



Lesson Plan: Studying and Exploring Space

Grade Level: 6

Subject: Earth Science

Duration: 45–60 min

NGSS MS-ESS1-3: Analyze and interpret data to determine scale properties of objects in the solar system.

Learning Objectives

By the end of this lesson, students will be able to:

- **Identify** key figures in the history of astronomy and explain how their contributions changed our understanding of the solar system.
- **Describe** how rockets work using Newton's third law of motion, including the concepts of



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gases out of the rocket's exhaust nozzle; when this force exceeds the force of gravity, the rocket lifts off.

- **Escape Velocity:** The minimum speed a rocket must reach to completely break free of Earth's gravitational pull and travel into space. From Earth, this is approximately 11 km per second.
- **Orbital Velocity:** The specific speed and direction a rocket must maintain to orbit Earth rather than fly away from it or fall back down. A rocket must travel at about 8 km/s to achieve orbital velocity.



- **Space Probe:** An unmanned vehicle equipped with scientific instruments that travels to other planets and moons to study their features, compositions, and movements without carrying a human crew.
- **Combustion Chamber:** The sealed chamber inside a rocket engine where fuel is burned. The force of the burning gases pushing against the top of the chamber is what generates the thrust that propels the rocket.
- **Cosmic Background Radiation:** Faint microwave radiation that travels in all directions throughout the universe. Scientists believe it is leftover electromagnetic energy from the Big Bang, the massive explosion thought to have started the universe 10 to 15 billion years ago.
- **Big Bang Theory:** The scientific theory that the universe began approximately 10 to 15 billion years ago as a massive explosion of space itself, not just matter, and has been expanding ever since.

 **Materials Needed:** (all links are included in this PDF)



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- Small ball and open space (or hallway) to demonstrate Newton's third law of motion as a rocket thrust analogy — push the ball against a wall and observe the equal and opposite reaction on your hand/body



Lesson Procedure

Step 1: Introduction (7 minutes)



- Ask students: 'If you could send one instrument into space to learn something new about the universe, what would it be and what would you want to find out?' Allow 2–3 responses to surface prior knowledge.
- Show the opening section of the Study Guide, which contrasts Ptolemy's Earth-centered model with Copernicus's heliocentric model, and ask: 'Why did it take so long for scientists to accept that Earth orbits the sun?' (<https://newpathworksheets.com/api/guide/study-guide-science-grade-6-studying-and-exploring-space-1.pdf>)

Step 2: Direct Instruction (15 minutes)

- Walk through the Study Guide sections on early astronomers (Ptolemy, Copernicus, Galileo, Newton, Hubble), emphasizing how each built on the previous model and what tool or observation drove the change. (<https://newpathworksheets.com/api/guide/study-guide-science-grade-6-studying-and-exploring-space-1.pdf>)
- Demonstrate Newton's third law as the physics of rocketry: press a small ball firmly against a wall and release it, noting the equal and opposite push on your hand. Connect this to how exhaust gases exiting a combustion chamber push the rocket upward (thrust).



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(<https://newpathworksheets.com/api/worksheet/worksheet-science-grade-6-studying-and-exploring-space-1-0.pdf>)

Step 4: Independent Practice (15 minutes)

- Students independently complete Practice Worksheet 1, which covers Newton's third law, thrust, orbital velocity, escape velocity, space probes, and Mars missions. (<https://newpathworksheets.com/api/worksheet/worksheet-science-grade-6-studying-and-exploring-space-1-1.pdf>)



- Students then complete Practice Worksheet 2, which covers the ISS, cosmic background radiation, the Big Bang Theory, and solar radiation hazards for astronauts.
(<https://newpathworksheets.com/api/worksheet/worksheet-science-grade-6-studying-and-exploring-space-1-2.pdf>)

Step 5: Assessment (8 minutes)

- Review Practice Worksheet 0 as a formative check; use questions 6–10 (Hubble Space Telescope, Tsiolkovsky, NASA, Saturn V) to assess comprehension of key facts from the Study Guide. (<https://newpathworksheets.com/api/worksheet/worksheet-science-grade-6-studying-and-exploring-space-1-0.pdf>)
- Ask students to classify each of the following as a tool for observation, a vehicle for exploration, or a source of radiation hazard: Hubble Space Telescope, Saturn V rocket, space probe, cosmic background radiation, ultraviolet light from the sun. Students write their answers and share with a partner.
- Exit question: 'A satellite orbiting Earth at low earth orbit moves too fast to track a single weather system. Using what you learned today, explain why geosynchronous orbit solves



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- Provide a pre-filled astronomy timeline card listing each key figure (Ptolemy through Hubble) with one sentence describing their contribution, so students can follow along during direct instruction without losing the sequence.
- Pair students with the Study Guide open to the 'Rockets and Rocketry' section during independent practice on Worksheet 1, and highlight the sentences defining thrust, escape velocity, and orbital velocity so they can locate answers directly in the text.

