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Title: EARTH, THE MOON, AND OTHER SATELLITES.

Benchmarks: Earth & Space Sciences -- Astronomy -- Solar System

Subject Terms: SOLAR system; EARTH; MOON; METEOROIDS; COMETS

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Source: Sun & the Solar System; 1996, p26 (Click to view "Table of Contents") 12p, 2 diagrams, 3 color

Publisher: Lerner Publishing Group

ISBN: 9780805044751

Abstract: Provides information on Earth, moon and other satellites in the solar system. Rotation and revolution of Earth; Explanation for the difference in amount of iron, oxygen and silicon found in Earth and moon; Discussion on meteorites, meteoroids asteroids and comets. (Copyright applies to all Abstracts)

Lexile: 970

Full Text Word Count: 2608

Accession Number: 8654826

Database: Book Collection: Nonfiction

CHAPTER 3

EARTH, THE MOON, AND OTHER SATELLITES

Earth is a most unusual planet in that it sustains life. On Earth, food grows and air is available to be used over and over again, as are water and soil. These--plus energy from the Sun--are all the necessities for life as we know it.

Earth is the third-closest planet to the Sun. Mercury and Venus are the two planets that are closer. Earth's distance from the Sun is just right for the emergence, development, and sustenance of life as we know it. A bit closer would be too hot; a bit farther out would be too cold.

As far as we know, there is no life anywhere else in the solar system. However, as we continue to learn what a small spot we occupy in the vast universe, many scientists and other people suggest that life may exist in places other than Earth. Organic molecules, the kind of particles that are associated with life, have been identified elsewhere in the Milky Way. And some people believe that they may have found organic molecules in meteorites that have fallen to Earth from outer space. But this has not been proven.

It is true that we have found no evidence of other life in the solar system, but we have not investigated all parts of it. Scientists do not have all the answers about the solar system, but there are many theories about it. For example, most astronomers believe that there are planets out among the stars still undiscovered. In fact, in 1995 and 1996, different groups of scientists in Switzerland and the United States found what they believe is evidence of previously unknown planets orbiting stars similar to our Sun. Could there, then, be other forms of life in our galaxy? Some argue that, if there are so many planets, it is likely that some of them have life-conducive conditions similar to those on Earth. At least one of the newly discovered celestial bodies appears to be the right temperature for water to exist--which means that life might be able to exist there! We may not be alone.

The Traveling Earth

Earth is always moving, as is everything else in the universe. Earth moves in many different ways, the main ones being rotation and revolution.

Earth has a diameter of 7,926 miles (12,756kilometers), and the planet spins completely around in one day--to be precise, in 23 hours, 56 minutes, and 4.09 seconds.

How is one complete rotation measured? Suppose you are spinning in place. When you started spinning, a distant tree right in front of you would reappear in front of you after one complete rotation. That is the way Earth's rotation is measured. Instead of a tree, however, a point on Earth is lined up with a distant star--one that is so far away that the star has no apparent movement. When the point once again lines up with that star, one rotation is said to be complete. One day has passed. This is called a sidereal day; the word sidereal means "of the stars."

Now, suppose the point on Earth lines up with the Sun and begins its rotation. When the Sun once again is in line with the point, one day will have passed. This is called a solar day. It is four minutes longer than a sidereal day because, as Earth rotates, it is also going around the Sun. As viewed from Earth, the Sun appears to move among the background stars, an effect of our motion around the Sun. As Earth spins, the Sun "moves," and it takes four minutes for Earth to catch up to the Sun.

Earth spins around on its axis, much as a wheel spins around on an axle. The axis is not straight up and down; it is tilted 23.5° from the vertical. In June, July, and August, the Northern Hemisphere of Earth tilts toward the Sun, receiving a lot of solar energy. That is when it is summer in the Northern Hemisphere. During this season, Earth's arctic zone has continuous daylight, because it is constantly tilted toward the Sun. Six months later, during the Northern Hemisphere's winter, the northern half of Earth is tilted away from the Sun. Now the arctic region has continuous night and receives less energy from the Sun.

While Earth is rotating, it is also revolving around the Sun. It makes one complete revolution in about 365.25 days, what we call a year. Each Earth year, we complete a journey of 595 million miles (958 million kilometers). Amazingly, we do not feel our planet's motion, even though we are rotating at approximately 1,000 miles per hour (1,609kilometers) and, at the same time, revolving around the Sun at a speed of nearly 66,600 miles (107,200kilometers) per hour.

