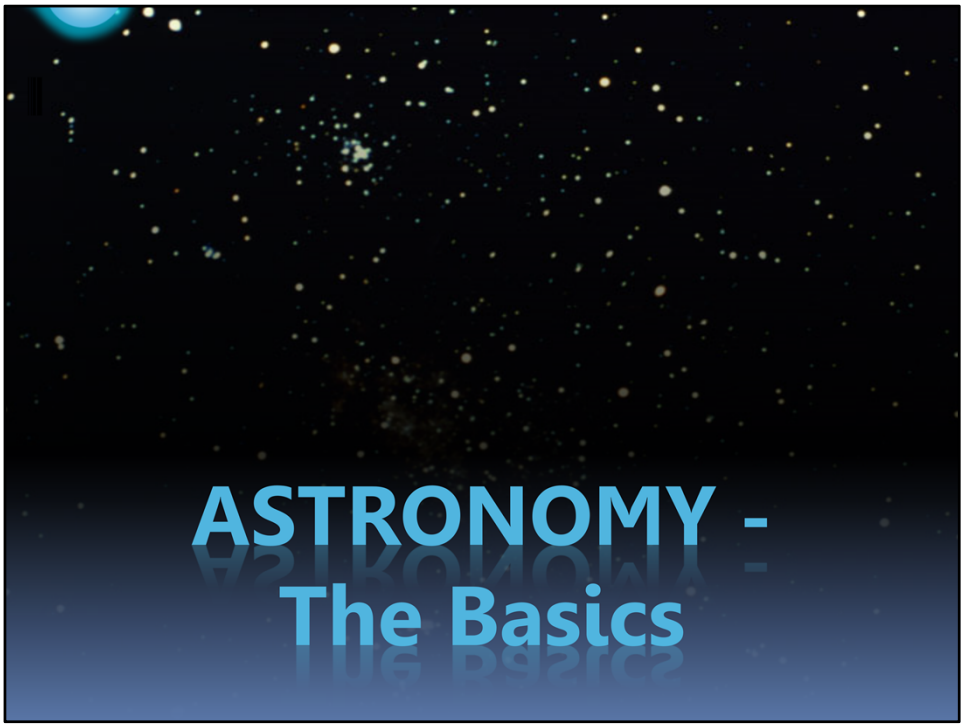
Module 1: What Is Astronomy?

Topic 1: Astronomy – The Basics



Astronomy - The Basics

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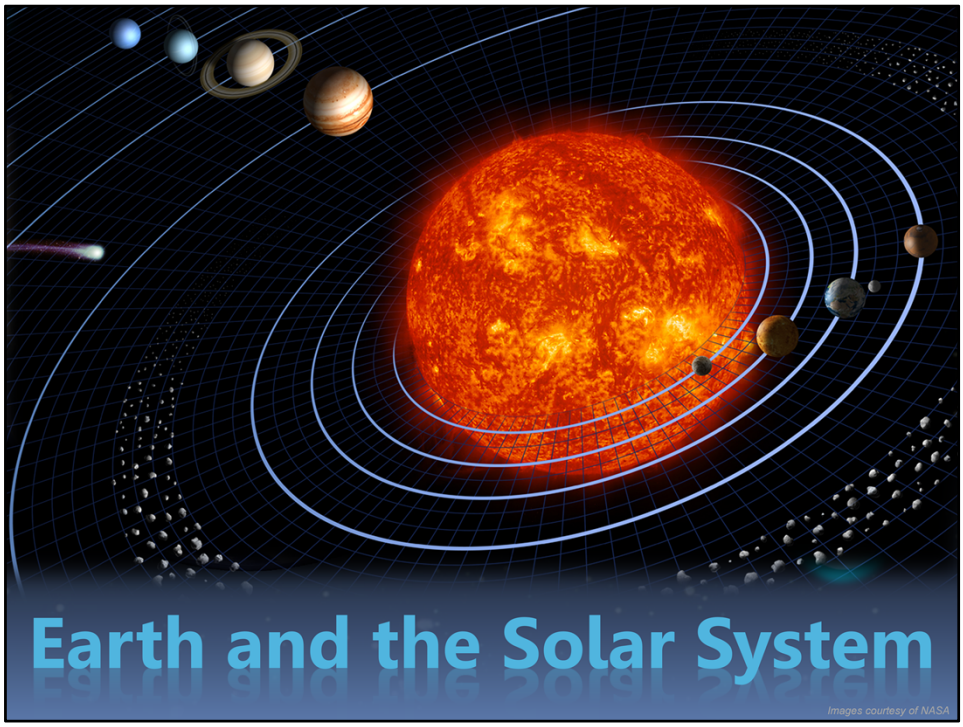

