Chapter 20 – Stars, Galaxies, and the Universe

Section 2 – The Sun: Our Very Own Star

Objectives

- **Describe** the basic structure and composition of the sun.
- **Explain** how the sun generates energy.
- **Describe** the surface activity of the sun, and identify how this activity affects Earth.

The Structure of the Sun

- The sun is basically a large ball of gas made mostly of hydrogen and helium held together by _____.
- Although the sun may appear to have a solid surface, it does not. The visible surface of the sun starts at the point where the gas becomes so _____ that you cannot see through it.

Energy Production in the Sun

- The sun has been shining on the Earth for about _____ billion years. Many scientists once thought that the sun _____ fuel to generate its energy.
- The amount of energy that is released by burning would _____ to power the sun. If the sun were simply burning, it would last for only 10,000 years.
- **Burning of Shrinking?** Scientists later began thinking that gravity was causing the sun to slowly shrink and that gravity would release enough energy to heat the sun.
- While the release of gravitational energy is more powerful than burning, it is not enough to power the sun. If all of the sun's gravitational energy were released, the sun would last only _____ million years.
- **Nuclear Fusion** Albert Einstein showed that _____ and energy are interchangeable. Matter can change into energy according to his famous formula:

$$E = mc^2$$

(E is _____, m is _____, and c is the speed of _____.)

- Because c is such a large number, tiny amounts of matter can produce a huge amount of energy.
- The process by which two or more _____ join together, or fuse, to form another nucleus is called **nuclear fusion.**
- In this way, four hydrogen nuclei can fuse to form a single nucleus of helium. During the process, energy is produced.
- Scientists now know that the sun gets its energy from nuclear fusion.
- **Fusion in the Sun** During fusion, under normal conditions, the nuclei of hydrogen atoms never get close enough to combine.
- The reason is that the nuclei are _____ charged, and like charges repel each other, just as similar poles on a pair of magnets do.

- In the center of the sun, however, temperature and _____ are very high.

- As a result, hydrogen nuclei have enough energy to overcome the repulsive force, and hydrogen fuses into _____.

- Energy produced in the center, or _____, of the sun takes millions of years to reach the sun's surface.

- Energy passes from the core through a very dense region called the _____ *zone*.

- Eventually, energy reaches the _____ *zone*. Gases circulate in the convective zone, which is about 200,000 km thick.
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- Hot gases in the convective zone carry the energy up to the _____, the visible surface of the sun.

- From the photosphere, energy leaves the sun as light, which takes only _____ minutes to reach Earth.

Solar Activity

- The churning of hot gases in the sun, combined with the sun's rotation, creates _____ fields that reach far out into space.

- The constant flow of magnetic fields from the sun is called the *solar* _____.

- Sometimes, solar wind interferes with the Earth's magnetic field. This type of *solar storm* can disrupt TV signals and damage satellites.

- **Sunspots** The sun's magnetic fields tend to _____ activity in the convective zone. When activity slows down, areas of the photosphere become cooler than the surrounding area.

- These cooler areas show up as sunspots. **Sunspots** are cooler, _____ spots of the photosphere of the sun. Some sunspots can be as large as 50,000 miles in diameter.
- **Climate Confusion** Sunspot activity can affect the Earth. Some scientists have linked the period of low sunspot activity, 1645-1715, with a period of very low temperatures that Europe experienced during that time, known as the "_____."

- **Solar Flares** The magnetic fields responsible for sunspots also cause solar flares. *Solar flares* are regions of extremely high temperatures and _____ that develop on the sun's surface.

- When a solar flare erupts, it sends huge streams of _____ charged particles into the solar system. Solar flares can interrupt radio communications on the Earth and in orbit.