

Science Benchmark: 06 : 04

The sun is one of billions of stars in the Milky Way Galaxy, that is one of billions of galaxies in the universe. Scientists use a variety of tools to investigate the nature of stars, galaxies, and the universe. Historically, cultures have observed objects in the sky and understood and used them in various ways.

Standard 04:

Students will understand the scale of size, distance between objects, movement, and apparent motion (due to Earth's rotation) of objects in the universe and how cultures have understood, related to, and used these objects in the night sky.

STUDENT BACKGROUND INFORMATION

Stargazing

You have probably wondered how far away from Earth are the celestial bodies you see in the **universe**, *the space that consists of all matter, all light and all forms of radiation and energy*. Stars are so far away that our present mode of space travel would take more than a lifetime to reach the nearest star. Planets in our solar system would take a varied number of years to reach, depending on the planet you wanted to visit. Rockets can travel through space at about 75,000 mph or 121,000 kph. If we wanted to visit Venus, our closest planet, we would have to travel about 14.5 days. Pluto, our furthest planet, would take us about 5.5 years to reach.

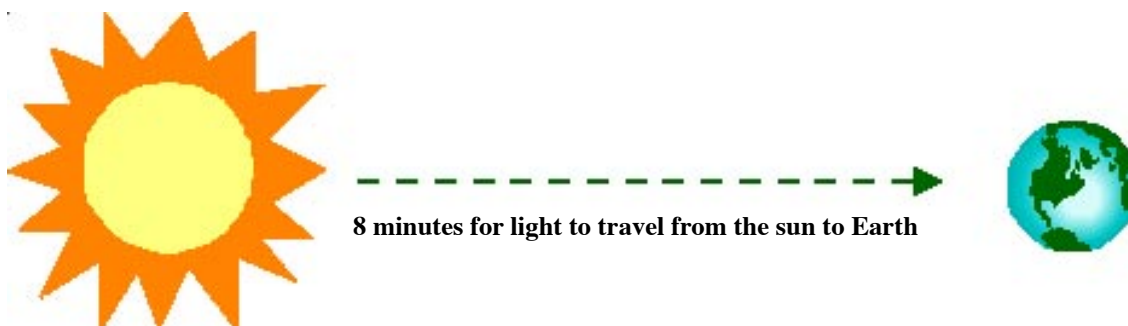


14.5

Since celestial bodies are so far away from each other, our present system of miles and years make it difficult for our minds to comprehend because the numbers are so large. Scientists and astronomers use **the light-year**, *the distance light travels in one year*, to help us understand these distances,

Let's use the sun and Earth to see how this works. Earth is about 93,000,000 miles or 150,000,000 kilometers away from the sun. A beam of light from the sun takes about 8 minutes or 500 seconds to reach us. The **speed of light** *travels at a rate of 186,000 miles per second or 300,000 kilometers per second*. This is much faster than our rockets can travel today.

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To find the distance light travels in a year, we need to determine how many seconds are in a year, then multiply it by the speed of light. To begin, multiply 60 seconds in a minute times 60 minutes in an hour. This equals 3,600 seconds in an hour. Next, multiply 3,600 seconds in an hour times 24 hours in a day. This equals 86,400 seconds in a day. Now, multiply 86,400 seconds in a day times 365 days in a year. This equals 31,536,000 seconds in a year. Finally, by multiplying 31,536,000 seconds in a year with 186,000 miles per second, we find that a **light-year in miles** is about 5,865,696,000,000 (*five trillion, eight hundred sixty-five billion, six hundred ninety-six million*) miles.

By multiplying 31,536,000 seconds in a year with 300,000 kilometers per second, we find a **light-year in kilometers** is about 9,469,800,000,000 (*nine trillion, four hundred sixty-nine billion, eight hundred million*) kilometers.

