Science Nine

Module Five:

Space

Name:

Date Received:

Date In:

Grade:

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Unit E: Space Exploration

Outcome #1- Investigate how technology has impacted human understanding of Earth and space.

Essential Outcomes (Ideas I must understand)	My Understanding
• Describe the distribution of matter in space.	1 2 3 4
• Describe techniques used to estimate distances of objects in space, and determine their direction of motion.	1 2 3 4
• Describe the position of objects in space using angler coordinates (altitude and azimuth)	1 2 3 4
Important Outcomes (Ideas that are important to know and be able to do)	My Understanding
• Identify different ideas about Earth and space based on culture and science.	1 2 3 4
• Explain how the following technological advances have contributed to a scientific understanding of space: optical telescopes, spectral analysis, space travel	1 2 3 4
• Using evidence, describe characteristics of bodies that make up the solar system and compare their characteristics to those of Earth.	1 2 3 4
• Interpret drawings and physical models that show the motion of objects in space.	1 2 3 4
• Examine evidence concerning motion, alignment and collisions of bodies in space.	1 2 3 4

Outcome #2- Identify problems in developing technologies for space exploration, describe technologies developed for supporting life in space, and explain the scientific principles involved.

Essential Outcomes (Ideas I must understand)	My Understanding
• Using knowledge of space environments, identify the challenges that must be met to develop life supporting systems.	1 2 3 4
Important Outcomes (Ideas that are important to know and be able to do)	My Understanding
• Describe technologies for life support systems and interpret the scientific principles on which they are based.	1 2 3 4
• Describe the major purposes of artificial satellites and how they were developed.	1 2 3 4
Outcomes Worth Being Familiar With	My Understanding
• Identify materials and processes developed to meet needs in space.	1 2 3 4

Outcome #3- Describe the science of optical and radio telescopes, space probes and remote sensing technologies.

Essential Outcomes (Ideas I must understand)	My Understanding
• Explain the operation of optical telescopes, including those that are positioned in space.	1 2 3 4
• Describe the technologies used in global positioning systems and remote sensing.	1 2 3 4
Important Outcomes (Ideas that are important to know and be able to do)	My Understanding
• Explain how radio and optical telescopes help us to determine the characteristics of red shift and star systems.	1 2 3 4

Outcome #4- Identify issues and opportunities arising from the development of space technologies, and the implications of these technologies.

Essential Outcomes (Ideas I must understand)	My Understanding
• Recognize risks and dangers with space exploration.	1 2 3 4
• Describe Canadian contributions to space research and development and to the astronaut program.	1 2 3 4
Important Outcomes (Ideas that are important to know and be able to do)	My Understanding
• Identify factors that are important to decisions regarding space exploration and development.	1 2 3 4

Part A: What did our ancestors think about space?

The Ancient Europeans

Aristotle

About 2000 years ago, a Greek philosopher named Aristotle shared his idea that the Earth was the centre of the universe. His geocentric (Earth-centred) model showed the Earth in the middle, surrounded by a ring of air and a ring of fire, and then the moon, Venus, Mercury, the Sun, Mars, Jupiter and Saturn orbiting around the outside. He believed that the planets were attached to solid spheres (circular paths) and that the stars were "stuck" to an outer shell (firmament) that held the universe inside it. Although he did not have modern optical technology (like a telescope), Aristotle used mathematical principles to calculate the different sizes of the bodies in space.

Ptolemy

Ptolemy was another Greek philosopher who shared Aristotle's theory, although he believed that the outer shell of stars also rotated.

Copernicus

Later in the 16th century, an astronomer named Copernicus theorized that the Sun (not the Earth) was actually the centre around which the planets, moons and stars rotated. In his heliocentric (sun-centred) model, the planets' orbits were not solid nor was there a solid outer shell (firmament) to the universe. Copernicus also believed that each planet rotated on an axis and that this was what determined day and night. He believed that months and years were determined by the orbits the planets followed and that the time it took a planet to travel around the sun could be used to calculate its distance from the Earth. Although people accepted his theory of planetary rotation and circular orbits, very few accepted that the sun was the centre of the universe.