By watching other celestial bodies, though, we can perceive Earth's motion. As Earth revolves, it appears to us that the Sun is moving among the stars. No motion of the distant stars is apparent because they are so much farther away. Because of the Sun's apparent motion among the stars, we see changing star patterns in our night sky. These apparent star patterns, called constellations, change from summer to winter.

In the summer sky of the Northern Hemisphere, we see the constellations known as Cygnus (the swan), Scorpius (the scorpion), Aquila (the eagle), and Ophiuchus (the serpent-bearer). In winter in the Northern Hemisphere, Orion (the hunter) dominates the sky, and we can also see Gemini (the twins), Auriga (the charioteer), and Canis Major (the big dog). Today, stargazers recognize some 88 constellations.

Earth's Distance from the Sun

Earth's average distance from the Sun is about 93 million miles (150 million kilometers). In July, we are farther away--some 94,400,000 miles (152 million kilometers). In December and January, we are closer approximately 91,300,000 miles (147 million kilometers). Distance from the Sun is a factor in our seasonal changes on Earth. But it is the tilt of Earth's axis that is the main cause of seasonal differences on Earth.

The Moon and Other Satellites

There is no big change of seasons on the Moon. Year in, year out, the seasons remain nearly the same. The Moon is very hot when in sunlight and very cold when in darkness.

The Moon is Earth's natural satellite. All of the planets except Mercury and Venus have

satellites, or moons, that revolve around them--Pluto has one, Mars has two, there are at least 16 around Jupiter, 17 around Saturn, Uranus has at least 15, and Neptune has at least 8. The planets with gaseous rings have the most satellites; the two planets closest to the Sun have none. More satellites may be discovered as space research progresses.

Our Moon has a diameter of 2,160 miles (3,476kilometers) and is one of the larger moons in the solar system. The Moon rotates in the same amount of time that it revolves around the Earth--exactly 27 days, 7 hours, 43 minutes, and 11.47 seconds. As a result, the same half, or hemisphere, of the Moon always faces toward us. We did not see the other side of the Moon until 1959, when lunar probes with cameras aboard went around the "far side" of the Moon, took pictures, and sent them back to Earth.

Like Earth, the Moon is made of space debris. So are all of the other satellites, the comets, the meteoroids, and the asteroids. The Moon was probably formed out of the same cloud that was the origin of the Sun, Earth, and the other planets.

The materials found on the Moon are the same as those found on Earth. However, the percentages of the various elements, such as iron, silicon, and oxygen, are not the same. That is likely because the different substances in the original gas cloud were not distributed evenly throughout the cloud. This would also account for the great variations in the percentages of different materials in the planets.

As the lunar materials consolidated, their temperature went up rapidly. Volcanoes developed, breaking through the Moon's outer surface, which had solidified earlier. Even though those volcanoes became extinct billions of years ago, many of their craters still exist. Today, the Moon is covered with craters and lava fields. They remain much as they were when they first formed because there is no wind or water on the Moon to erode them.

Meteorites, Meteoroids, Asteroids, and Comets

Space is far from empty. A large part of the meteoric dust in space is left behind by the passage of comets. When Earth moves through a comet's orbit, the planet sweeps up the debris. Every day, about 1,000 tons (910 metric tons) of meteoric material fall on Earth.

A meteoroid is a space particle, while a meteorite is a type of meteoroid that lands on Earth. As many as 3,000 meteorites fall to Earth each year. A meteor is the trail of light that is made as a meteoroid streaks through Earth's atmosphere.

Most meteoroids are very small--the size of a grain of sand. But some can be quite large, perhaps the size of a football or baseball. Meteorites have struck animals and people on rare occasions. One such incident occurred in Sylacauga, Alabama, when a meteorite weighing about ten pounds (4.5 kilograms) crashed through the roof and then the ceiling and struck a surprised Mrs. Hewlett Hodges on her leg. In 1971, a meteorite weighing about a pound went through another person's roof and embedded in the ceiling. Despite these unusual stories, there is no reason to worry about being hit by a meteorite because the chances of this happening are extremely remote. When you're outside, however, meteorite dust probably falls on you constantly.

Asteroids are larger meteoroids that travel mostly between the orbits of Mars and Jupiter. The largest asteroid, named Ceres, measures about 600 miles (966 kilometers) across. Very rarely, asteroids may come near Earth.

Comets consist mostly of gases, but they have a small, solid core. Comets move in long and narrow elliptical orbits. As a comet orbits closer and closer to the Sun, it develops a "tail" as the ice that makes up most of it vaporizes into space. There are probably millions of comets that we never see from Earth. Occasionally, however, one comes near

enough so we can see what has been described as a "hairy star" in our night skies.