Light-Year Calculation

60 seconds per minute (x) 60 minutes per hour = 3,600 seconds per hour.
 3600 seconds per hour (x) 24 hours per day = 86,400 seconds per day.
 86,400 seconds per day (x) 365 days a year = 31,536,000 seconds per year.

31,536,000 seconds per year (x) 186,000 miles per second =
 5,865,696,000,000 miles per year = **1 light-year in miles.**

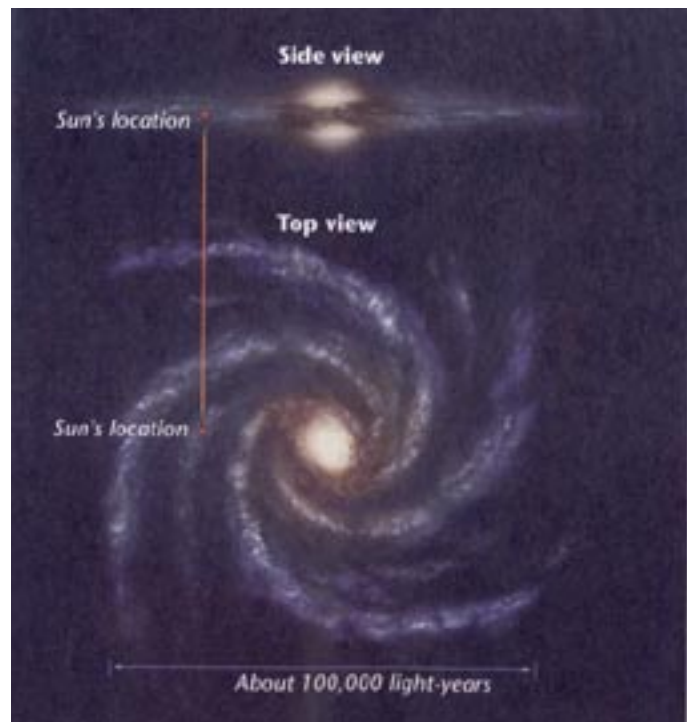
or

31,536,000 seconds per year (x) 300,000 kilometers per second =
 9,469,800,000,000 kilometers per year = **1 light-year in kilometers.**

Scientists measure the approximate distance of one celestial body to another in miles or kilometers and divide by the speed of light to determine the light-years. The closest star, other than our sun, is Alpha Centauri. It is 4.3 light-years away. This means it would take about 4 years and 4 months to reach it from Earth traveling at the speed of light.

<u>Distance from the Sun in Light Years to the Planets</u>	
Planet	Light-Years
Mercury	0.000006 (3 light minutes)
Venus	0.000011 (6 light minutes)
Earth	0.000016 (8 light minutes)
Mars	0.000024 (12.5 light minutes)
Jupiter	0.000082 (43 light minutes)
Saturn	0.000151 (79 light minutes)
Uranus	0.000304 (160 light minutes)
Neptune	0.000476 (250 light minutes)
Pluto	0.000624 (327 light minutes)
Alpha Centauri (nearest star)	4.3

Most stars belong to a **galaxy**, a group of millions of stars held together by gravity. Our solar system lies on the outer edge of a huge galaxy called the **Milky Way Galaxy**, a group of about 200 billion stars formed in a disk-shaped spiral. Our solar system is a tiny dot compared to the Milky Way Galaxy. The Milky Way Galaxy is 100,000 light-years from one end to the other. This is about how many years it would take someone to cross the Milky Way traveling at the speed of light. Our solar system is about 0.00125 of a light-year. You can see how small our solar system is compared to the Milky Way. In the picture, most of the celestial bodies you see in the sky are in the Milky Way Galaxy.