Galileo

One of a few people who believed Copernicus in the 16th century, Galileo first used optical technology (a telescope) to examine solar bodies and found support for his theories. Unfortunately, others were not yet willing to accept theories that went against the teachings of the church and Galileo was charged and imprisoned for sharing his ideas.

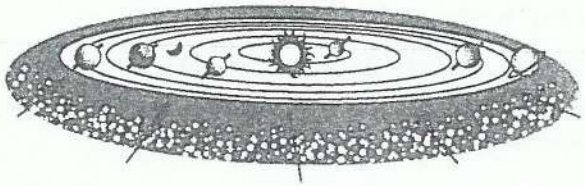
Kepler

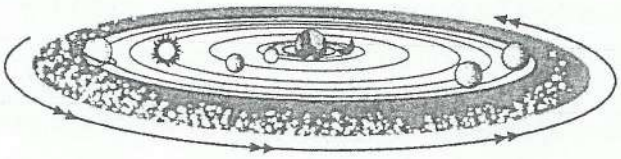
A German astronomer and philosopher, Johannes Kepler held similar views to Galileo but went a step further and described the orbits that planets travelled as ellipses (oval-shaped).

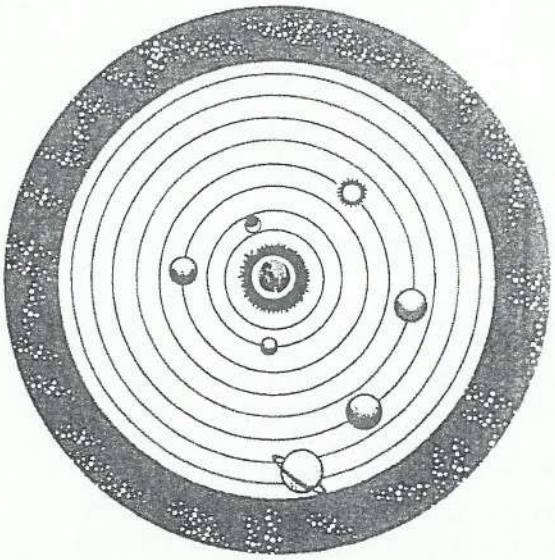
Newton

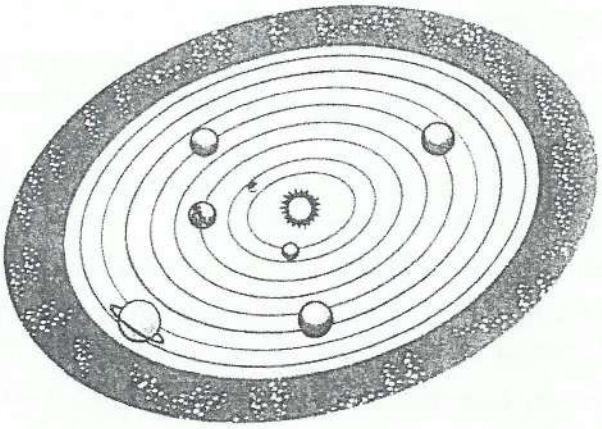
In 17th century England, Sir Isaac Newton began to develop mathematical proof that supported the theories of Copernicus and Kepler. His ideas were believed in England, France, Denmark and the Netherlands. It took a century for the rest of the world to reach the same conclusions.

Analyze the graphics below and then identify which historical figures (views) are best represented by each. Write each of the names from the previous page below a graphic (some graphics will be associated with more than one name).









The Earth on Turtle's Back

(Onondaga—Northeast Woodlands)

Long before the Earth looked like it does today, it was completely covered with water. Many kinds of birds and animals lived on and in the water. The space far above the Earth was called the Skyland and a great and beautiful tree lived there. The tree had four white roots that grew deep into the Skyland and on the tree's branches all kinds of fruits and flowers sprouted.

In the Skyland, there was a very old chief whose wife dreamed that she saw the great tree uprooted (dug up), and the next morning she told her husband the story.

When she finished telling him about her dream, the chief said he was sad because it was a dream of great power. According to their beliefs, when a person had such a powerful dream, the people must try to make it come true.

He said sadly, "The Great Tree must be uprooted."

