Earth, Moon and our Solar System

Suggested time: 1.25 Hours

What's important in this lesson:

- understand the formation, structure, and nature of our solar system.
- patterns and trends in our solar system.
- the location and movement of planets and satellites in our solar system.

Complete these steps:

1. Complete the Diagnostic/Introductory Activity. Get this checked as being completed on your Course Checklist.

2. Use the textbook, *Science 9 Concepts and Connections* and get started on the student handout. If you are having difficulty with a section, note this in the box below, Questions for Teacher and move on to the next activity in your student handout. You'll need to use the internet for the last page on the student handout.

3. Once the student handout is complete, check your answers **or** have the teacher review your answers with the Answer Key. Get this checked as being completed on your Course Checklist.

4. You'll need at least 10 -15 minutes to complete the quiz on the material you've reviewed today. If you've got at least that much time ask your teacher for the quiz and hand the quiz in when you are done. If you don't have enough time move on to the Reflective Activity and try the quiz next day.

5. Complete the Reflective Activity. Get this checked as being completed on your Course Checklist.

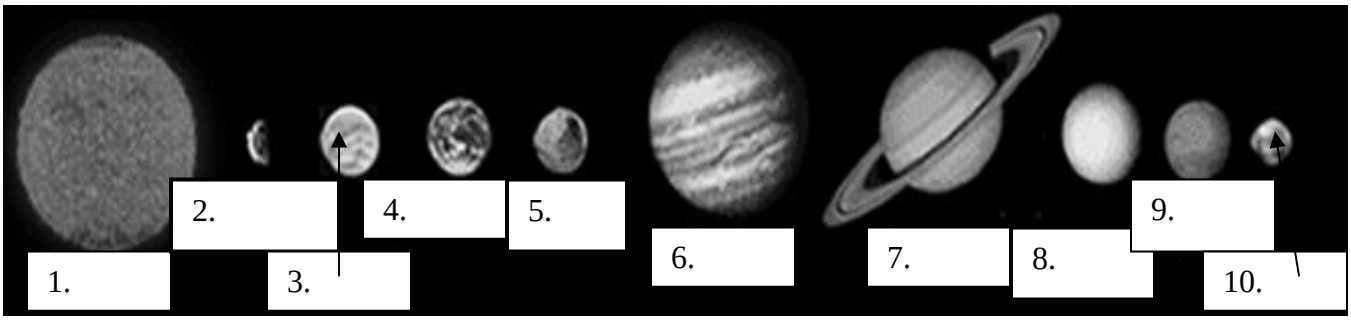
Hand-in the following to your teacher:

1. The lesson quiz.

Questions for the teacher:

Diagnostic/Introductory Activity

The picture below describes the order of planets in our solar system.
With the words provided below, match the Planets and Sun with the corresponding space provided.



A) Mars
B) Mercury
C) Venus
D) Jupiter
E) Pluto
F) Saturn
G) Neptune
H) Uranus
I) Sun

Match the words in column A with the definitions found below. Place the corresponding letter in the space provided.

	Column A	**Column B**
	Planet	
	Terrestrial Planet	
	Satellite	
	Solar System	
	Jovian Planet	

A) A celestial body that orbits a planet; a Moon. Also an object launched to orbit Earth or another celestial body.

B) The Sun together with the nine planets and all other celestial bodies that orbit the Sun and held together by the gravity exhibited by the central star and the planets themselves.

C) A non-luminous celestial body larger than an asteroid or comet, illuminated by light from a star, such as the Sun, around which it revolves. In the solar system there are nine.

D) Any of the four planets, Mercury, Venus, Earth, or Mars, that are nearest the Sun and have similar size and density.

E) Four major planets, Jupiter, Saturn, Uranus, and Neptune, which have very large masses and are farther from the Sun than the terrestrial planets.

