

Scaling the Sun-Earth-Moon System

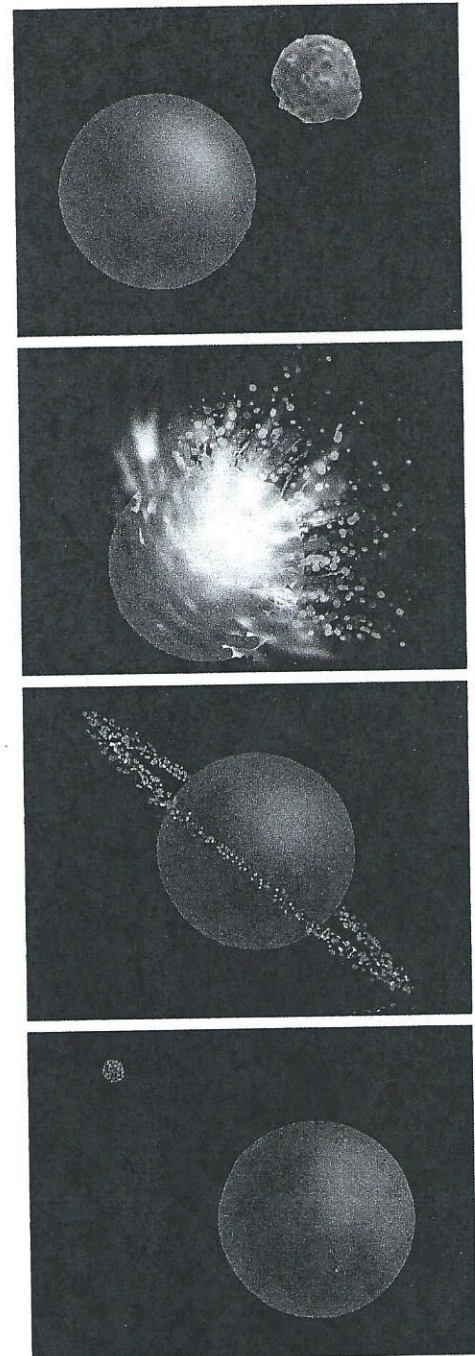
Earth's Moon

The Moon's age is estimated to be between 4.3 billion and 4.5 billion years. There are many theories about how the Moon was formed. Some astronomers think the Moon may have been formed when a Mars-sized asteroid collided with Earth about 100 million to 200 million years after Earth was formed approximately 4.5 billion years ago. The debris from that collision was thrown out into space, and that debris eventually joined together to form the Moon. The newly formed Moon traveled at just the right speed so that it remained within the control of Earth's gravitational field.