Since the beginning of time, people have tried to understand humans' place in the universe. Through discoveries, people have learned that the Earth is not unlike other objects in the universe. Humans live on what seems to be an ordinary rocky *planet* called Earth, one of eight planets orbiting an average *star* called the Sun. The Sun is part of a small group called the Solar System which includes planets, dwarf planets, asteroids, meteors, and comets.

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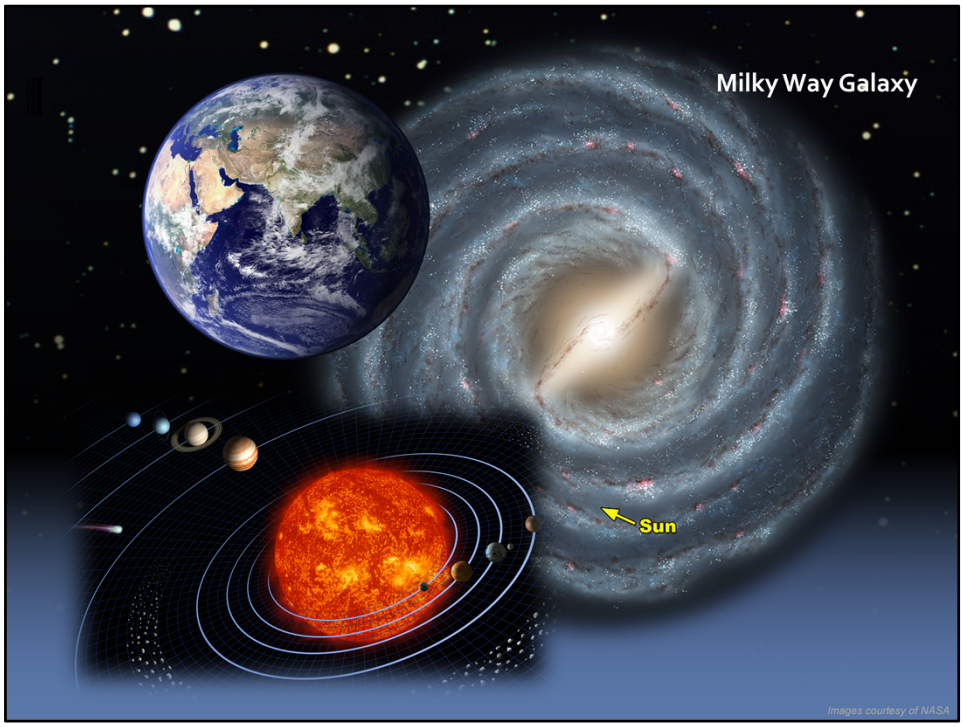

The Sun is placed in one of the spiral arms, near the edge of the *Milky Way Galaxy*, a huge collection of billions of stars. The Milky Way Galaxy is just one *galaxy* among countless billions of others spread throughout the observable universe. Observe the images of the Earth, Sun, the Solar System, and the Milky Way Galaxy. The field of view, or the portion of the sky that you see from your position on Earth, differs for each of the images. Even though the images are the same size, the scale of each photo is very different.

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The *universe* is the totality of all space, time, matter, and energy. *Astronomy* is the study of the universe and everything found within it. It is a unique subject that requires humans to consider matter on scales totally unfamiliar from the everyday experience. When you look at the picture of the galaxy, visually you see an object that is the same size as the picture of the Earth, but the scale is very different. This galaxy, whose catalog name is NGC 4414, is close to 100,000 *light-years* in diameter, and contains more stars than all of the people who have ever inhabited the Earth.