Earth, Moon and our Solar System

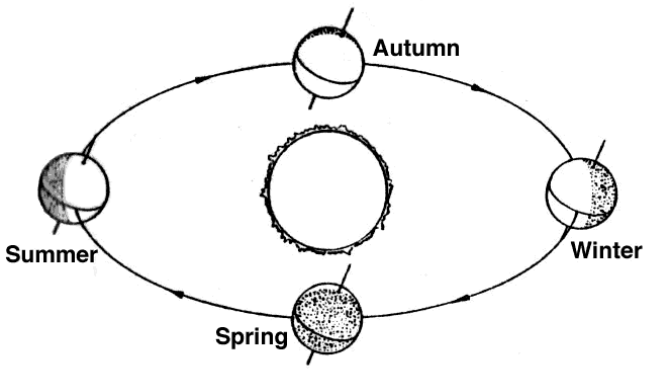
Earth

The Earth is our home, and is the only planet in the solar system with the exact conditions required to support life. The Earth is thought to have formed about 4.6 billion years ago along with the rest of the solar system, but since its beginnings the Earth has been a unique planet. About **71% of the Earth's surface is covered by water**, and is the only planet in the solar system with water in liquid form. Unlike other planets in our solar system, the amount of energy we receive from the Sun generates a climate ideal for life. We experience such diverse weather patterns on Earth because of our atmosphere and the constant circulation of air due to the Earth's rotation. Our atmosphere is unlike any other planets, and has played a role in the Earth's ability to sustain life. The air we breathe is rich in **nitrogen (77%)** and **oxygen (21%)**, unlike the toxic carbon dioxide found on Venus and Mars. Our upper atmosphere blocks harmful radiation from the Sun while still allowing heat to escape, and the weight of the air above us is not heavy enough to crush us as the atmosphere of Venus would. The Earth is dynamic and has been under constant change since its birth; the thick crust of our planet is constantly shifting (plate tectonics), causing Earthquakes and volcanoes to continually reshape the surface. The biological diversity on our planet is incredible, and makes our planet a wonderful place to live.

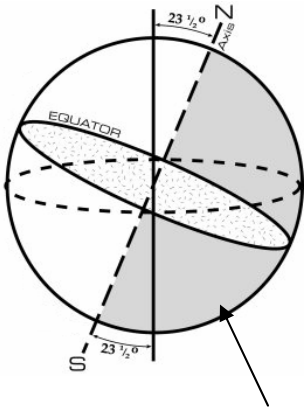
Day and Night and the Seasons

Because we live on the Earth and can study it directly, we know more about our home planet than any other. But before understanding our place in the Universe and the solar system, ancient civilizations had difficulty explaining events such as the day/night cycle, tides, eclipses, and seasons.

Heliocentric model Fig 1.



It is impossible to explain scientifically the causes for the seasons on Earth without the understanding that our planet is in orbit around the Sun **(fig. 1)**. This heliocentric (Sun-centred) model of our solar system helps to explain the seasons on Earth. It is often thought that it is warmer in summer because the Earth is simply closer to the Sun, but our proximity to the Sun does not affect our seasons. The seasons are caused because the Earth is tilted at an angle of 23.5 degrees from the orbital plane while we circle the Sun (**fig. 2)**. Because of this tilt, the **ecliptic** and the **celestial equator** are inclined 23.5 degrees from each other. The progression of the Sun along the ecliptic will cause it to be located north of the celestial Equator for half the year and south for the other half of the year. The Northern Hemisphere experiences the warm temperatures of summer while the Sun is north of the celestial Equator (**fig. 3)**. This is because the Sun travels higher in our sky, and the Northern Hemisphere receives more direct sunlight (and therefore, more intense energy and heat). Our days are also longer

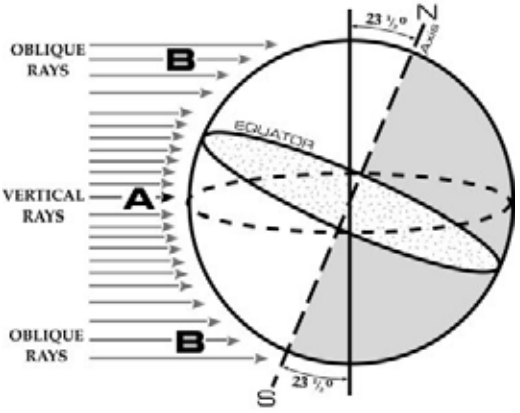


Celestial equator (fig. 2)

during the summer, and the direct sunlight combined with longer days result in warmer temperatures. The point along the ecliptic when the Sun is furthest north of the celestial Equator is called the Summer Solstice and is the longest day of the year in the Northern Hemisphere.