The old chief gathered with the young men and told them what must be done to the tree. The men tried, but the roots of the tree were so deep and strong that they could not. At last, the old chief tried. He wrapped his arms around the great trunk, bent his knees and pulled with all his might. Amazingly, he uprooted the tree and laid it down on its side.

There was now a big hole where the tree's roots had grown deep into the skyland. The chief's wife came close and looked down the hole, holding one of the fallen tree's branches for safety. She thought she could see something far below that glittered like water. When she leaned out further to look, she lost her balance and fell down through the hole. As her hand slid off the branch of the fallen tree, her hand filled of seeds and she fell to the water far below.

As the woman fell, the birds and animals saw her and called to one another.

"Someone is falling from the sky!" cried one of the birds.

"We must help her," said another.

Then two swans flew up and caught the woman between their great wings. They floated her gently down near to the water where all of the other birds and animals were watching.

"She is not like us," said one of the animals. "I don't think she can live in the water; look, she doesn't have webbed feet."

"What should we do with her?" asked another of the water animals.

"Well," suggested one of the water birds. "I believe that there is Earth far below our water. If we dive down and bring up Earth, she will have a place to stand."

So, one by one, the birds and animals tried to bring up Earth.

The duck dove down first, swimming far below the surface but he could not reach the bottom. Then the beaver tried. He went even deeper, so deep that it was all dark but still he could not reach the bottom. The loon tried swimming with his strong wings and was gone a very long time but he couldn't reach the Earth either. When it seemed that every animal had tried and failed, a small voice spoke.

"I will bring up Earth or die trying."

They looked to see who it was. It was the tiny muskrat. She dove down and swam and swam. She was not as strong or as fast as the other animals, but she was determined. The muskrat went so deep that there was nothing but darkness, and still she swam deeper. She went so deep that she felt her lungs would burst but she kept going. At last, just as she could stand it no more, her tiny paw dug into the Earth at the bottom. Almost dead, the tiny muskrat floated up to the surface of the water.

When the other animals saw her float to the surface, they thought she had failed. Then they noticed that one of her paws was closed tightly around something.

"She has the Earth," they said. "What should we do with it?"

"Put it on my back," came the deep voice of the great turtle, who had come up from far below the surface to see what was happening."

They lifted the muskrat up and opened her paw. The Earth formed a tiny pile on the turtle's back and then the animals used the muskrat's empty paw to pat it down (to this day there are marks at the back of the turtle's shell that were made by the muskrat's paw).

Almost immediately, the Earth began to grow bigger and bigger. Once it was so big that it became the whole world; the two swans brought the woman down from the sky. She stepped onto the new Earth and opened her hand letting the seeds fall onto the bare soil. From those seeds, the trees and the grass grew and life on Earth began.

What are your thoughts and feelings about this aboriginal tale about the origin of the Earth?

Part B: What types of technology have helped us learn about space?

Optical Telescopes

Although Galileo is credited with first using the telescope to view space, it was actually invented by a Dutch optician named Hans Lippershey. An optical telescope is a tool that collects light rays using lenses and mirrors. The bigger they are, the "further" the telescope can see.

Today, scientists combine telescopes to make them more powerful, and even send, unmanned telescopes (like the Hubble Space Telescope) out into space.

Spectral Analysis

Scientists use an instrument called a **spectrometer** to examine the light rays from stars. By comparing the patterns of colour in light rays refracted from stars with the colour patterns in light refracted off elements on Earth, they can predict what stars millions of miles away are made of. By analyzing how the light waves change, they can identify how fast and in what direction the stars are moving.

Space Travel

Since first sending an unmanned rocket into space, scientists have been able to find ways to create space shuttles that can go fast enough to reach Earth's orbit or to break free of Earth's gravity and move on to other planets. They have also been able to create equipment that can handle the "extreme" environment of space, and transport people to and from space in relative safety. Astronauts have visited the moon and probes have visited other planets, bringing back or sending back valuable information that teaches us about space. One of the most astounding accomplishments of the 20th century was the establishment of the International Space Station; a "floating" structure that orbits Earth and inside which astronauts will live and study space for long periods of time.

Artificial Satellites and Probes

A satellite is a smaller body in space that orbits a larger one (e.g., Earth's moon). Artificial satellites are man-made for purposes of communication and research. A space probe is an unmanned satellite or remote-controlled vehicle that lands on objects in space that are too difficult or dangerous for humans to get to. Information from satellites and probes is transmitted back to Earth electronically.