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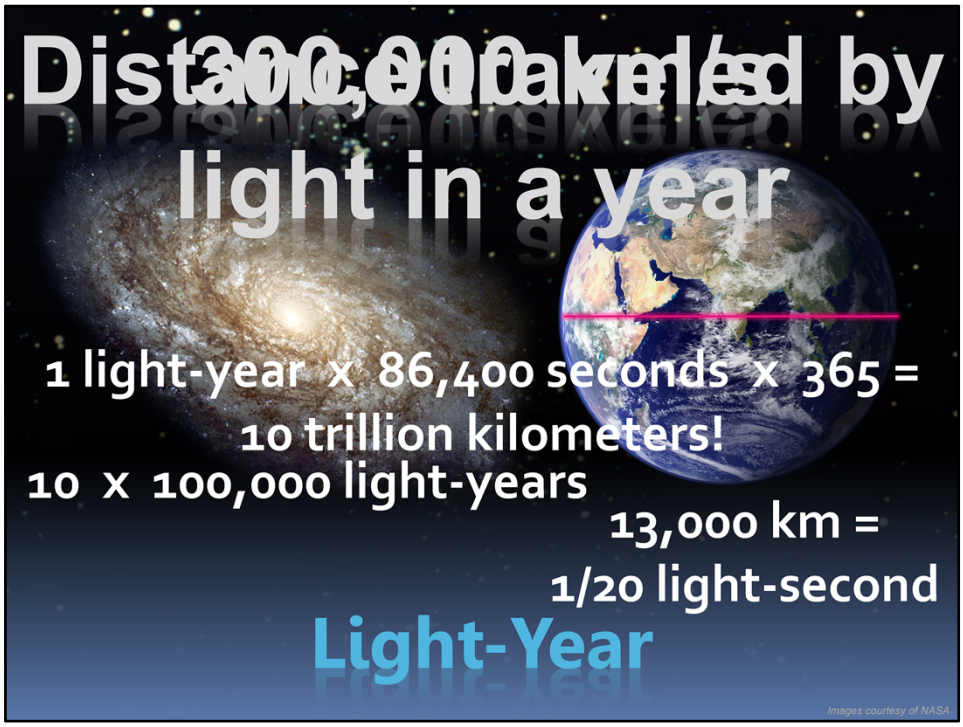
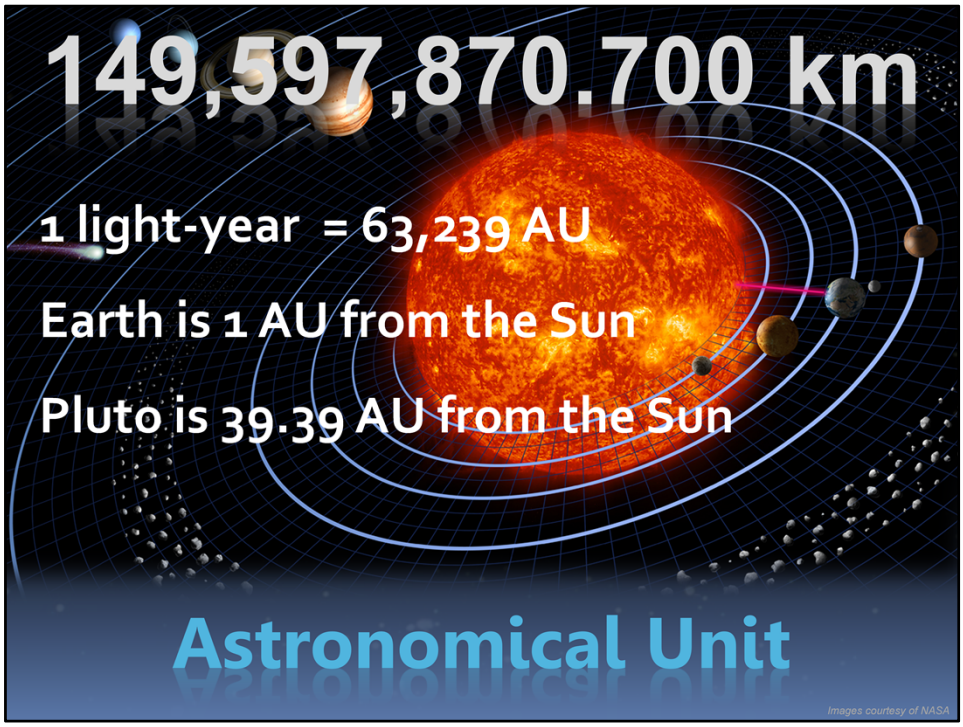