Winter occurs for the exact opposite reason: the Sun is south of the celestial Equator and as a result is far lower in the sky, which results in our receiving less energy from the Sun combined with short days. There is also a Winter Solstice, which is the day (about December 21) when the Sun is furthest south of the ecliptic. It should be noted that when it is winter in the Northern Hemisphere, the Southern Hemisphere is getting the longer days with more direct sunlight, so it is summer there. The rays from the Sun supply most of the heat on the Earth's surface. Some places receive more heat than other places. Some places receive so little heat from the Sun that ice covers them the entire year.

Due to the curved surface of the Earth, some places receive more direct Sunrays than others. The direct Sunrays focus heat on an area. Less heat occurs where the rays are less direct. The drawing to below shows how the more direct rays occur near the Equator **(fig.3)**. Direct rays are also called vertical rays. The term vertical describes rays that are coming from directly overhead. Because the Earth is round, not all of the Sun's rays strike the Earth in a vertical, or direct, manner. These less direct rays are called oblique rays. Oblique rays are spread out when they strike the Earth, and because of this they lose some of their heat. The picture shows that the arrows representing oblique rays are farther apart as they reach the North and South Pole.



Direct Sun and Earths Inclination (fig. 3)

Activity 1:

1. The Polar Axis is shown at a 23½-degree inclination. What other Earth line is shown at 23½ degrees from level? _____.
2. In fig. 3 which pole is receiving the most Sun's rays during winter in Toronto? North _____ or South _____
3. The Sun's rays strike the Earth more obliquely at A _____ or B _____

Latitude	Sun
Equator, 0 degrees	100%
10 degrees latitude	100.5%
20 degrees latitude	98%
30 degrees latitude	92%
40 degrees latitude	82%
50 degrees latitude	67%
60 degrees latitude	59%
70 degrees latitude	49%
80 degrees latitude	41%
90 degrees latitude	37%

- The purpose of the table to the left is to show the amount of the Sun's heat measured at various degrees of latitude. The table assumes that the Equator is receiving 100% of the Sun's heat.
- The tables show that the Sun's rays create more heat in the low latitude zones and less heat in the high latitude zones.
- 10° latitude shows more heat than the amount at the Equator due to drier air at this latitude. Dry air and fewer clouds allow more Sun's rays to reach the Earth's surface at this latitude.
- 90° latitude is the location of the pole. This area received just a little more than one-third (1/3) of the heat that occurs at the Equator.

Furthest from the equator

Use the atlas or class globe to research the answer these questions.

4. Arrange these places in order based on there distance from the Equator. Place 1 in front of the closest location to the Equator. Place 2 in front of the location that is the next closest, complete this ranking by putting the rest in order, and finishing with 8 by the farthest location.

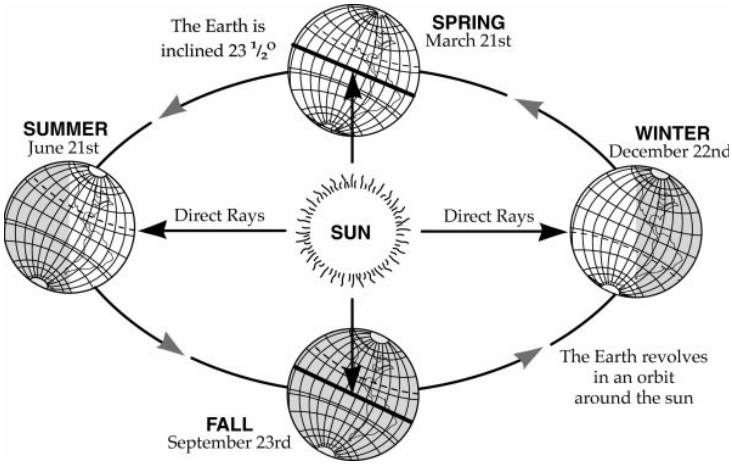
_____ Tokyo, Japan
_____ Lagos, Nigeria
_____ Helsinki, Finland
_____ Pretoria, South Africa
_____ Portland, Oregon
_____ Point Barrow, Alaska
_____ Mexico City, Mexico
_____ Dublin, Ireland

Although many factors contribute to an area's weather and annual average temperature, what general conclusion can be made when you consider each city, average yearly temperature and then compare it to distance from the Equator.