Answer the following questions with complete sentences. Where possible, use examples from the previous page to support your answers.

1. Which do you think was more important—Lippershey inventing the telescope or Galileo using it to investigate space? Explain your answer.

2. An *analogy* is a comparison of different things that is used to explain something unknown by showing how it is like something known. Which type of technology is based on an analogy? Explain your answer.

3. What are three things scientists had to learn how to do in order to make space travel possible?

4. How are satellites and probes different from shuttles?

5. Explain how the space station can be considered both a shuttle and a satellite?

Part C: What types of technology have helped us travel into space?

Rockets

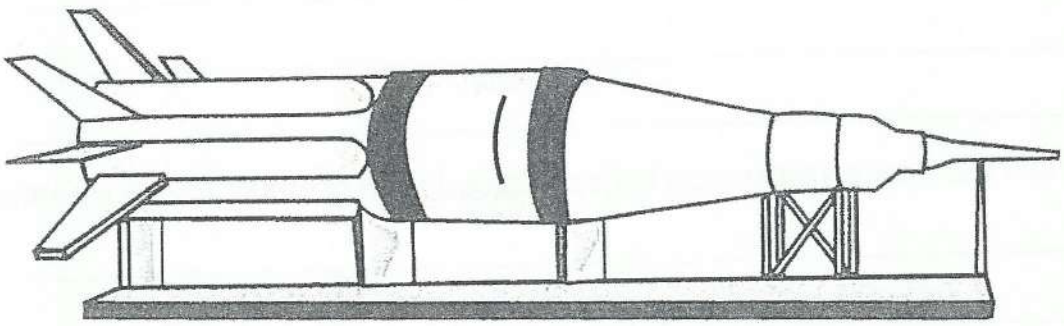
A rocket is a vehicle that carries astronauts and satellites up into space. The propulsion (pushing force) is usually created by burning fuel such as a mixture of oxygen and nitrogen. The gas is then compressed and pushed out of the rocket through its boosters. This causes a reaction that thrusts the rocket forward.

Multi-stage Rockets

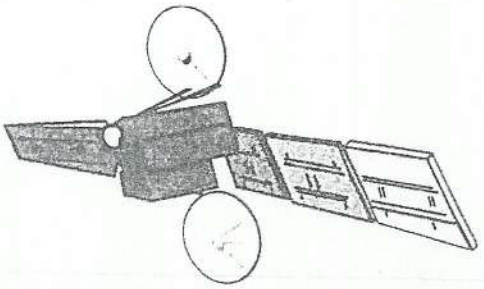
Multistage rockets are made up of two or more sections called stages. Each stage has an engine. Multistage rockets can reach higher speeds because they reduce their weight by dropping stages as the propellant (fuel) in each stage is used up. A three-stage rocket can reach about three times the speed of a single-stage rocket carrying the same amount of fuel.

The first stage is called the booster and it launches the rocket off the ground. Once the first stage burns all of its propellant, the vehicle drops that section and starts burning the fuel in the second stage. The second stage carries the payload (the tip of the rocket that houses the crew) into Earth's orbit or farther into space.

Label the diagram below with the terms **payload**, **second stage**, and **booster** based on the above information.



Part D: What types of technology, developed for space, do we use everyday?



Artificial Satellites

Artificial satellites are objects that are built and sent into orbit by humans. First developed by scientists for exploring space, satellites are now used for everything from weather forecasts and long distance phone calls, to television broadcasts and global location systems.

Computer Technology

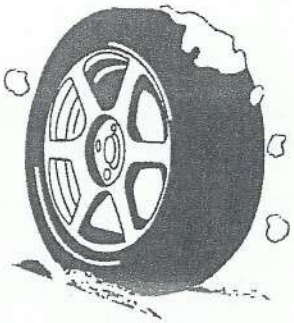
Computer technology originally created for structural analysis of spacecrafts, on-board monitoring and simulated training environments for astronauts is now used in appliances, office equipment, analysis software and virtual reality software.