A light-year is the *distance* traveled by light in a year. The speed of light is about 300,000 kilometers per second and is considered finite, meaning it is a fixed speed. If you multiply a light-year times 86,400 seconds in a day times 365 days in a year, you should get about 10 trillion kilometers. This is the distance that light travels in one year. This is roughly six trillion miles. That makes this galaxy about 10 times 100,000 in size in kilometers. To get a perspective of how large this really is, use the Earth's diameter. Roughly 13,000 kilometers in diameter, the Earth is less than 1/20 of a light-second – an even smaller unit of measurement. The light-year is a convenient unit created by astronomers to help them describe tremendous distances.



Astronomers also use the astronomical unit to measure the large distances of space. One astronomical unit is equal to 149,597,870.700 kilometers, which is the mean distance between the Earth and the Sun. That is nearly 93 million miles! One light-year is equal to 63,239 astronomical units.

The astronomical unit makes it easier for scientists to describe distances. Instead of saying that Earth is 149,597,870.700 kilometers from the Sun, a scientist could just say that it is just 1 AU away. Did you know that Pluto is nearly 39.39 AU from the Sun?

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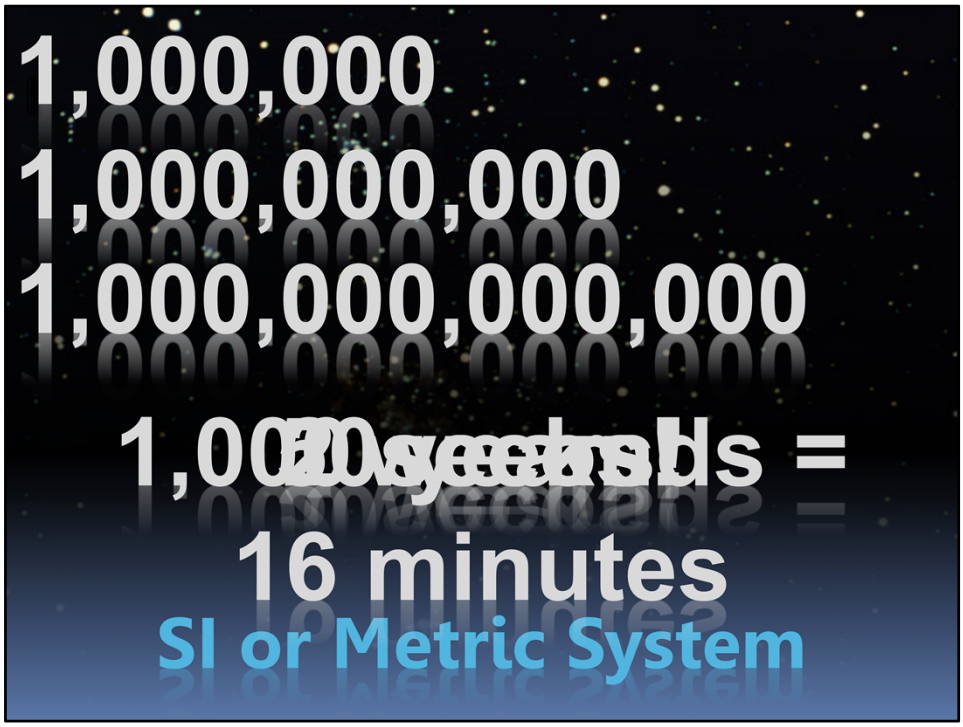

Astronomers use the standard Système International d'Unités, or metric system. Metric units are used in science, sort of like an international language for science. Large numbers such as a million, a billion, and even a trillion are familiar numbers, but the magnitude of these numbers is tremendous. You could count to one thousand in about 1,000 seconds, which is about sixteen minutes. If you wanted to count to one million, you would need more than two weeks of counting at the rate of one number per second, sixteen hours per day, allowing eight hours per day for sleep. To count from one to one billion at the same rate of one number per second and sixteen hours per day would take nearly fifty years, which is more than half of a human lifetime!