Answer:

_____

Does Earth's tilt contribute to this trend? Yes/No.



Opposite Seasons (Fig. 4)

- In addition to the solstices, which officially mark the first days of summer and winter, there are also two equinoxes. On these two days the Sun is in the sky for 12 hours; these are the only days of the year where day and night are of equal duration

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When it is winter in the Northern Hemisphere it is summer in the Southern Hemisphere. The seasons are exactly the opposite. Look at the drawing again. On June 21st, the Arctic Circle is tilted toward the Sun. This is the first day of summer in the Northern Hemisphere. The Antarctic Circle is tilted away from the Sun. This is the first day of winter in the Southern Hemisphere.

Answer the following:

5. On December 27th, the Arctic Circle is tilted (toward / away) from the Sun.
6. December 22nd is the first day of (summer / winter) in the Southern Hemisphere.
7. What is the first day of fall in the Southern Hemisphere?

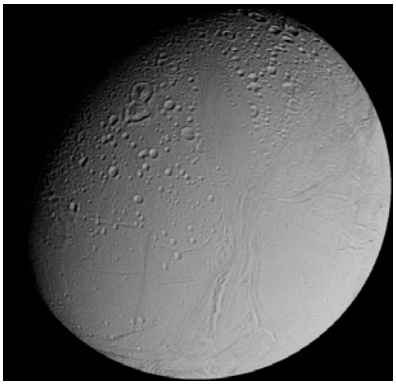
The Earth is vibrant and full of colour, but our closest neighbour in space is a dark and desolate world. Despite its lifeless appearance, the Moon is a significant object in our night sky.

The Moon

There are a few theories about the origin of the Moon, but the collision ejection theory is the most probable. It suggests that the Moon formed when a large asteroid collided with the Earth about 4.6 billion years ago, ejecting molten debris into space which eventually cooled and formed the Moon. Although we will never know for certain the exact origin of the Moon, supercomputer simulations of a collision and the density and composition of lunar rock support this theory, making it the most widely accepted.

The Earth's only natural satellite is the Moon. The Moon's diameter is about a quarter the size of the Earth's, and its mass is about 80 times less. The Moon completes one

orbit of the Earth every 27.3 days (a sidereal month) at an average distance of about 384,400 kilometers from earth. The orbit of the Moon is not perfectly circular, and its distance from the Earth will vary through the sidereal month. Because the Earth is moving in its own orbit around the Sun during the sidereal month, it actually takes the Moon an extra 2 days and 5 hours to return to the same spot in the sky with respect to the Sun. For this reason, the lunar cycle (time for the Moon to go through a complete set of phases), is 29.5 days.



Moon (fig. 5)

Interestingly enough, the Moon has a synchronous orbit, revolving once on its own axis in the same amount of time it takes to orbit the Earth so that we always see the same "face" of the Moon. How did this happen? This occurs because the Earth exerts tidal forces on the Moon, causing its near side to be held in place facing the Earth. We had never seen the far side of the Moon until space probes photographed it for the first time in 1959. It is a common misconception that the far side of the Moon is actually the "dark side of the Moon". In fact, the far side of the Moon gets sunlight just as the near side does; we just can't see it from the Earth.

Interesting Point: The saying "Once in a blue moon" is a referral to when two full moons occur in the same calendar month. Because full moons occur more than 29 days apart, a "blue moon" could only occur on the 30th or 31st day of a month.