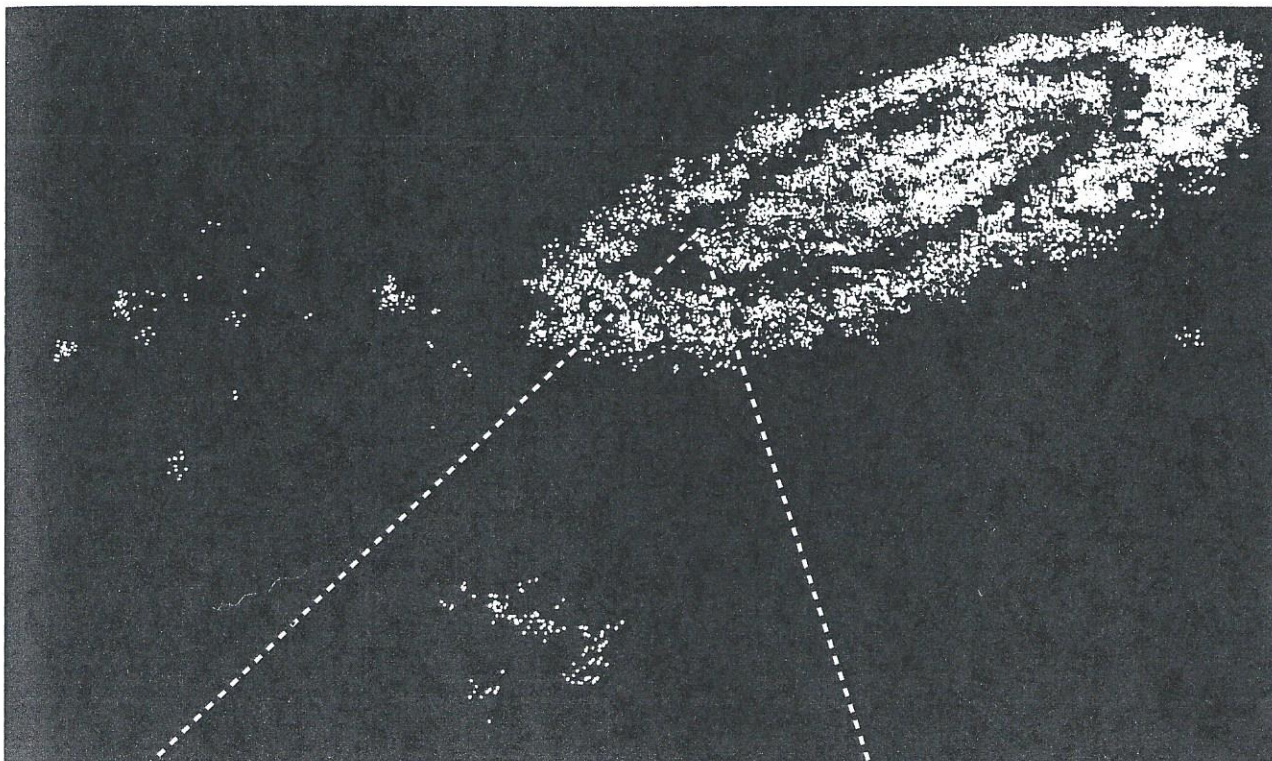
Now the Moon is Earth's natural satellite. This means that the Moon revolves around, or orbits, Earth. If the Moon were to travel too quickly, it could escape Earth's gravity and zoom out into space. If the Moon were to travel too slowly, Earth's gravity could overcome it and the Moon could fall to Earth.

Since the Moon is our nearest neighbor in the sky—about 384,000 kilometers away—it was the first object that humans visited when space travel became possible. Because the Moon has no atmosphere, it has no weather patterns. Because the Moon has no weather—no wind, rain, ice, or snow—it is still in its near-original state. This makes the Moon a perfect object for scientists to study the history and origin of the solar system.

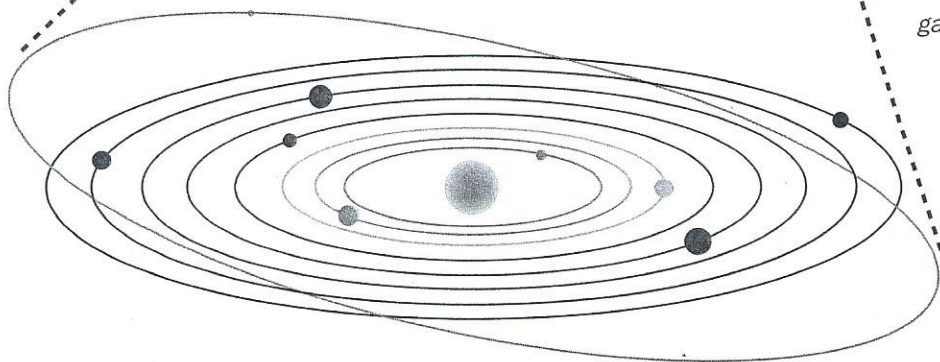
The Moon is about 3500 kilometers in diameter. The Earth is 12,756 kilometers in diameter at the equator. (The Earth is not an exact sphere. It is slightly flattened at the poles, where its diameter is only 12,720 kilometers.)



One theory of how the Moon formed



The Milky Way galaxy is a spiral galaxy. Our solar system is one small point of light in one of the galaxy's spiral arms.



The Sun may seem close to Earth, but it is actually about 150 million kilometers (93 million miles) away. With a diameter of 1,392,000 kilometers, the Sun is 400 times larger than the diameter of the Moon. The Sun is also 400 times farther away from Earth than the Moon is. This means that the Moon and Sun appear to be the same size in the sky.

