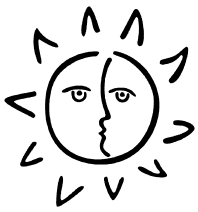
Solar Geometry



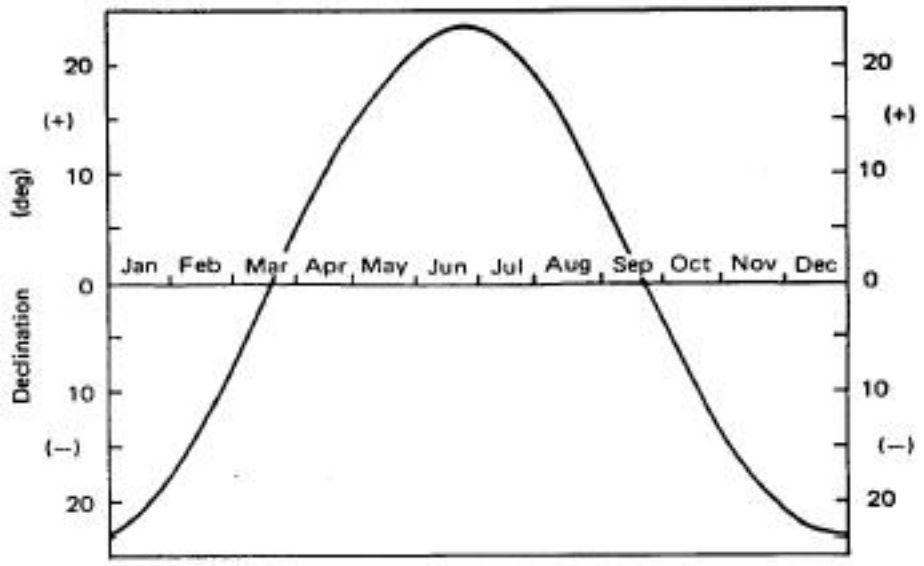
Our Sun — The Primary Source of Energy

Our sun is the source of energy for almost all life on Earth (except for the creatures that live near geothermal vents). The energy in all living creatures and fossil fuels is derived from the sun. Plants capture solar energy through photosynthesis. All other creatures get energy from eating plants or other creatures that have eaten plants. Even the movement of wind and water are caused by the sun, so wind power and hydropower are really other methods of using solar energy. Only nuclear energy, energy from the heat of the Earth, and energy from the tides in the ocean are not solar in origin.

