles present, it is also has very little heat. Radiation and impacts with high speed atoms will be enough to damage our skin and give us a bad sunburn, but it will not be enough to keep our overall body temperature in a survivable range. Essentially, anyone unlucky to be caught out in the thermosphere would freeze to death while receiving the world's worst sunburn. The thermosphere is also thin enough that satellites can orbit the planet freely without friction with the atmosphere slowing them down enough to cause them to spiral to the ground and crash. It is for this reason that most military, communications and scientific satellites are found here, including the current international space station.

The next layer down is the Mesosphere, meaning the middle atmosphere. As you move deeper into the Mesosphere, it gets denser and warmer, but the very top of the Mesosphere is actually colder than the layer above it, probably because it is somewhat shielded from solar radiation by the Thermosphere above. It is the very top of the Mesosphere that is the coldest place in Earth's atmosphere. Deeper in the mesosphere, there are sometimes enough crystals of frozen water to form ice clouds. This is a testament to how dense the atmosphere is becoming at this layer (even if very cold) and it is friction with this denser air that causes most meteors to heat up and break apart as they fall through this layer.

Below the Mesosphere is the Stratosphere. Oddly, the stratosphere is actually hotter as altitude increases, and cooler as you go deeper. This is because the ozone layer is found near the top of the Stratosphere. Ozone is a molecule made of three connected oxygen atoms. The electromagnetic bonds that hold these atoms together as a molecule are just the right size to allow them to absorb ultraviolet electromagnetic radiation from the sun as it passes through the atmosphere. This heats the upper Stratosphere, and it filters out a large amount of the ultraviolet radiation as it passes through the ozone layer. Overall, this is a good thing for the organisms on the surface below, because this radiation is particularly damaging to our DNA.

As the stratosphere grows denser (and cooler) towards its bottom, we approach the Troposphere. The "tropo" prefix refers to the movement found in this layer of the atmosphere. It is the last and deepest of the atmospheric layers, and it is in constant motion because of the changes in temperature and densities create convection currents that perpetually stir and mix the air. It is in this layer that weather and climate really take place. This layer extends from Sea Level up to over nine kilometers. It is dense, well mixed, and relatively warm. It is here that life is found, and storms, and lightning.

At sea level, (this is the altitude at which most of the worlds water runs down to rest at,) the entire atmosphere is resting overhead. The pressure of the air from above is by definition "One Atmosphere" (1 atm) worth of pressure. This is the standard amount of air pressure, which all other air pressures are compared to. In general, as air gets denser as it cools, pressures can exceed 1 atm, and as it warms air pressure drops below 1 atm. In general, as altitude increases air pressure also drops lower and lower.

In the troposphere, the well mixed air of the atmosphere is generally predictable. It is mostly (78%) made of nitrogen gas. The remainder is about 20.9% oxygen and 0.9% argon gases, with a tiny fraction made up of trace gases, including carbon dioxide and methane. The mix of gases in the atmosphere makes it particularly good at absorbing some types of electromagnetic radiation. In particular, the atmosphere is fairly good at absorbing (and then re-emitting) blue light. As blue light gets scattered and reflected through the sky, it generally can be seen no matter what direction you look. This is why the sky appears an overall blue. On the other hand, the further light has to travel through the atmosphere, the more blue light gets scattered. If the sun is near the horizon, and is traveling through a longer distance to reach the observer, enough blue light is scattered and reflected that very little of it reaches the observer, leaving reddish light as the dominant color. (This is why sunsets and sunrises appear as a different color. It is also why pollutants can change the sky's appearance, since different chemicals absorb and reflect light differently.)

Answer the following questions using a SARs format.

1. From outer space to sea level, what are the layers of the atmosphere?
2. What are the characteristics of the exosphere?
3. What are the characteristics of the thermosphere?
4. What are the characteristics of the mesosphere?
5. What are the characteristics of the stratosphere?
6. What are the characteristics of the troposphere?
7. How do we measure air pressure?
8. What it the relationship between air pressure and altitude?
9. What is the atmosphere mainly made of?