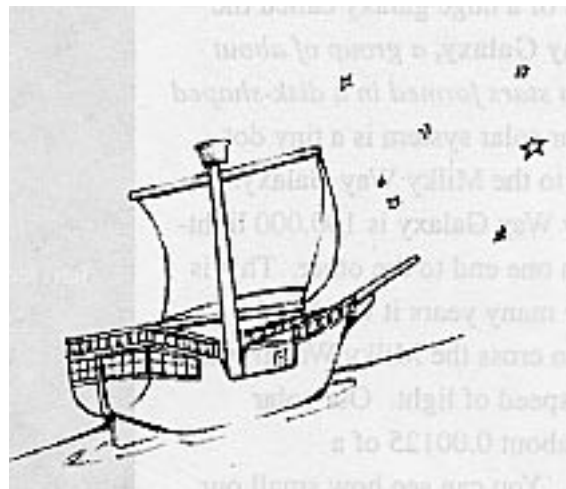
Milky Way Galaxy

The Milky Way Galaxy is only one galaxy. There are billions of galaxies that span the universe. One of the Milky Way's neighboring galaxies is Andromeda. It is 2 million light years away. It is so far away that you can't see its individual stars. You can only see a hazy spot in the night sky produced by the combined light of the stars. The pictures below were taken by the Hubble Space Telescope. There are many galaxies within the view of the Hubble Telescope. Even though our world seems big to us, in the universe we are very, very small.



Other Galaxies

Stars in the sky have fascinated people throughout the ages. Many years ago when people were out tending their flocks, sailing their ships, traveling or just star gazing, they noticed how some stars were always visible at night. Other stars were only visible during certain months of the year. People charted when these stars appeared and how they were positioned. They depended on these stars and star patterns for direction. Skywatchers noticed that during the spring, summer, fall and winter, there would be certain stars and star formations in the sky for each season. They began to make calendars of the months based on star formations.



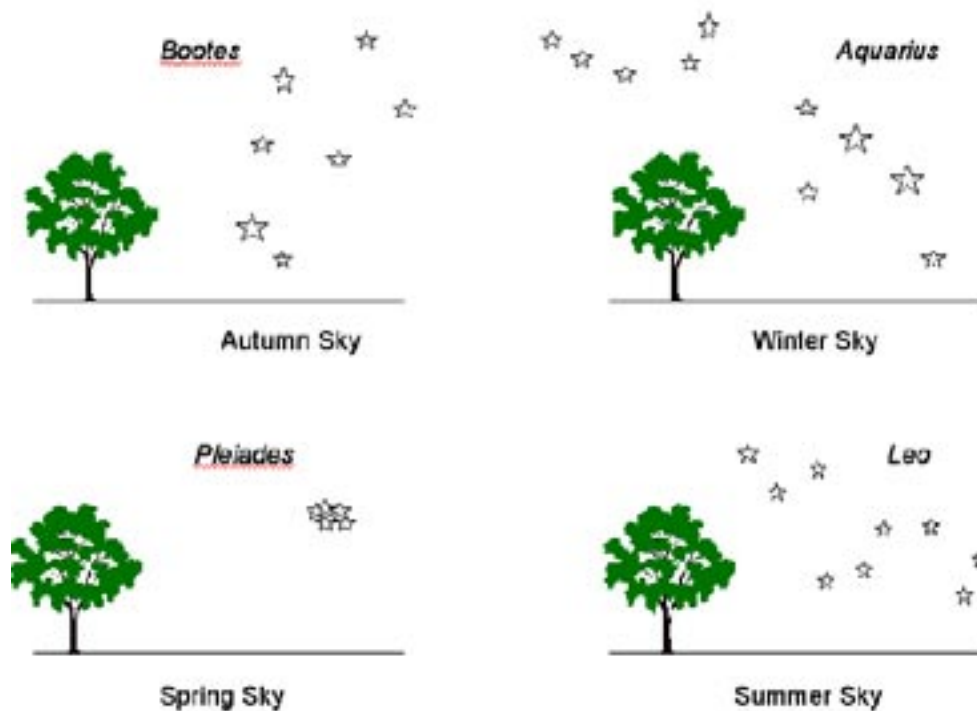
Ancient Arabs, Egyptians, Babylonians and Greeks were well aware of the different stars. Many varied interpretations were written and reported by those different populations. They had observed that some stars could be connected like a dot-to-dot picture. Depending on what they thought the picture looked like, ancient people associated them with objects, beasts or people. They wrote stories about stars related to heroes, heroines and beasts of their time and culture. Since those ancient times, people have continued to make up stories, develop religious practices and grow crops based on groups of stars.