Activity 2:

Fill in the blank

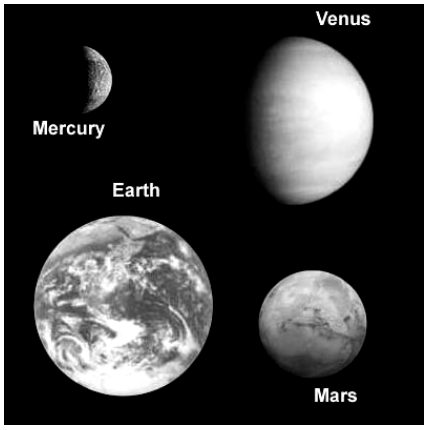
Complete each statement using a term or terms from your reading. Write your answer in the spaces provided.

Earth's only natural satellite is the _____ .
The Moon's rotation is in _____ with Earth's rotatation.
The full lunar cycle takes _____ days.
The lunar orbit is not perfectly _____,
The Moon's synchronous orbit helps explain the _____ side of the Moon. (never seen it from Earth).

Planets - General Characteristics

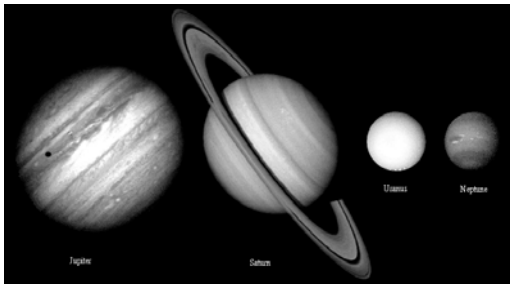
A planet is an object which orbits around a star and which does not produce its own energy; instead it is illuminated by reflected sunlight. The Earth is one of nine planets held in orbit around the Sun by the Sun's gravity. Because they are relatively close, many of the planets in our solar system appear brighter than the brightest stars, but they do not twinkle like a star. Our turbulent atmosphere causes the pinpoint of light from a star to shimmer, but planets appear as a tiny disk and are not as affected by the atmosphere. Planets are much smaller than the stars. In fact, the Sun composes 99.9% of the mass in the solar system and dictates the motions of the planets.

The planets have been placed in two main categories: solid and gaseous. Solid planets are relatively small and are composed of dense rock, often rich in iron. Gaseous planets are larger and have thick outer layers of hydrogen gas with small rocky cores. In our solar system, the four inner solid planets are known as **terrestrial planets** because of their resemblance to the Earth (**fig. 6)**. Mercury, Venus, the Earth and Mars are situated closest to the Sun and therefore, receive the most energy. They have solid surfaces with thin atmospheres and have high densities.



Terrestrial Planets (fig. 6)

Much further from the Sun lie the gaseous planets in the solar system. Jupiter, Saturn, Uranus and Neptune are labeled the **Jovian planets**, and are much larger than the terrestrial planets **(fig. 7)**. Their interiors contain a small rocky core surrounded by liquid hydrogen, and have strong magnetic fields and rapid rotation rates. It would be impossible to stand on a Jovian planet as they have no solid surface; the surface we see are gases covered by a thin upper layer of hazy clouds. The huge mass of these gaseous giants also creates a large gravitational field which has created ring systems around all four planets (Saturn's are the most well known) and numerous captured moons.



Jovian Planets (fig. 7)

A planet's moons are known as **satellites**, and are pieces of rock pulled in by the planet's gravity. The solar system has 98 known satellites including our Moon, and 94 of these are in orbit around the four Jovian planets. Pluto is the furthest planet from the Sun and does not adequately fit into either category of planet as it is a small mass of ice. It is thought that Pluto may be a captured comet, and scientists debate whether or not its status as a planet is justifiable due to its small size and irregular characteristics.

Because of the various masses and gravitational forces of the various planets, your body weight varies. This direct relationship between force and mass can be calculated when gravitational force and mass are known.

Activity 3:

In the following chart calculate your weight based on the gravitational force of the various planets: The given examples are for a 200lb male student.