Extension Activities



- Build a simple straw rocket: tape a paper cone to a straw, blow sharply, and measure how far it travels at different angles — then connect the results to the concepts of thrust and orbital trajectory discussed in the lesson.
- Research the International Space Station's current experiments at nasa.gov and identify one ongoing study related to weightlessness; prepare a 60-second verbal summary explaining what scientists hope to learn and how it could benefit life on Earth.

Complete List of Available Resources:

- NewPathWorksheets: Studying and Exploring Space (Grade 6)
(<https://newpathworksheets.com/science/grade-6/studying-and-exploring-space-1>)
- Study Guide: Studying and Exploring Space
(<https://newpathworksheets.com/api/guide/study-guide-science-grade-6-studying-and-exploring-space-1.pdf>)



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(<https://newpathworksheets.com/api/vocabulary/vocabulary-science-grade-6-studying-and-exploring-space-1-3.pdf>)

- Vocabulary Worksheet 4: Studying and Exploring Space
(<https://newpathworksheets.com/api/vocabulary/vocabulary-science-grade-6-studying-and-exploring-space-1-4.pdf>)

STUDYING AND EXPLORING SPACE

Our ability to understand our solar system and the universe beyond has grown by dramatic leaps in the last few decades. The truth is, though, that all that lies beyond our own home planet has fascinated people for countless centuries. Using very basic as well as very complex tools, humans have been able to discover and understand amazing realities about our solar system, the universe, planets and stars, how they all formed and how they are all changing.

The Early Space “Explorers”

Using simple tools and the power of observation, early theories about our solar system and the planets within it proved to ultimately be remarkably accurate. Of course, much was inaccurate, too.

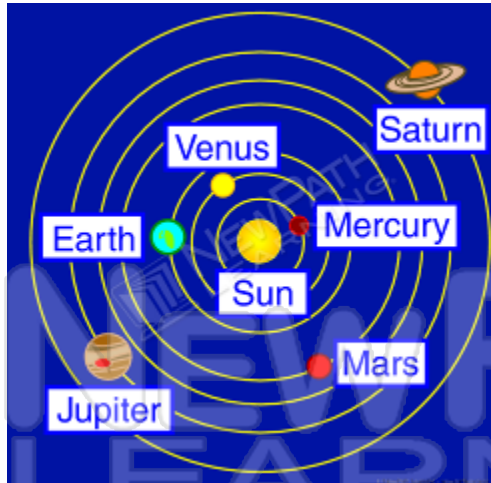
The ancient Greek astronomer named Ptolemy carefully studied



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revolutionary) theory about our solar system would be proposed. In 1543, a Polish astronomer named Nicolaus Copernicus (1473-1543) concluded that the Earth rotates on its own axis, that the *sun* is the center of the universe and that all the planets revolve around it.



Some call this the **Copernican Theory**. In technical terms, it is called the **principle of heliocentric planetary motion**.

Galileo Galilei (1564-1642) was the first person to use a



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around the Earth.

Traveling into Space

Our understanding of space, the planets, the stars and the universe as a whole made quantum leaps forward in the twentieth century. Edwin Powell Hubble (1889-1953) was an American astronomer who, in 1923, showed that the universe is expanding. He used photographs to prove that there are galaxies beyond our own. Prior to this, scientists believed that our galaxy was the *entire* universe.

Studying space from Earth has provided dramatic and rich information. But the Earth's atmosphere distorts incoming light and images of objects in space. To get the clearest view of the universe, one must get beyond Earth's atmosphere and use space-based telescopes.

It may be very surprising to discover that some of the most basic information about our universe has been discovered very recently using space-based telescopes. In 1990, the Hubble Space Telescope (clearly named in honor of the great 20th century astronomer) was launched by NASA and has provided some of the most spectacular images of the universe ever seen. Dramatic advances in physics and optics have allowed space-based telescopes like Hubble to see a wide range of electromagnetic radiation, far more than just visible light. This information has revealed more about the universe than we would ever have been able to know from even the best land-based telescopes.