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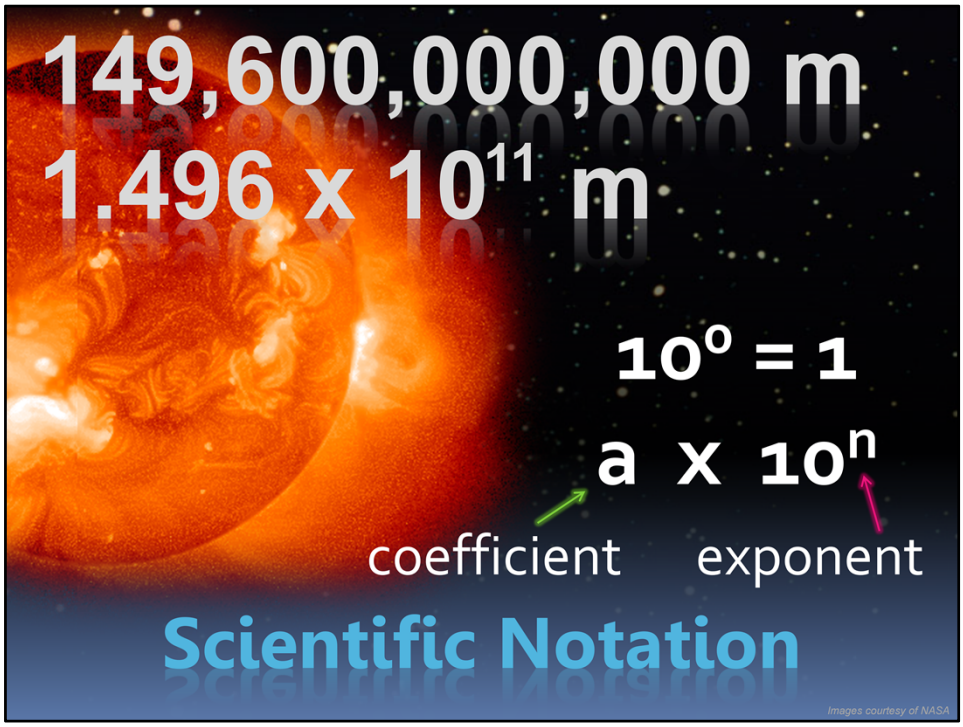
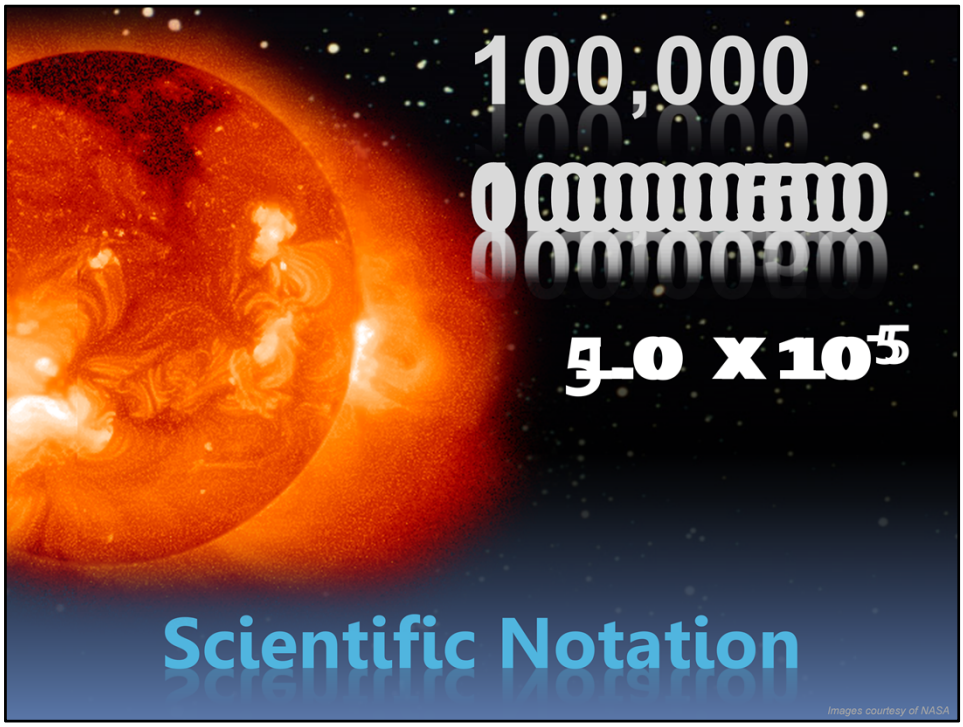
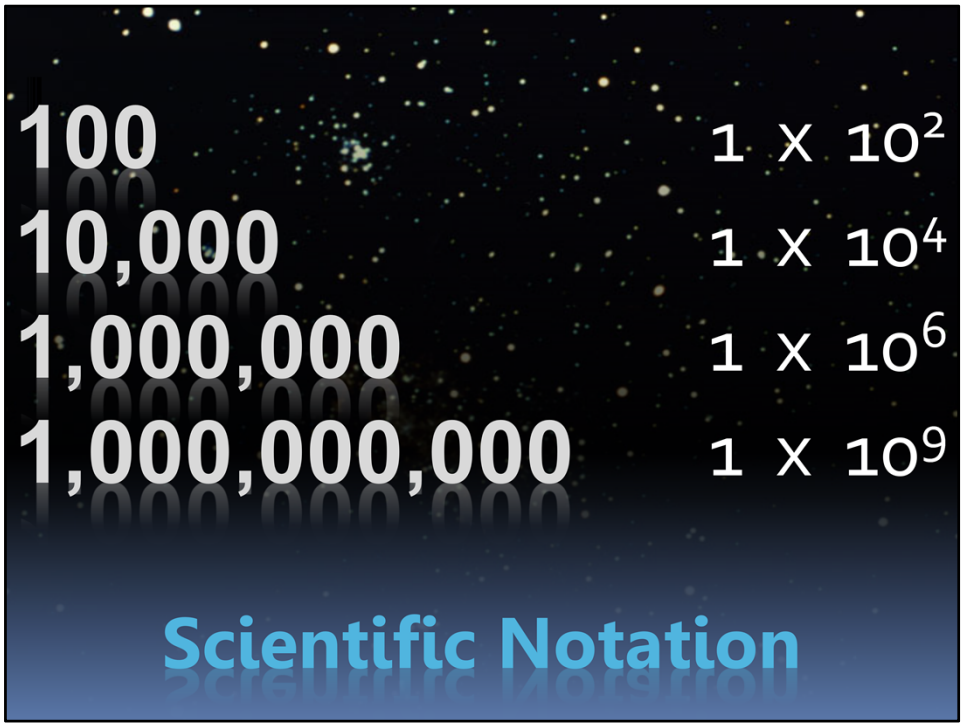


