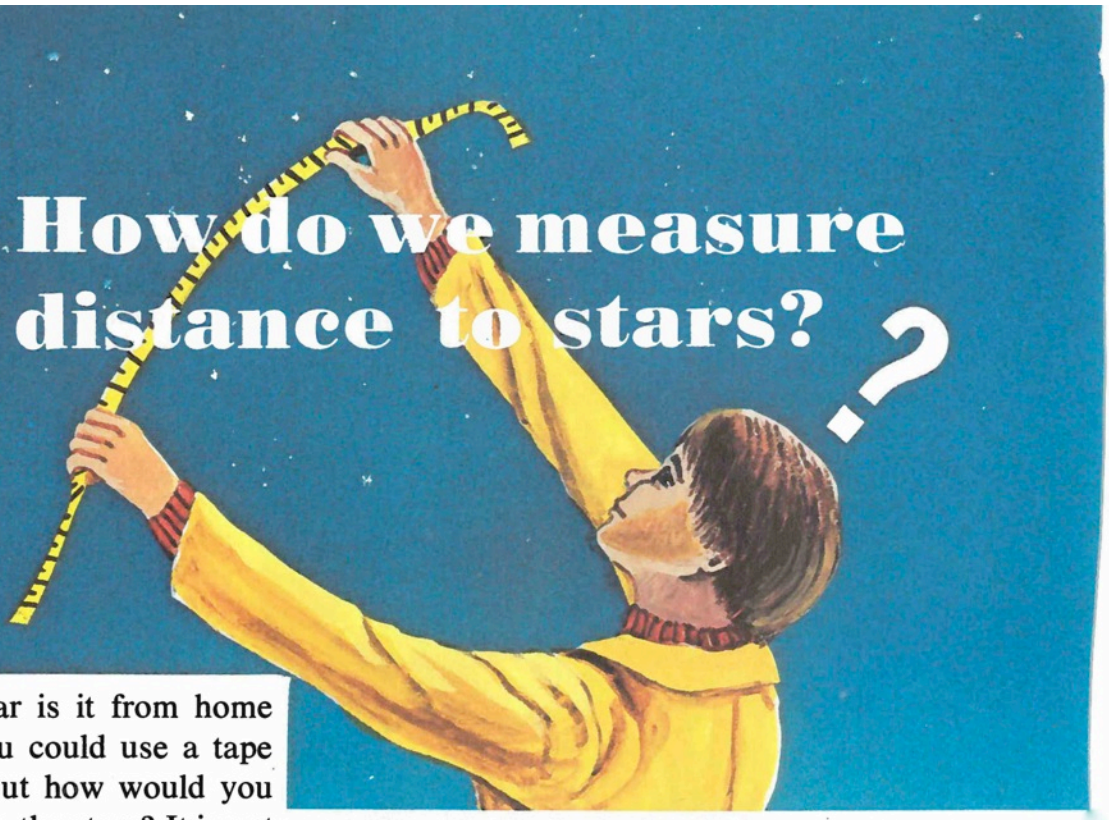
CONTENTS

How do we measure distance to stars?

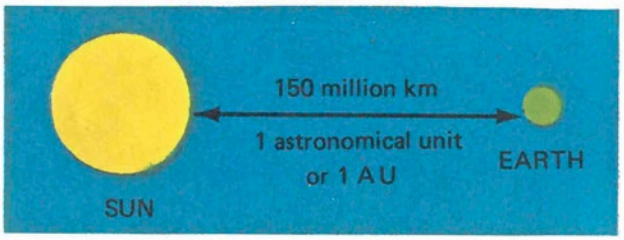


A long throw. How far is it from home plate to first base? You could use a tape measure to find out. But how would you measure the distances to the stars? It is not easy. Scientists have to put many facts together to figure out how far away the stars are. They have found that the stars are billions upon billions of kilometers away. The distances are so large that astronomers use special large units to measure distance in space.

▶ **Why do astronomers use special units to measure distance in space?**

How far is the sun from the earth? The sun is about 150 million (150,000,000) kilometers away from earth. Astronomers have a name for this distance. They call the distance between the sun and the earth one astronomical (astruh-NOM-ih-cul) unit, or 1 AU. One astronomical unit equals about 150 million kilometers. The sun is one astronomical unit away from the earth. Astronomical units are easier to work with than millions of kilometers.