Consumer Technology

Light weight space foods and insulation materials, created for space travel, have lead to the availability of enriched baby foods, freeze-dried foods and lightweight safety equipment such as bicycle helmets.

Medical and Health Technology

The electronic system designed for the Hubble Space Telescope lead to the development of digital imaging for the detection and treatment of breast cancer. Communications and robotic systems created for work in space lead to the development of voice-controlled wheelchairs.



Transportation Technology

Parachute material developed for Earth landings after re-entry lead to the improvement of traction materials on car's winter tires.

Summarize the information on the previous page in a diagram.

Optional Extension: Research to find other examples of products used everyday that were first created for space travel.

Part E: How is it possible for human beings to survive in space?

Environmental Control and Life Support System (ECLSS)

Human beings need air and water to live and fresh supplies of these are not available in space. To carry great quantities of water or tanks of air up in a space shuttle is not realistic, so scientists have developed ways of filtering, purifying and recycling air and water.

The greatest need for this technology is in the International Space Station because it houses astronauts for months at a time. The space station's ECLSS is made up of two main systems, the Water Recovery System (WRS) and the Oxygen Generation System (OGS).

Water Recovery System (WRS)

A system that filters, purifies and recycles "used" water from handwashing and bathing, toilets (urine) and condensation, so it can be used again. There are strict health standards that must be met in order for the water to be considered safe for reuse.

Oxygen Generation System (OGS)

A system that takes water molecules and breaks them apart into oxygen and hydrogen molecules. The oxygen is put back into the space station's atmosphere and the hydrogen is vented out into space.

The ECLSS is also responsible for filtering carbon dioxide, micro-organisms and dust from the air and venting them out into space, and for maintaining the air pressure, temperature and humidity (air moisture) of the space station.

Identify whether the following statements are **True (T)** or **False (F)** based on the information on the previous page. For the statements you identify as False (F), write the "true" statement on the lines below.

1. _____ Air and water recycling systems are essential on the International Space Station because astronauts have to live there for months at a time.

2. _____ The Water Recovery System recycles water used for washing but not the water in human wastes like urine.

3. _____ The Oxygen Generation System uses water molecules to"create" more oxygen.

4. _____ Two gases vented into space are hydrogen and carbon dioxide.

5. _____ The space station does not have to worry about cleaning dust out of the structure because there is no dust in space.

6. _____ In order for the crew to be safe and comfortable, the air pressure, temperature and humidity must be kept at a stable level.

Part F: What issues are involved with space exploration?

Choose one issue from one of the following topics and complete the organizer on the next page with ideas that support either side of the issue.

Human Health Safety

Should people be allowed to risk their health and lives for little more than an "adventure?"

What if the negative physical effects of space travel aren't realized until years later when many astronauts have travelled in space?

Environmental Concerns

Should the environment in space be protected (e.g., so people are not allowed to make changes to it)?

Should people be responsible for cleaning up "space junk" (the debris left in space from flights)?

Ethical Concerns

Should money and resources be spent on space exploration instead of solving problems here on Earth?

Do we have the right to "use" the things in space or change it to meet our needs?

Is it important to have a "system" to make sure the resources in space are shared equally by all countries?

Political Concerns

Are objects in space things that can be owned?

Who has the right to use the resources in space?

Who has the right to make decisions regarding space exploration?

Choose one issue from the topics on the previous page and complete this organizer with ideas that support either side of the issue and then complete the sentences below.

The issue...

Reason(s) why your position should be supported.

-
-
-
-
-
-

Reason(s) why your position should **not** be supported.

-
-
-
-
-
-

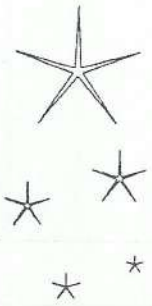
The side that I think has the strongest/best argument...

Action that I think should be taken...

Part G: How is matter distributed in space?

Stars

A star is a hot, glowing ball of gas that gives off incredible light energy. Stars come in many sizes and all the colours of the rainbow. The colour of a star depends on its temperature. The hottest stars are nearly white and the coolest stars are red. Stars evolve (change) over very long periods of time.



Star Systems

A star system is a group of stars held together by gravity.