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From the standpoint of physics, rockets operate based on **Newton's third law of motion** that states that for every action there is an equal and opposite reaction. Rocket fuel is burned inside the rocket in a **combustion chamber**. The force that is exerted out of the rocket's exhaust nozzle equals the force of the gas pushing at the *top* of the combustion chamber. When the force pushing at the top of the combustion chamber is greater than the force of gravity holding the rocket on Earth, the rocket moves upward. This force that moves the rocket is called **thrust**.

For rockets to move people and machinery into space and completely out of Earth's gravitational pull, they must reach **escape velocity**. The escape velocity from Earth's gravitational pull is 11 km/second. A rocket must travel at 8 km/s to achieve **orbital velocity**. Orbital velocity is the speed and direction needed to orbit the Earth.

Lesson Checkpoint: What is 'escape velocity'?

Early Space Missions

The first application of rocketry was military: they were used to deliver bombs. Late in the 1950's, though, the former Soviet Union launched a rocket that put the first satellite, Sputnik, into orbit around the Earth. This marked the beginning of a



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There were a number of missions throughout the 1960's that prepared for the moon landings. The Apollo missions were the space flights that eventually landed the United States on the moon. The first purpose of the moon landings was purely political in that we intended to strengthen American national pride in light of the accomplishments of the Soviet space program. However, the technologies developed for NASA and space travel proved to be invaluable for science, technology and use in everyday life. In addition, important scientific information about the moon was collected during the lunar missions, including

studies of solar wind activity, moonquake activity, and collections of rock and dust samples from the moon's surface.

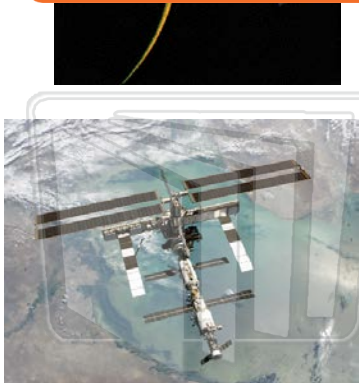
By the mid-1970's, the focus of space work for the United States and NASA shifted from moon landings to regular travel into space in a reusable craft. These missions would be used for a number of purposes including scientific studies of the effects of weightlessness on astronauts and for a variety of experiments from growing plants to growing crystals and more. The Space Shuttle has also placed telescopes and other equipment in space, such as large pieces of the International Space Station.

The advancement of the Space Shuttle program was that the air craft is reusable. Remember that the Saturn V rocket that transported astronauts to the moon, for example, was a single-use vehicle. All the components of the Saturn V rockets, including the vehicles that landed on the moon and returned the astronauts to Earth, were used only once. The **Space Shuttle** was the first generation space vehicle designed to be used over and over again.



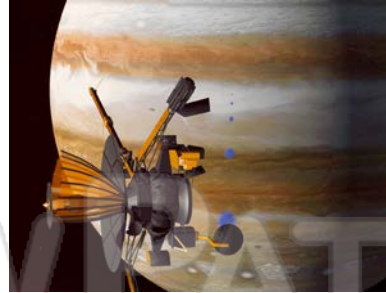
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Magellan Space Probe

The Viking 1 and Viking 2 probes were sent to study Mars in 1975. In 1997 the Mars Pathfinder mission sent two movable robotic rovers to study the surface of Mars. Mars is of particular interest because it is physically similar to Earth and it may have had significant quantities of water one time that could have allowed the development of some form of life.



at

The Pioneer, Voyager and Galileo missions were unique because the purpose of these space probes was to study the outer portions of the solar system. Specifically, these probes studied **solar wind**, Jupiter, Saturn, Uranus and Neptune. *Stardust* was the first space probe designed to study a comet.

New concepts for space exploration are developing all the time. NASA has a New Millennium program that focuses on the development of new technologies in space probes. For example, Deep Space 1 is a



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counteract these effects while living in space. The ISS promises to be an important base of specialized research designed to improve space travel and living in space as well as bringing benefits to life on Earth.

Lesson Checkpoint:
Name one advantage of the International Space Station.

Solar Radiation

There are big dreams for activity in space. Some believe the moon will be a place where specialized materials and products can be manufactured. Perhaps the moon and Mars can be mined for important mineral resources. Perhaps a colony of people could live on the moon. For these goals to be achieved, astronauts will have to overcome many obvious challenges for living in space such as oxygen supplies, weightlessness and all its physical consequences, and temperature control. Another challenge is the danger from **solar radiation**.