▶ **What is one astronomical unit?**



How fast does light travel? Light travels about 300,000 kilometers in one second. Something moving as fast as light could travel around the earth more than seven times in one second. The distance light can travel in one year is called a light-year. A light-year is nearly 10 trillion (10,000,000,000,000) kilometers. Distances to the stars are so large that astronomers use light-years to measure them.

▶ **What is a light-year?**

HOW FAR DOES LIGHT TRAVEL WITH TIME?
(all figures in kilometers)

1 second	300,000
1 minute	18,000,000
1 hour	1,080,000,000
1 day	25,920,000,000
1 year	9,460,800,000,000

How close are some stars? The star closest to the earth is the sun. Proxima Centauri (PROX-ih-muh sen-TOR-ee) is the next closest star. It is 4⅓ light-years away from earth. The North Star, Polaris

(poh-LAR-is), is about 300 light-years away. It takes about 300 years for light from the North Star to reach us. It takes only about 8⅓ minutes for light from the sun to reach us.

▶ **How long does it take for light from the North Star to reach us?**

WHAT YOU LEARNED

1. Stars are billions upon billions of kilometers from the earth.
2. One astronomical unit (1 AU) is about 150 million kilometers.
3. A light-year is the distance light can travel in one year.
4. Distances to the stars are measured in light-years.

SCIENCE WORDS

astronomical (astruh-NOM-ih-cul) **unit**
a unit of distance that astronomers use; it is about 150 million kilometers

light-year
the distance light can travel in one year; one light-year equals about 10 trillion kilometers

ANSWER THESE

1. How many astronomical units away is the sun from the earth?
   a. 1
   b. 150
   c. 150 million
2. A light-year is a measurement of
   a. brightness
   b. distance
   c. time
3. Astronomers use light-years because
   a. distances to the stars are so large
   b. stars are so bright
   c. they need to measure time in space
4. Something moving around the earth more than 7 times in one second is traveling at the speed of
   a. 55 kilometers per second
   b. sound
   c. light
5. How many years does it take for light to reach the earth from Proxima Centauri?
   a. 1
   b. 4⅓
   c. 300

NOW TRY THESE

1. The sun's nine planets are listed in the chart below. Their distances from the sun are shown in astronomical units. On a separate sheet of paper, arrange the planets in order of their distances from the sun. Put the closest planet first.

Planet	Distance in AU
Earth	1.0
Jupiter	5.2
Mercury	0.4
Uranus	19.2
Saturn	9.5
Venus	0.7
Neptune	30.1
Mars	1.5
Pluto	39.4

2. The sun is about eight light-minutes away from the earth. Pluto is about five light-hours from the earth. Which is closer to us?

FINDING OUT MORE

Hold your thumb up close to your face. Look at it first with one eye, then the other. Your thumb seems to move against the background of the room. Now move your thumb farther away. It still seems to move when you look with one eye at a time, but not as much. Nearby stars seem to move against a background of distant stars. Astronomers call this parallax (PAR-uh-lax). Parallax can be used to find distances to the closer stars.

