Space Systems: The sun

Although the sun is a rather ordinary star, it is very important to the inhabitants of Earth. The sun is the source of virtually all Earth’s energy. It provides the heat and light that make life on Earth possible. Yet Earth receives only about half a billionth of the energy that leaves the sun. The sun is a huge ball of hot gases. Like other stars, it produces enormous amounts of energy by converting hydrogen to helium deep within its interior.

Because this energy is so intense, it is very dangerous to stare at the sun. Radiation from the sun’s rays can damage one’s eyes, so one should never look directly at the sun with unaided eyes or with a telescope (unless it has a special solar filter). Dark glasses provide no protection. One safe way to observe the sun is to project its image through a pinhole or telescope onto a white screen or white cardboard.
Position In The Solar System

The sun lies at the center of the solar system. It contains more than 99 percent of the system’s mass. The immense pull of its gravity holds the planets, dwarf planets, asteroids, comets and other bodies in orbit around it. The average distance between the sun and Earth is roughly 93 million miles. Light travels through space at about 186,282 miles per second. So a ray of sunlight takes only about 8 minutes to reach Earth. Light from those other suns, the stars, takes much longer to reach the Earth.

The sun is in the outer part of the Milky Way galaxy. Light from the center of the galaxy takes many thousands of years to reach Earth. Because the sun is so close to Earth, it seems much larger and brighter than other stars. It is the only star whose surface details can be observed from Earth.

Basic Properties

Stars vary greatly in size and color. They range from giant stars, which are much larger than the sun, to dwarf stars, which can be much smaller than the sun. In color they range from whitish blue stars with very high surface temperatures (more than 53,500°F) to relatively cool red stars (less than 5,840°F). The sun is a yellow dwarf star, a kind that is common in the Milky Way galaxy. It has a surface temperature of about 10,000°F. Its diameter is about 864,950 miles, which is about 109 times the diameter of Earth. Its volume is about 1,300,000 times Earth’s volume. Its mass, or quantity of matter, is some 333,000 times as great as Earth’s mass.
More than 90 percent of the sun’s atoms are hydrogen. Most of the rest are helium, with much smaller amounts of heavier elements such as carbon, nitrogen, oxygen, magnesium, silicon and iron. By mass, the sun is about 71 percent hydrogen and 28 percent helium.

The sun has no fixed surface. It is much too hot for matter to exist there as a solid or liquid. Rather, the sun’s matter consists of gas and plasma, a state in which gases are heated so much that the electrons are stripped away from their atomic nuclei. The heated gas is said to be ionized because it consists of a group of ions, or electrically charged particles. The free electrons carry a negative charge. The atomic nuclei carry a positive charge.

Like the planets, the sun rotates. Because the sun is not solid, different parts of it rotate at different rates. The parts of the surface near the equator spin the fastest, completing one rotation about every 25 Earth days. The parts of the surface near the poles take 36 days to complete a rotation.

**Structure And Energy Production**
The sun can be divided into several different layers. Energy is produced in the dense, hot central region, which is called the core, and travels outward through the rest of the interior. The surface is called the photosphere. It emits most of the light and heat that reach Earth. The surface is the innermost part of the solar atmosphere. The atmosphere also has a thin middle layer, called the chromosphere, and a large outer layer, the corona. The corona gives rise to a flow of charged particles called the solar wind that stretches beyond Earth and the other planets.

The sun looks like a burning sphere. It is too hot, however, for an Earth-type chemical reaction such as burning to occur there. Besides, if burning produced its energy, it would have run out of fuel very long ago.

Various theories have been advanced to explain the sun’s tremendous energy output. All the bits of matter in the sun exert gravitational attraction on each other. One 19th-century theory said that this gravitational attraction causes the sun to shrink and its matter to become more tightly packed. This process, called gravitational contraction, could release a great deal of energy. However, gravitational contraction would produce energy for only 50 million years at most, while the sun’s age must be at least as great as Earth’s age of 4.6 billion years.

In the 20th century atomic theory finally provided an explanation. Scientists now agree that thermonuclear reactions are the source of solar energy. Albert Einstein’s theoretical calculations showed that a small amount of mass could be converted to a great amount of energy. Reactions in the sun’s core convert almost 5 million tons of matter into enormous amounts of energy every second. The vast amount of matter in the sun can provide the “fuel” for billions of years of atomic reactions. Astronomers believe that the sun is nearly halfway through its “lifetime” of 10 billion years.

The sun’s thermonuclear reactions also keep the star from squeezing inward. While the sun’s gravity exerts a huge inward pull, the energy it produces exerts a huge outward pressure. At this stage in the sun’s life, these forces balance each other out, so that the sun neither collapses under its own weight nor expands.
Quiz

1. Read the summary below. Choose the answer that BEST goes into the blank to complete the summary.

The sun is a yellow dwarf star that lies in the center of our solar system, composed mainly of hydrogen and helium.

The energy produced in the sun's core provides almost all the heat and light necessary for life on Earth.

(A) The parts of the sun near the equator complete one rotation every 36 days.
(B) The sun is divided into several layers, with a dense core and a surface consisting of gas and plasma.
(C) The yellow dwarf star is one of several kinds of stars, but is the most common star in the Milky Way galaxy.
(D) Gravitational pull from the sun causes the matter in the sun to become more tightly packed, producing energy.

2. Complete the sentence below.

The author MAINLY explains the importance of the sun by:

(A) providing general information about the sun's composition
(B) explaining why the sun's energy is important and how it is produced
(C) describing the characteristics of yellow dwarf stars
(D) highlighting the dangers of the sun's radiation

3. Which selection from the article BEST supports the idea that the sun is necessary to the Earth?

(A) Although the sun is a rather ordinary star, it is very important to the inhabitants of Earth. The sun is the source of virtually all Earth's energy. It provides the heat and light that make life on Earth possible.
(B) The average distance between the sun and Earth is roughly 93 million miles. Light travels through space at about 186,282 miles per second.
(C) The corona gives rise to a flow of charged particles called the solar wind that stretches beyond Earth and the other planets. The sun looks like a burning sphere.
(D) The vast amount of matter in the sun can provide the “fuel” for billions of years of atomic reactions. Astronomers believe that the sun is nearly halfway through its “lifetime” of 10 billion years.
Which paragraph in "Structure And Energy Production" BEST supports the idea that the sun is able to produce large amounts of energy?