Astronomers deal with numbers that range from macroscopic to microscopic. To make things easier to work with, astronomers use scientific notation to represent distances, wavelengths, et cetera. For example, it would be inconvenient to write out the distance to the Sun as 149,600,000,000 meters, but using scientific notation makes the number more manageable at 1.496×10^{11} meters. It is like numeric shorthand, or an abbreviation. The system is based on multiples of ten and can be used to represent large or small numbers. For simplicity, powers of ten tell you how many times to multiply by ten. The trick is to remember that $10^0 = 1$. In using scientific notation with the following formula, a x 10n, "a" is called the coefficient and the "n" is called the exponent.



When converting numbers in scientific notation, it is sometimes easier to think of how to move the decimal. If the number is large, like 100,000, think of the number as 100,000.0. To transform the number into scientific notation, move the decimal to the left. For each time you move the decimal to the left, you are getting a power of 10. The correct way to write 100,000 is $1.0 \text{ X } 10^{5}$.

If the number is small, like 0.00005, you would do the opposite. Move the decimal to the right each time. For each time you move the decimal to the right, you are getting a negative power of ten. The correct way to write this small number is $5.0 \text{ X } 10^{-5}$.



In the study of astronomy, it is important to be comfortable working with enormous numbers. A good way to begin is by learning to recognize just how much larger ten thousand is as compared to one hundred, and how much larger one million is to ten thousand. Even larger is how much one billion is to one million. Using *scientific notation* allows you to better understand the scope of the universe.