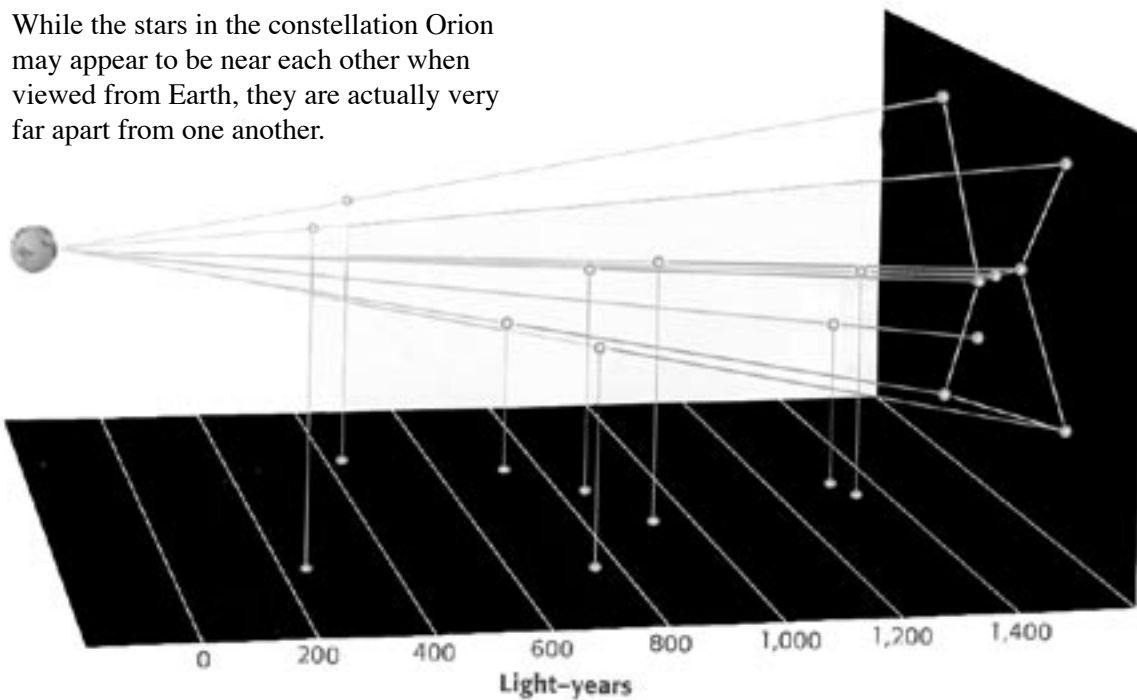
Groups of stars are called **constellations**, *patterns of stars in the sky that have been identified and named*. Some constellations can be seen all year. These are stars that are close to the North Star. The North Star is directly above the North Pole and does not appear to move. The other stars seem to move around it at night because of Earth rotating on its axis.



