The Solar System

Our Solar System consists of the Sun and the astronomical objects bound in orbit around it. This includes:

- the four inner planets
- the asteroid belt (between Mars' and Jupiter's orbits)
- the four outer planets
- the Kuiper belt (beyond Neptune's orbit)
- the five dwarf planets
- thousands of small bodies, such as comets

The Solar System is located in the Milky Way galaxy, which contains about 200 billion stars.

The Sun

The Sun is the Solar System's star. It is a nearly perfect sphere and accounts for about 99.9% of the mass of our solar system. Around three-quarters of the mass of the Sun is hydrogen, while the rest is mostly helium.

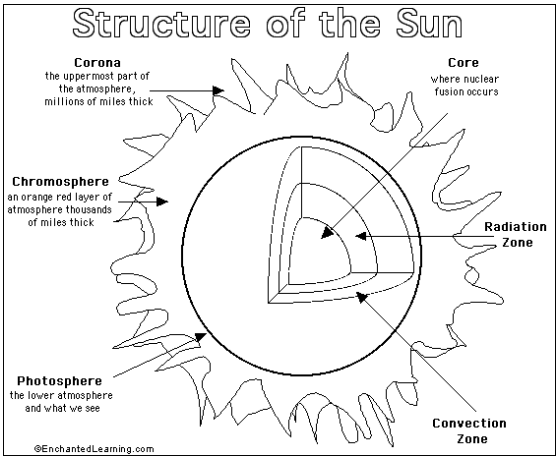
The Sun is classified as a yellow dwarf, because its visible radiation is most intense in the yellow-green portion of the spectrum. Although its color is white, it appears yellow on Earth because of atmospheric scattering of blue light.

In its core, the Sun fuses 620 million metric tons of hydrogen each second. Once considered to be a small star, the Sun is now thought to be brighter than about 85% of the stars in our galaxy.

The average distance from the Sun to the Earth is approximately 149.6 million kilometers, a distance that astronomers call 1 **astronomical unit** (AU). At this distance, it takes light from the Sun around 8 minutes and 19 seconds to reach Earth. It is interesting to note that the Sun and the Earth are closest to each other in January, and farthest from each other in July.

The energy of sunlight supports almost all life on Earth by photosynthesis, and drives Earth's climate and weather.

Structure of the Sun



The structure of the Sun is illustrated in the diagram to the right.

The **core** is the very center of the Sun, and takes up about 25% of its radius. The temperature in the core is around 15.7 million degrees Celsius. The core is the location where 99% of hydrogen fusion takes place. In other words, 99% of the Sun's energy is produced

in the core. This energy must travel through many other layers before it escapes into space as sunlight.

The **radiation zone** is the layer that extends from the core to about 70% of the Sun's radius. The heat energy produced in the core is radiated outward through this layer towards the surface of the Sun. The temperature of this zone decreases as you move farther from the center of the Sun, eventually dropping as low as 2 million degrees Celsius.

The **convection zone** extends from the end of the radiation zone to the surface of the Sun. In this zone, the hot solar material moves outward toward the surface of the Sun. Once the material cools off at the surface, it moves downward to the base of the convection zone. Once it has heated up again, this cycle repeats. This movement of hot and cool solar material is known as convection. At the visible surface of the Sun, the temperature has dropped to around 5500 degrees Celsius.

The **photosphere** is the visible surface of the Sun. Below this layer, the Sun does not allow visible light to escape. Above this layer, visible light is free to move into space and travel to Earth. The photosphere is tens to hundreds of kilometers thick, and is slightly less see-through than air on Earth. Because the upper part of the photosphere is cooler than the lower part, an image of the Sun appears brighter in the center than at the edges. The average temperature of the photosphere is around 5700 degrees Celsius.

The parts of the Sun above the photosphere are referred to collectively as the **solar atmosphere**.

The **chromosphere** is an orange-red layer roughly 2000 kilometers deep and is normally invisible from Earth. It can, however, be seen as a colored flash at the beginning and end of a total eclipse. The temperature in the chromosphere increases gradually with altitude, reaching around 20 000 degrees Celsius near the top.

The **corona** is the extended outer atmosphere of the Sun, which is much larger than the volume of the Sun itself. It extends into space filling all of the Solar System. The portion of the corona that is near the Sun can reach temperatures as high as 20 million degrees Celsius. The average temperature, however, is closer to 2 million degrees Celsius.

Life Cycle

The Sun was formed about 4.57 billion years ago. It is about halfway through its lifespan. In another 5 billion years, it will enter a **red giant** phase. At this time, the hydrogen fuel in the core will be used up, causing the core to shrink and get hotter. This increased heat will cause the outer layers of the Sun to expand.

Once the temperature of the core reaches 100 million degrees Celsius, helium fusion will begin. During this phase, the Sun will throw off its outer layers leaving only the hot core behind. This core will slowly cool and fade over billions of years, becoming a **white dwarf**.

The Fate of Earth

During the red giant phase of its life cycle, it is likely that the Sun's outer layers will expand enough to swallow the Earth. Even if Earth escaped incineration in the Sun, all of its water would be boiled away and most of its atmosphere would escape into space.

It should be noted that life on Earth is likely to end long before the Sun enters its red giant phase. The surface temperature of the Sun is slowly increasing as it ages. In another billion years, the Sun's temperature will have increased enough that Earth will be too hot to support liquid water, thus ending all life on Earth.