The Sun is bigger in volume than anything we can imagine. One million Earths would fit inside the Sun, and 109 Earths could fit across the Sun's diameter.

Models of the Sun, Earth, and Moon

Sometimes the best way to understand abstract concepts is to use models. Models are smaller representations of an object that might be too large, too complex, or too far away to study firsthand. Look at the facts that you have read here. Use your models and what you know about math to demonstrate what you know about these facts. □

calendars and timekeeping methods that eventually led to the clocks, calendars, and timekeeping devices we use today.

Day and Night Day and night are caused by Earth's rotation on its axis. It takes Earth

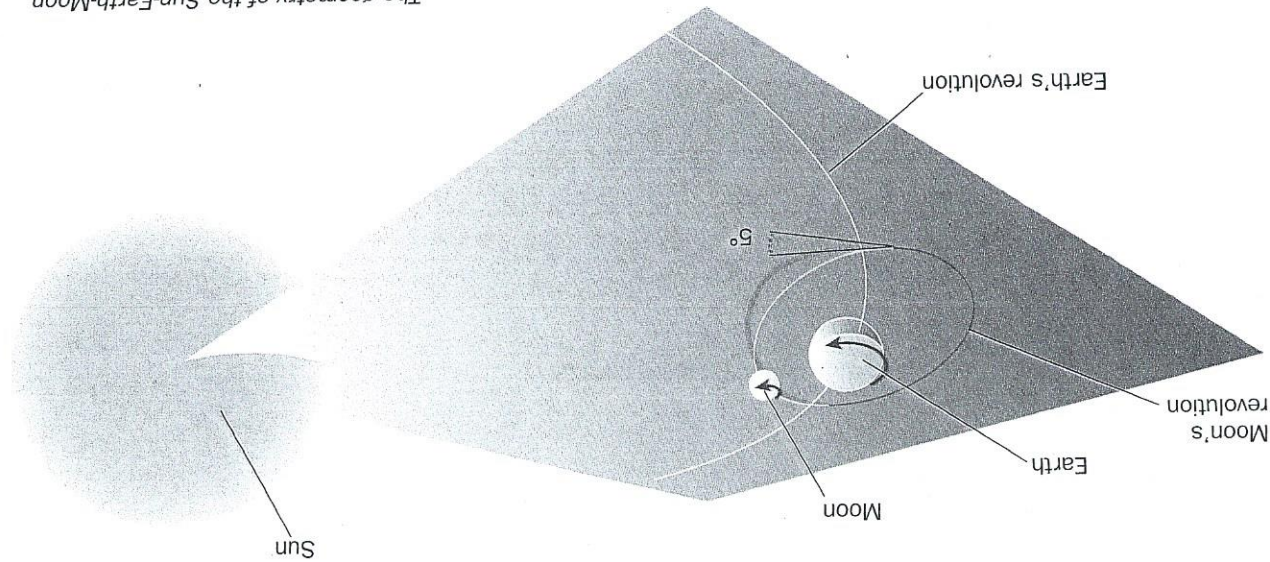
approximately 24 hours to rotate one time through day and night. This repetitive cycle of light and dark provides a clocklike regularity for measuring our days, and ancient cultures based the measure of a day on this rotation.

Month The Moon takes approximately one month—about 27 days—to orbit Earth. We observe the Moon's orbit by seeing its appearance change shape throughout each month. This repetitive cycle of the Moon's apparent change in shape led ancient cultures to identify this pattern and to measure each month.

Year It takes Earth $365\frac{1}{4}$ days, or one year, to orbit the Sun one time. Since a calendar year is 365 days long, we have an extra $\frac{1}{4}$ day every year that needs to be accounted for. So every four years, we have a leap year in which an extra day—February 29—is added to our calendar. It's easy for us to see the links between the relative motions of the Sun, Earth, and Moon and the calendars and clocks that we use every day. But earlier civilizations had to carefully track these planetary motions to arrive at predictable, measurable results.