Radiation from a number of sources is moving throughout the universe. The sun produces the full spectrum of electromagnetic radiation. In addition, **cosmic background radiation** travels in all directions throughout the universe. Cosmic background radiation is faint microwave radiation. It was discovered in the mid 1960's by A. Penzias and R.W. Wilson. It is thought that this cosmic background



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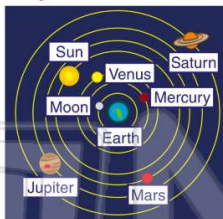
Despite the exciting progress in space exploration, space is ultimately a hostile environment. Sending humans into space, particularly for extended periods of time, will always present significant technological challenges. While these challenges are being studied, unmanned space probes will continue to peek into the far reaches of the solar system and the universe. This is a very exciting time of human history to be an astronomer!



Name _____ Class _____ Date _____

1

The ancient Greek astronomer named Ptolemy used all the ancient knowledge he could find about astronomy to create the **Ptolemaic theory**. Ptolemy concluded that the sun is the center of the universe and all planets revolve around it.

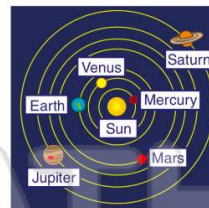


True or false?

- A** true **B** false

2

The first astronomer to propose that the **sun** is the **center of the universe** and that the earth and all other planets travel around the sun was _____.



- A** Claudius Ptolemy
B Galileo Galilei
C Nicolaus Copernicus
D Isaac Newton

3

The first person to use a **telescope** to study the moon and planets supported Copernicus' theory that the sun is the center of the universe. He also discovered **moons** orbiting **Jupiter**. This astronomer's name was _____.



- A** Claudius Ptolemy

4

In 1687, this famous astronomer and scientist created similar drawings to explain that **gravity** is the force that causes planets to **orbit** the sun and moons to orbit their planets. Who was this great scientist?



- A** Claudius Ptolemy
B Sir Isaac Newton

5

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- B** Konstantin Tsiolkovsky
C Fyodor Dostoyevsky
D Robert Goddard

9

What is the name of the organization created by the **United States** to improve rocket technology and to explore the moon and space?



- A** Federal Bureau of Investigation (FBI)
B National Aeronautics and Space Administration (NASA)
C Central Intelligence Agency (CIA)
D Homeland Security Office

10

The **Saturn V** rocket that brought Americans to the moon in 1969 was _____.



- A** a reusable rocket
B made from recycled materials
C powered by jet fuel
D a one-time use vehicle



Name _____ Class _____ Date _____

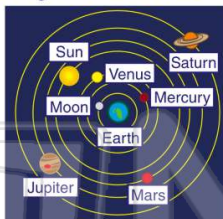
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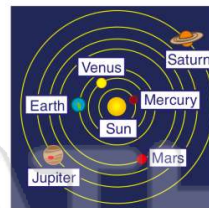
True or false?

- A** true **B** false

**B****2**

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**C****3**

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**B****5****C**

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**B****10**

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B made from recycled materials
C powered by jet fuel
D a one-time use vehicle

**D**



Name _____ Class _____ Date _____

1

One of the basic laws of physics behind rocket science is **Newton's third law of motion**, which states that _____.

- A** every explosion causes forward motion
- B** to escape the pull of gravity, an object must be aerodynamic
- C** for every action there is an equal and opposite reaction
- D** fire, when hot enough, pushes away from itself

**2**

Rocket fuel is burned inside the rocket in a **combustion chamber**. The force that is exerted out of the rocket's exhaust nozzle equals the force of the gas pushing at the **top** of the combustion chamber.

This force, which ultimately moves the rocket, is called _____.

- A** pressure
- B** thrust
- C** combustion
- D** gravity

3

In order for a rocket to leave the **launch pad**, the **thrust** must _____.

- A** begin immediately
- B** start slowly and increase rapidly
- C** exceed the force

**4**

The **speed** and direction a rocket needs to completely escape earth's **gravitational pull** is called _____.

- A** thrust
- B** orbital velocity
- C** escape velocity

**5**

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9

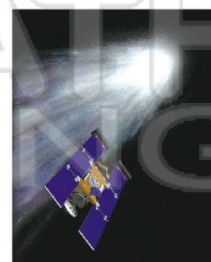
The Pioneer, Voyager, and Galileo missions were **unique** because the **purpose** of these space probes was to study _____.

- A** Venus and the Sun
- B** asteroids and Mars
- C** the outer portions of the solar system
- D** the effects of weightlessness on scientific experiments

**10**

Stardust was the first space probe designed to study _____.