Galaxies

A galaxy is a group of millions or billions of stars, gas and dust that are held together by gravity. Galaxies can be spiral-shaped, elliptical or irregular (with no specific shape). Our galaxy is called the Milky Way and it is spiral-shaped.

Nebulae

Nebulae are regions in space where there are huge accumulations (build-ups) of gas and dust. Nebulae are where solar systems are born as particles in space become attracted to one another and come together as a central star and the other gas and dust combines to form planets. This can take billions of years.

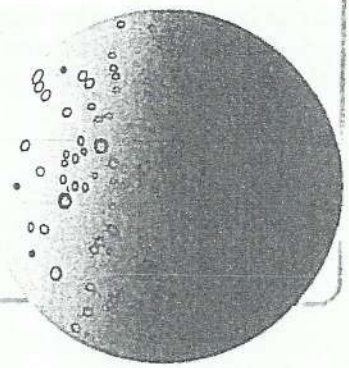
In the space below, draw a diagram that shows how stars, star systems, galaxies and nebulae are related. Use words and graphics in your diagram.

Part H: What are the planets in our solar system?

Mercury

Mercury is the closet planet to the sun and is similar to our moon because it has no atmosphere to protect it from meteors, asteroids and comets that crash into it and mark up the surface. Some parts of Mercury are smooth and this leads scientists to believe that lava flows out of cracks in the planet's crust and then dries hard and smooth.

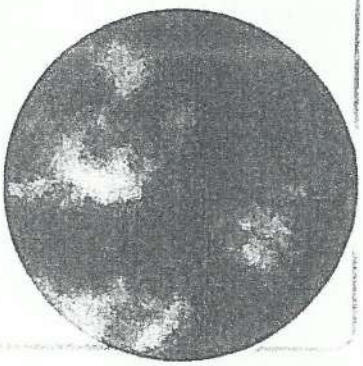
The information scientists know about Mercury, like the fact that the temperature is 400°C in the sunshine and 180°C in darkness, has mostly been learned using telescopes and satellites because humans have not yet found a safe way to get that close to the sun.



Venus

Venus is often called "Earth's Twin" because the two planets are similar in diameter (distance across) and mass and have a similar gravitational pull. Venus, however, is surrounded by a deadly layer of carbon dioxide clouds that rain sulfuric acid. The clouds allow sun rays in but block them from getting out (greenhouse effect), so the temperature on the planet can reach 450°C. An interesting fact that makes Venus unusual is that it rotates from east to west so it's sunrise and sunset are opposite to ours.

The first probe to land on Venus lasted less than an hour before being destroyed by the environmental conditions. Since then, radio waves from a space craft outside the atmosphere have been used to examine the surface of the planet and we now know Venus has giant canyons and extinct volcanoes with ancient lava flows.



Earth

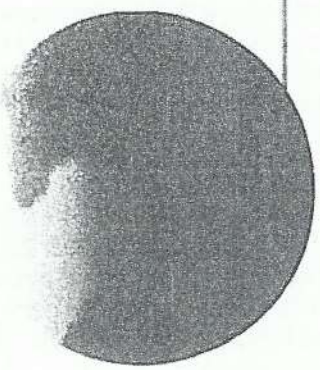
Earth is the only planet in the solar system that has water in all three states (solid, liquid and gas); 70% of the planet is covered with water.

Scientists believe that Earth is the only planet that is close enough to the Sun to be able to use it to support life and far enough from the sun that life is not destroyed by the power of the sun. Earth's atmosphere also provides a protective barrier from the hazards of space. Earth is one of the only planets that has active volcanoes.

Mars

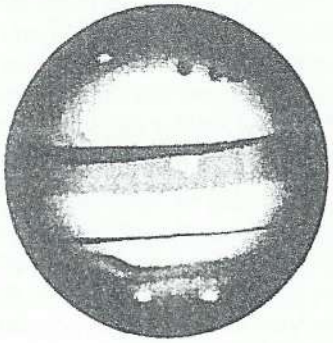
Mars is often called the "Red Planet" because of the iron oxides on its surface that give it an orangey colour. The planet has two polar ice caps and a thin atmosphere. Although Mars is quite cold, at times it can reach up to 16°C.

Mars has been studied through telescopes and by landing robotic probes on the surface of the planet. Mars has two small moons called Phobos and Deimos.