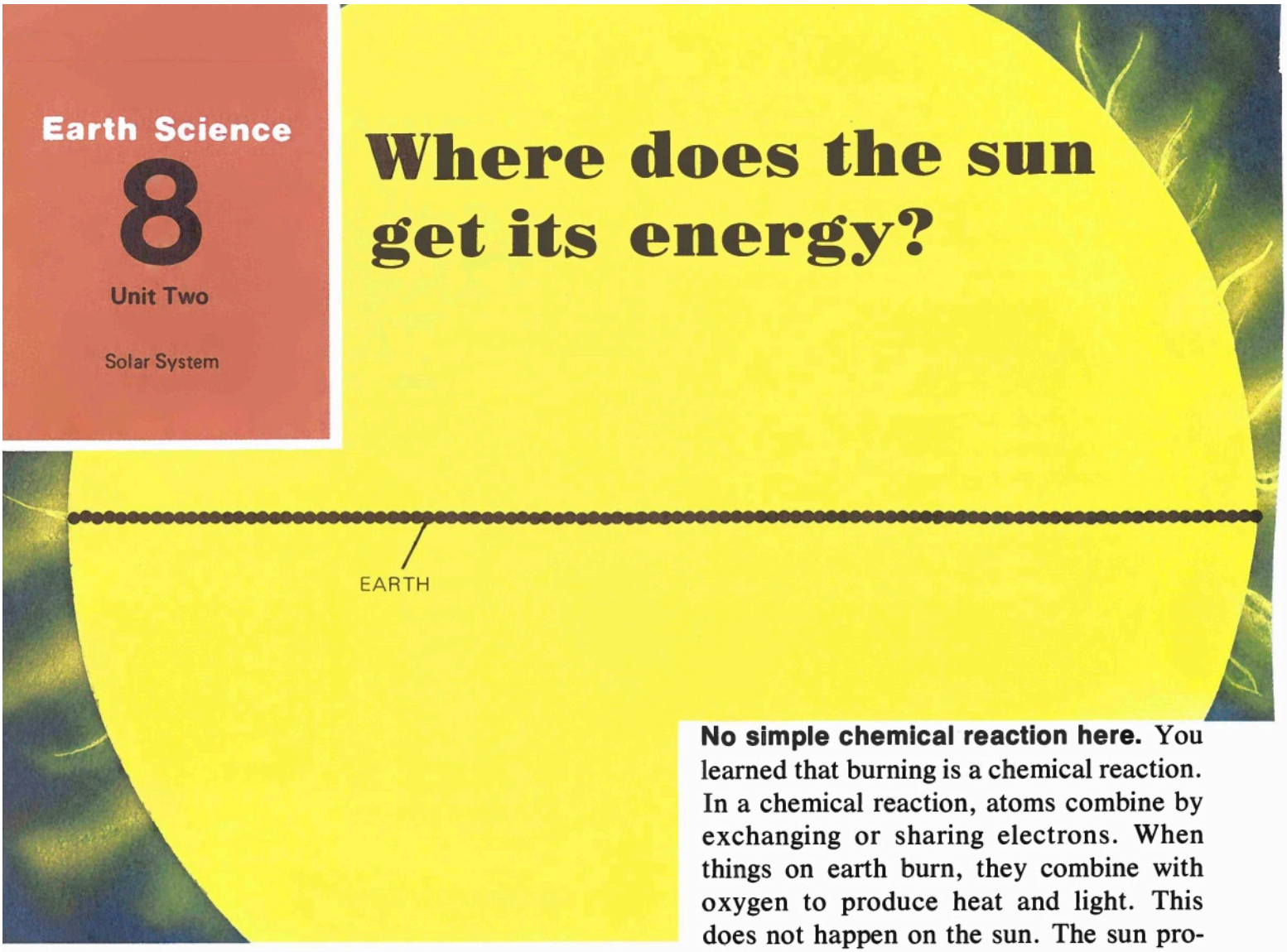
Earth Science

8

Unit Two

Solar System

Where does the sun get its energy?



How big is the sun? The sun is 1,400,000 kilometers in diameter. Compared to other stars, the sun is medium-sized. The earth's diameter is about 13,000 kilometers. More than 100 earths could fit in a line along the sun's diameter. It would take over a million earths to fill the entire space taken up by the sun.

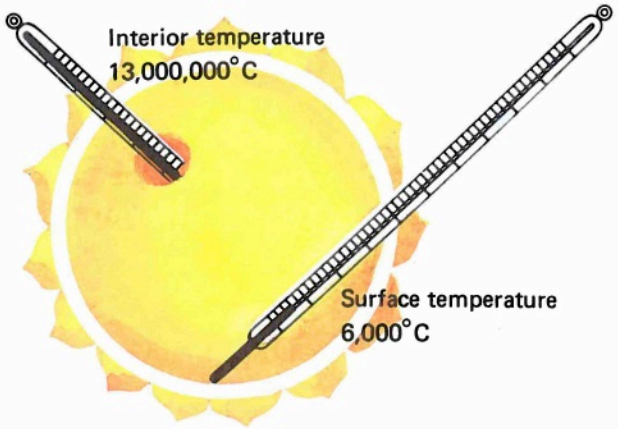
▶ How big is the sun?