- A** Jupiter
- B** Venus
- C** the asteroid belt
- D** a comet





Name _____ Class _____ Date _____

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C

5



B

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D

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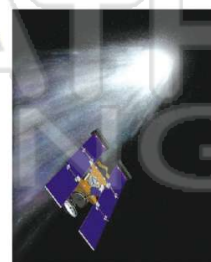


C

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D



Name _____ Class _____ Date _____

1

Deep Space 1 is among a new breed of space probes. Its purpose has been to study the universe using new and potentially risky **technologies** such as _____.

- A** nuclear fuel
- B** ion rockets that expel charged particles
- C** traveling near the speed of light
- D** long-lasting metals to build shuttles that are functional for over 100 years

**2**

What is the name and in what year did the **first human** travel to space?

- A** astronaut John Glenn in 1962
- B** cosmonaut Yuri Gagarin in 1961
- C** astronaut Neil Armstrong in 1969
- D** astronaut Sally Ride in 1983

3

The **Apollo** missions were the space flights that eventually allowed the United States to **land on the moon**. The **first purpose of the moon landings** was to _____.

- A** study solar wind activity
- B** study moonquake activity
- C** collect rock samples to study the moon's geology

**4**

In 1972, President Richard Nixon announced to the American public that NASA would begin a **new era** in space exploration. **What would be the unique feature of this new generation of space flight?**

- A** rockets would be faster
- B** flights would take humans to Mars and beyond
- C** the launch vehicle would be reusable

**5**

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- C** climate control
- D** the cost of these concepts versus the financial return



- B** black hole theory
- C** big bang theory
- D** expanding universe theory

**9**

The gold **protective layer** on the visor of the astronauts' headgear protects them from _____.

- A** harmful ultraviolet radiation from the sun
- B** space debris left over from space travel
- C** wind
- D** spy satellites

**10**

Ionizing radiation, solar protons, and high energy electrons and protons are _____.

- A** passive forms of light that do not harm astronauts
- B** rays from distant stars that help light outer space
- C** harmful types of radiation from which astronauts must be protected
- D** forms of radiation created by rockets entering outer space





Name _____ Class _____ Date _____

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B**3**

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**C****5****B**

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C

- C** climate control
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**A****10**

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**C**



Name _____ Class _____ Date _____

Match each of the following terms to its definition:

Astronomical unit

Convective zone

Accretion

Combustion chamber

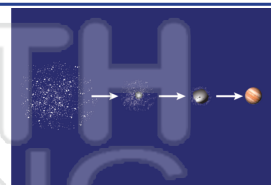
Copernican theory

Asteroid

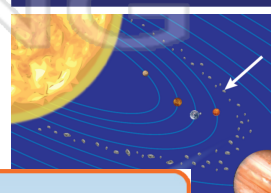
Comet

Corona

1. _____ - the process by which dust particles collide, stick together and form larger particles



2. _____ - objects in space that are made of pieces of rock and ice and travel at very high speeds; rocky body that circles the Sun in an area between Mars and Jupiter



3. approx



4. fuel is

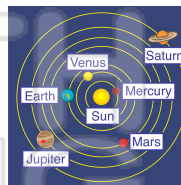
5. and ic

6. gases

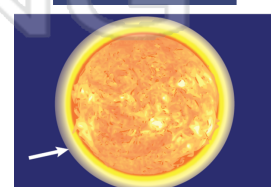
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7. _____ - the theory proposed by Copernicus that the sun is the center of the universe and that the Earth and all other planets travel around the sun



8. _____ - the sun's outer atmosphere that extends for millions of miles beyond the sun





Name _____ Class _____ Date _____

Match each of the following terms to its definition:

Astronomical unit

Convective zone

Accretion

Combustion chamber

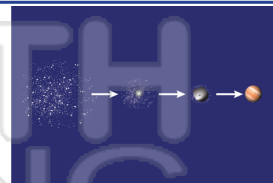
Copernican theory

Asteroid

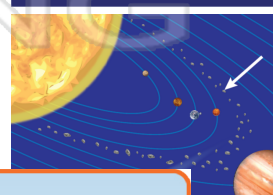
Comet

Corona

1. accretion - the process by which dust particles collide, stick together and form larger particles



2. asteroid - objects in space that are made of pieces of rock and ice and travel at very high speeds; rocky body that circles the Sun in an area between Mars and Jupiter



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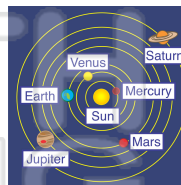
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7. Copernican theory - the theory proposed by Copernicus that the sun is the center of the universe and that the Earth and all other planets travel around the sun



8. corona - the sun's outer atmosphere that extends for millions of miles beyond the sun