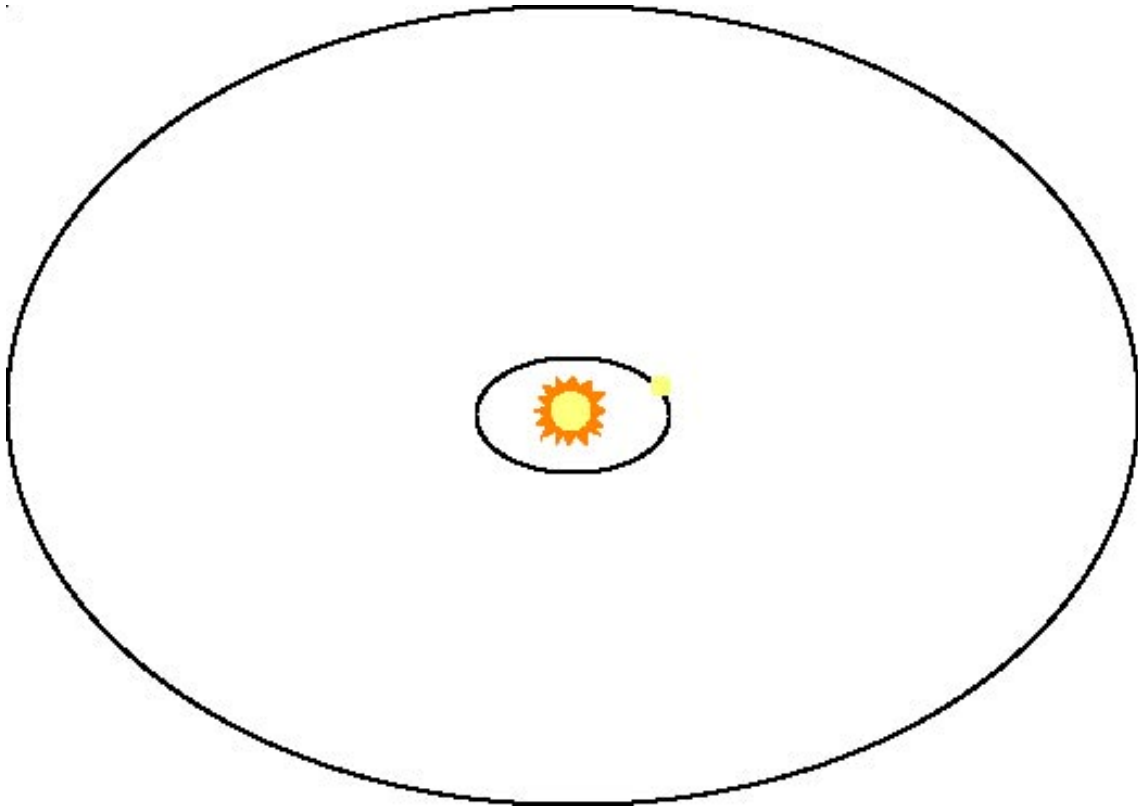
There are other constellations that are seen only during certain seasons. The positions of these constellations have shown stargazers for thousands of years what time of year it is. The pictures below show constellations seen in the western sky at about 10:00 P.M. in North America at the beginning of the different seasons. You can see how people of ancient times were able to tell what season it was just by looking west in the evening.



Stars in a constellation may look like they are close together. Actually, stars that make up constellations may be very far apart. Look at the picture below to see how the stars of Orion appear close together when viewed from Earth, but they are many light-years apart.



As Earth moves around the sun, different constellations seem to appear nightly. In reality, the constellations are always in place, but the sun's light blocks our view of them about six months a year.



People of all ages have discovered that constellations can be used as reference points. Sailors used them to help guide their ships at night. African-Americans fleeing slavery sought what they called the Drinking Gourd, or Big Dipper, found near the North Star, as a guide to freedom. Pioneers migrating west used constellations as a guide while traveling on the Oregon Trail. Constellations have been important, not only in the development of ancient civilizations, but in the development of modern ones as well.

Science Language Students Need to Understand and Use

1. **constellation:** a pattern in the stars that has been identified and named
2. **galaxy:** a group of millions of stars held together by gravity
3. **light-years:** the distance light can travel in one year
4. **Milky Way Galaxy:** a group of about 200 billion stars formed in a disk-shaped spiral that contains our solar system
5. **speed of light:** 186,000 miles per second or 300,000 kilometers per second
6. **universe:** the space that consists of all matter and all light and other forms of radiation and energy