Color me yellow. The sun is a yellow star. The color of a star tells us its temperature. Yellow stars have a surface temperature of about 6,000°C. The sun's temperature is about 6,000°C at the surface. The inside of the sun is hotter. Astronomers believe that the inside temperature of the sun is over 13 million degrees Celsius (13,000,000°C).

▶ What is the surface temperature of the sun?

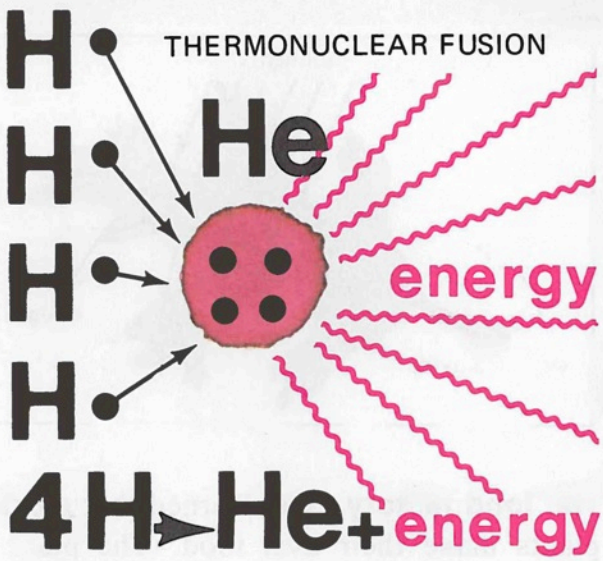
No simple chemical reaction here. You learned that burning is a chemical reaction. In a chemical reaction, atoms combine by exchanging or sharing electrons. When things on earth burn, they combine with oxygen to produce heat and light. This does not happen on the sun. The sun produces its heat and light by a nuclear (NOO-clee-er) reaction. In a nuclear reaction, atomic nuclei are changed. Atomic nuclei combine in the sun's interior. This kind of nuclear reaction is called thermonuclear fusion (ther-moh-NOO-clee-er FYOO-zhun).

▶ What kind of reaction produces heat and light on the sun?



What is the sun made of? The sun is about 80% hydrogen and 18% helium. The other 2% is made up of other elements. Deep inside the sun, hydrogen nuclei fuse (FYOOZ), or combine, to form nuclei of helium. In this reaction, 4 hydrogen nuclei fuse to form 1 helium nucleus. The mass of the helium nucleus is less than that of the 4 hydrogen nuclei all together. The missing mass is matter that has changed into energy.

▶ **What elements make up most of the sun?**



WHAT YOU LEARNED

1. The sun is a medium-sized, yellow star.
2. The sun gets its energy from thermonuclear fusion.
3. Inside the sun, hydrogen nuclei combine to form nuclei of helium.

SCIENCE WORDS

nuclear (NOO-clee-er) **reaction**
a reaction in which the nuclei of atoms change

thermonuclear fusion (ther-moh-NOO-clee-er FYOO-zhun)
a reaction in which the nuclei of atoms combine

fuse (FYOOZ)
combine

ANSWER THESE

1. Compared to other stars, the sun is
   a. small
   b. medium-sized
   c. large
2. The surface temperature of a yellow star is about
   a. 600°C
   b. 6,000°C
   c. 60,000°C
3. In the sun, hydrogen nuclei combine to form
   a. helium
   b. salts
   c. water
4. The weight lost in thermonuclear fusion is changed into
   a. helium
   b. nuclei
   c. energy

NOW TRY THESE

Write the correct words on a separate sheet of paper.

1. Color of the sun.
2. Most of the sun is this element.
3. Heat and light are forms of _____.
4. A reaction that takes place in the sun.

PEOPLE IN SCIENCE

Albert Einstein (1879-1955)

Albert Einstein was born in Germany and lived many years in the United States. He was a scientist who helped explain how the sun produces its energy. Einstein said that small amounts of matter could be changed to large amounts of energy. Einstein's work helped develop the use of atomic energy on earth.