Jupiter

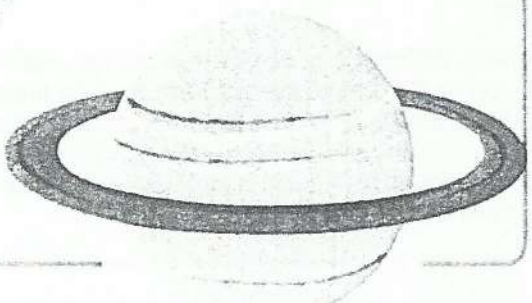
Jupiter is the largest planet in our solar system—so large that it could almost have become a star (like the sun). Jupiter is made mostly of gas and has a large red spot where a constant storm rages in its atmosphere. Jupiter's 16 moons and three rings have been observed through telescopes and by probes that have been sent to the planet.



Saturn

Saturn is the second-largest planet in our solar system and has the most visible rings. The planet's one thousand rings are made of ice and dust that orbit the planet. Saturn is similar to Jupiter because it is also made mostly of gas, but Saturn is unique because it spins so quickly that the planet has winds of up to 1800 km/hour.

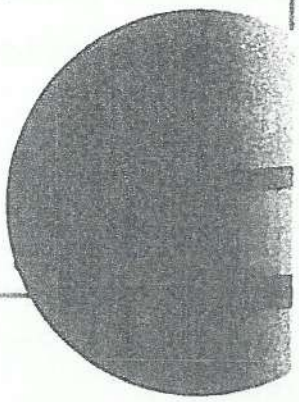
Saturn has been studied through telescopes and by probes flying by the planet. In the near future, a probe will be dropped on one of Saturn's 19 moons.



Uranus

Uranus is made mostly of gas and has an atmosphere of methane that gives the planet a blue colour. Uranus is tilted in such a way that it looks like it is rolling on its axis, although it is actually rotating from east to west.

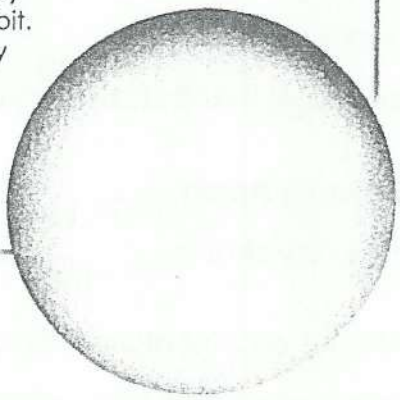
Telescopes, satellites and passing probes have taught scientists what they know about Uranus and its rings and 17 moons.



Neptune

Neptune is very similar to Uranus and was actually discovered by scientists who were investigating the other planet's unusual orbit. It has since been viewed by passing probes. Neptune has many rings as well as eight moons. Its winds are faster than those on Saturn, travelling at 2500 km/hour.

Very little of the sun's energy reaches Neptune; in fact, the planet gives off more energy than it receives.



Pluto

Pluto has (as of yet) only been observed by telescope.

Scientists disagree about whether or not Pluto is actually a planet or a frozen ball of methane gas smaller than our moon. It isn't like the other outer planets that are large and made of gas, and it isn't like the rocky inner planets. Pluto's orbit is slightly different from that of other planets as well. Regardless, Pluto is currently considered the ninth planet in our solar system and has one moon called Charon.

Fill in the blanks in the following sentences that explain how the other planets compare to the planet Earth.

1. Mercury is not very similar to Earth but it is like the ____ (1) because it does not have a protective ____ (2).

2. Venus has a similar ____ (3), ____ (4) and ____ (5) pull to Earth but has a deadly ____ (6) and ____ (7) in the opposite direction to Earth.

3. Mars has ____ (8) like Earth but has ____ (9) moons.

4. Jupiter is much ____ (10) than Earth and is made mostly of ____ (11), although it does have a protective ____ (12) and moons.

5. Saturn is much ____ (13) than Earth and is made mostly of ____ (14). It has very strong ____ (15) and the most obvious ____ (16).

6. Uranus and Neptune have atmospheres of ____ (17) gas that make the planets look blue, whereas Earth looks blue because of it's water.

7. Pluto may not be a planet at all because...

_____

_____