Our Sun the Star

Our Sun is the only star in our solar system. Within the Milky Way galaxy—the collection of dust, gas, and stars to which our solar system belongs—the Sun is just one of 100 billion or so stars. There are billions of other galaxies in the universe.



The geometry of the Sun-Earth-Moon system, showing the Moon and Earth's rotation and revolution

This means that the Moon is slightly more than one-fourth (0.27) the size of Earth. See Table 1 for a summary of this information.

Natural Calendars

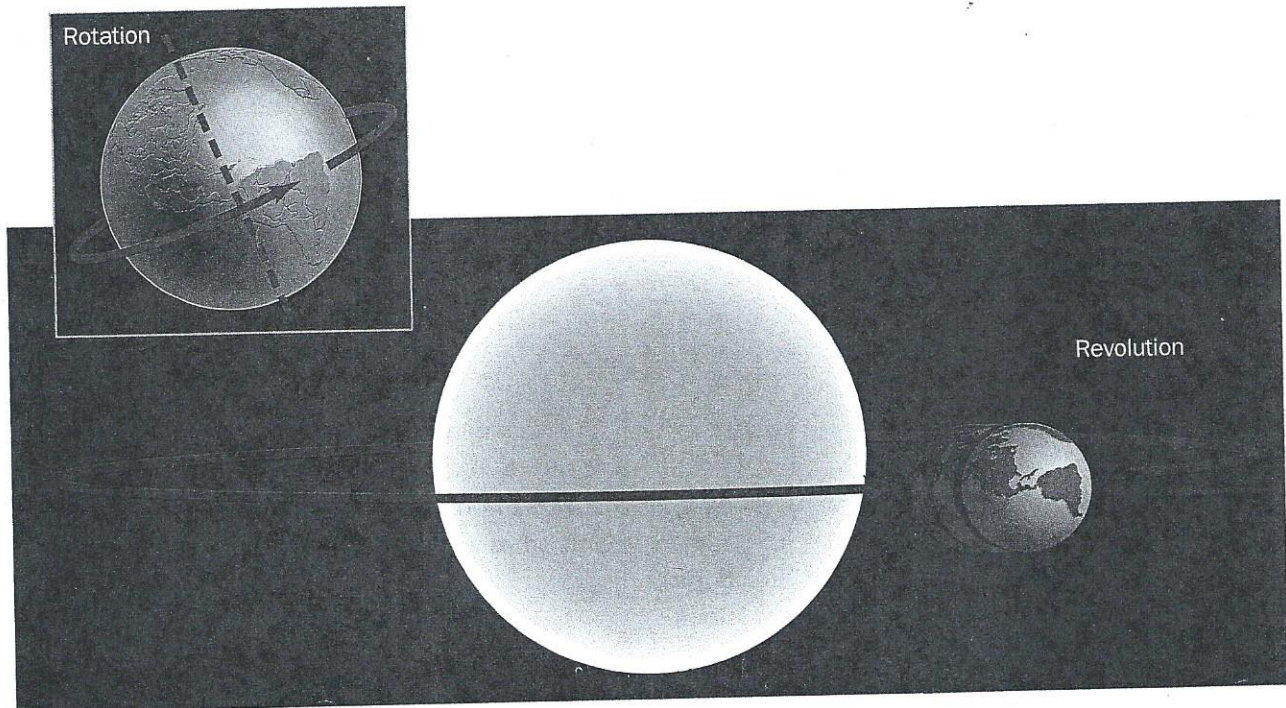
Earth rotates, or spins, on its axis. It also revolves, or orbits, around the Sun. Like Earth,

the Moon also rotates on its axis. But the Moon rotates much more slowly than Earth, taking approximately 27.3 days to turn once on its axis. The Moon also takes 27.3 days to orbit Earth.

The relative motions of the Sun, Earth, and Moon spurred ancient cultures to develop natural

Table 1 Size and Distance Comparison Sun-Earth-Moon Data

Solar System Body	Distance from Earth (km)	Earths Away	Diameter (km)	Earths Across
Sun	150,000,000	~12,000	1,392,000	109
Moon	384,000	30	3500	0.27
Earth			Equator = 12,756	1



Rotation and revolution