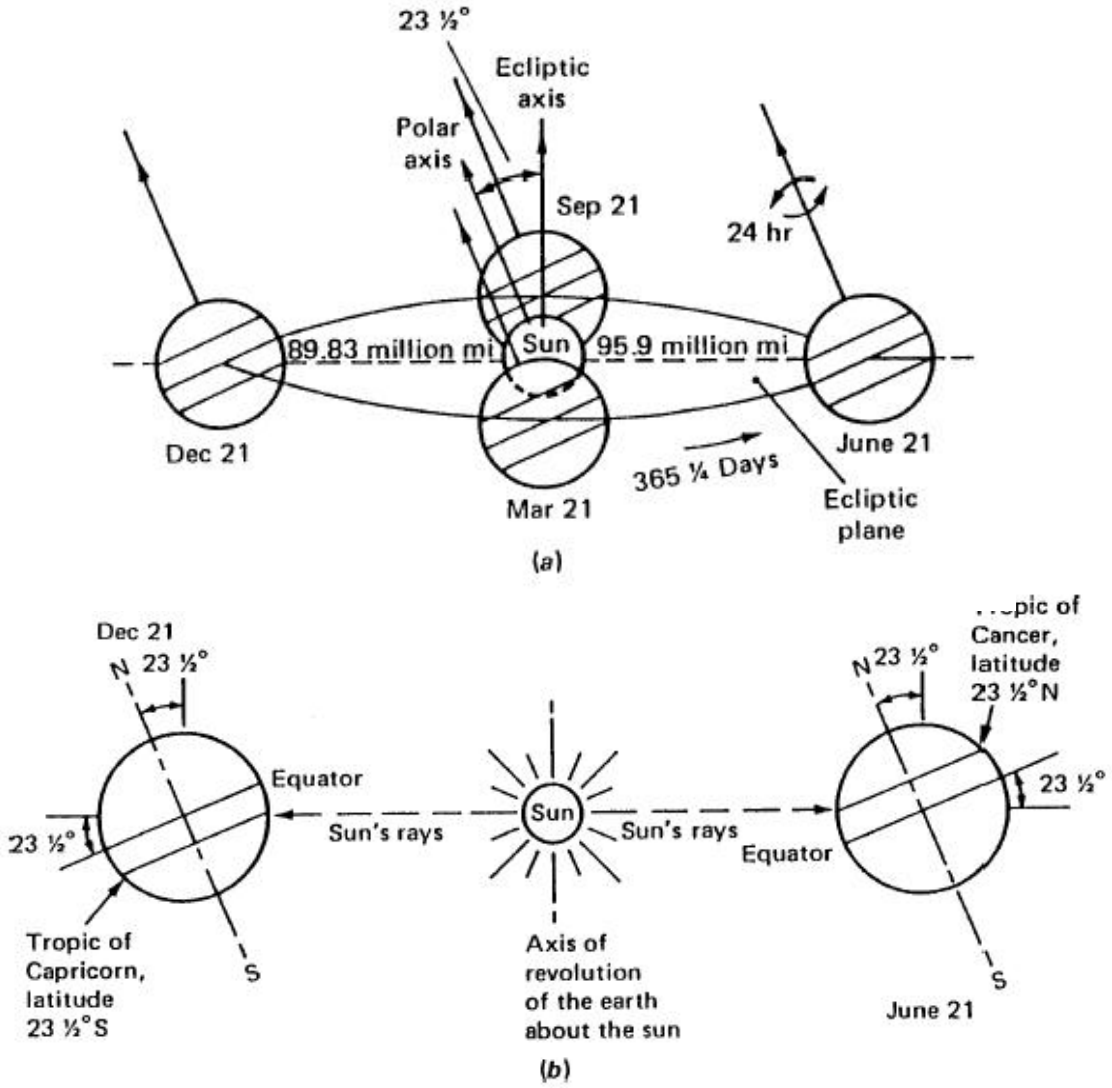
The sun is mostly made up of hydrogen (about 73% by mass) and helium (about 25% by mass). The remaining 2% consists of traces of other elements. All the heavier elements were produced by thermonuclear fusion reactions in the sun. In every thermonuclear reaction, some of the original mass is converted to energy ($E = mc^2$). Electromagnetic radiation, including visible light and heat (infrared), are emitted from the sun's surface. The sun is about 93 million miles (149 million km) from Earth, so energy from the sun — electromagnetic radiation — takes eight minutes and 20 seconds to reach Earth. The Earth intercepts less than one billionth of the sun's total radiated energy, about 1,343 Watts per square meter.

The Sun's Position in the Sky

While the Earth revolves around the sun, for solar design it is more convenient to talk about the position of the sun in the Earth's sky. In winter, in either the northern or southern hemisphere, the sun is low in the sky and days are short. In summer, the sun is high in the sky and days are long. The graph below shows the latitude at which the sun is directly overhead at solar noon throughout the year. Engineers who design solar systems refer to this type of graph information because they must be aware of the precise position of the sun in the sky throughout the day and throughout the year at a given latitude. Note that solar noon is not always the same as clock noon, since solar noon occurs when the sun is directly south. The graph shows that the sun is directly overhead at solar noon at 23.5 degrees south of the equator on the winter solstice, or about December 21. Likewise, the sun is directly overhead at the equator at solar noon at both the autumnal and vernal equinox.



The following diagrams show the relative positions of the Earth and sun throughout the year. Use models to demonstrate the position of the Earth in its orbit and how the Earth's orientation affects the amount of solar radiation received at different latitudes.



The orientation of the Earth on the winter solstice and summer solstice.

Source of images: Professor Jan Kreider, Advanced Solar Design, College of Engineering and Applied Science, Department of Civil, Environmental and Architectural Engineering, University of Colorado at Boulder, USA.