Signs of a comet collision with Earth have been found in Siberia. Scientists believe that, in 1908, a great comet flattened entire forests there and caused widespread destruction. Some scientists believe that a comet crashing into Earth may have killed the dinosaurs. The only other known comet collision was that of Shoemaker-Levy 9 with Jupiter in 1994, an event that is called the most violent recorded event in the history of the solar system.

Seasons in the Northern Hemisphere

The 23.5° tilt of the Earth's axis toward the Sun means that in summer, not only is there more daylight, but the Sun's rays reach the Earth's surface more directly through the atmosphere and so lose less of their warmth. In winter, when the Earth is tilted away from the Sun, not only is there less daylight, but the Sun's rays have to pass through more of the Earth's atmosphere, losing more of their warmth.

Landing on the Moon

On July 20, 1969, American astronaut Neil Armstrong stepped from the Lunar Lander, a part of Apollo 11, and put a foot on the Moon. He proclaimed it "one small step for a man, one giant leap for mankind." This was the first time that a human had been on the surface of any world other than Earth. Moments later, Edwin "Buzz" Aldrin followed Armstrong onto the surface of the Moon.

Five other successful missions to the Moon have since been made through a space-exploration program that is called Apollo. The Apollo program was created by the U.S. Space Agency, the National Aeronautics and Space Administration (NASA), headquartered in Houston, Texas.

The second lunar landing occurred just four months after the first. The third successful mission, in January 1971, brought back the largest amount of lunar material to date. During the fourth lunar landing, in July 1971, astronauts used a vehicle called the Lunar Rover for the first time. The fifth mission, in April 1972, set a new record for time spent on the Moon--a total of 20 hours and 14 minutes. And the last manned trip to the Moon, in December 1972, recovered about 243 pounds (110 kilograms) of lunar matter to be studied back on Earth.

Although we have now traveled to the Moon six times, it is never an easy trip to pull off. Being an astronaut is extremely dangerous. The original attempt at the third lunar mission, by Apollo 13, had to be aborted--cut short--in space when the spacecraft's oxygen tanks exploded. For a while, the survival of Apollo 13 and the three astronauts traveling in it was touch-and-go. There was a good possibility that the spaceship would be destroyed or lose power, making it impossible to bring the ship back to Earth. If that had happened, the crew would have died, and the spaceship would have gone into an Earth-circling orbit. Finally, most of it would have burned up in Earth's atmosphere. Fortunately, the crew and NASA were able to bring the ship safely back to Earth.

Eclipses

The Moon always casts a shadow. When the Moon gets in line between the Sun and Earth, the tip of its shadow, called a shadow cone, may fall on a region of Earth. When that happens, the Moon blocks the Sun from that region. This is called a total eclipse of the Sun. In the region where the Moon's partial shadow falls, however, only part of the eclipse is seen.

If the shadow cone does not quite reach Earth, there is an annular eclipse. In an annular eclipse, a thin ring of the Sun rims the Moon (an annulus is a ring).

Earth also casts a shadow. When Earth is between the Sun and the Moon, Earth's shadow cone reaches the Moon. As the Moon moves into this cone, there is a lunar

eclipse, meaning that the Moon can be viewed only very faintly from some parts of Earth. Eclipses of the Moon occur each year, as do solar eclipses. Because only a small part of the Earth is in the lunar (Moon) shadow at a given time, however, there is a long lapse between total solar eclipses at any single location. For example, people in New York City witnessed a total solar eclipse in 1925; the next time a total solar eclipse will be visible there is in the year 2024.

SOLAR ECLIPSES
The kind of solar eclipse visible from Earth depends on how much sunlight the Moon blocks from view when it passes between the Sun and Earth.

LUNAR ECLIPSE
When the Moon moves into Earth's shadow, it is mostly hidden from the Sun's view. This is called a lunar eclipse.

PHOTO (COLOR): A view of Earth rising over the Moon shows a blue, life-filled planet. We do not yet know whether or not there is life on any other planet.

PHOTO (COLOR): Seasons in the Northern Hemisphere

PHOTO (COLOR): Most of the planets in our solar system have moons, but ours is one of the largest. It has a diameter of 2,160 miles (3,476kilometers).

PHOTO (COLOR): SOLAR ECLIPSES

PHOTO (COLOR): LUNAR ECLIPSE

PHOTO (COLOR): Halley's Comet was discovered by Edmund Halley in 1910 and was seen again in 1986, when this picture was taken.

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By Franklyn M. Branley