Planet	Multiply your Earth weight by:	Your "new" weight
Mercury **(example)**	0.4	0.4 x 200lbs = **80lbs** new weight
Venus **(example)**	0.9	0.9 x 200lbs = **180lbs** new weight
Earth	1	
Moon	0.17	
Mars	0.4	
Jupiter	2.5	
Saturn	1.1	
Uranus	0.8	
Neptune	1.2	
Pluto	0.01	
Sun	28	

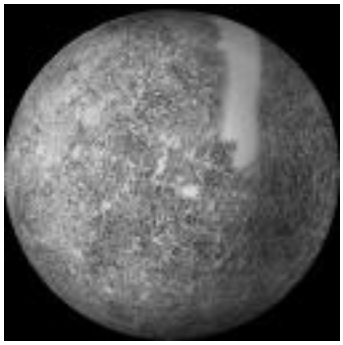
Your age differs through out our solar system as well. Since our year is defined as 365 days (time to revolve around the sun), your age would change based on earth's definition. In the following chart recalculate your new age based on each individual planet's rotation around our Sun. The given examples are for a 15 year old student.

Terrestrial Planets	Approximate length of year (orbit the Sun):	Your "new" age
Mercury **(example)**	88 Earth days	365 divided by 88 = 4.15, therefore your new age would be, 4.15 x 15(age) = **62 years old** on Mercury.
Venus	225 Earth days	
Earth	365 Earth days	
Mars	687 Earth days	

Outer Planets	Approximate length of year:	Your "new" age
Jupiter	12 Earth years	You must first determine how many days are in a Jupiter year, 12 x 365(days) = 4380 (days in Jupiter year), therefore, 365 divided by 4380 = .083 therefore, .083 x 15(age) = **1.25 years old** on Jupiter
Saturn	29.5 Earth years	
Uranus	84 Earth y*ears*	
Neptune	165 Earth years	
Pluto	248 Earth years	

Mercury (terrestrial planet)

The closest planet to the Sun is Mercury, a small and barren planet. It appears much like our Moon: grey and pocketed with thousands of impact craters **(fig. 8)**. There is no appreciable atmosphere on Mercury to protect it from small meteorites, and the absence of an atmosphere also affects the surface temperature. The face of Mercury nearest the Sun gets direct and intense sunlight, and as a result temperatures soar to 700K. But without an atmosphere to retain and disperse heat, the temperature drops to 100K in the absence of sunlight, creating the greatest temperature range of any planet. Mercury's proximity to the Sun causes it to race around its orbit in a mere 88 days, the fastest orbital period of any planet. A telescope will reveal only a hazy disk with very few surface features. The first detailed images of Mercury's surface came in 1974, when the spacecraft Mariner 10 traveled to the planet. It is the only probe to visit Mercury, and because it could not take images of the dark side we still do not have an image of the entire surface.



Mercury (fig. 8)

Venus (terrestrial planet)

Venus is the brightest object in the sky other than the Sun and Moon **(fig. 9)**. Venus is often called our sister planet, because it is the closest planet to the Earth and its diameter and density are very similar to the Earth's. Venus is, however, a planet unlike ours in many respects. Venus has a dense atmosphere of carbon dioxide which covers the entire planet with thick clouds. The clouds create a greenhouse effect, trapping heat from the Sun and raising the temperature to 750K, the hottest planetary surface in the solar system. The surface of Venus is extremely hostile and cannot support life for a variety of reasons. The thick clouds block out sunlight and contain droplets of concentrated sulphuric acid. The atmosphere is so dense and heavy that the pressure at the surface is 90 times that on Earth.

Venus (fig.9)

Through a telescope, Venus is brilliant because the atmosphere reflects more sunlight than any other planet. Surface features on Venus are not visible because the thick clouds obstruct our view. Equipped with radar, spacecraft in orbit around Venus successfully probed the surface between 1983 and 1995 and gave us a detailed topographical map of nearly the entire planet. Most of Venus is a huge and remarkably flat plain, while the remainder of the surface is raised with gently rolling hills and large volcanoes and lava domes. The volcanoes may still be active, contributing to the acidic content in the atmosphere. Several spacecraft from the former Soviet Union have landed on the surface of Venus, revealing a surface composition much like the basalt lava rocks on the Earth and Moon. These probes only operated for a short time, the first for a few seconds, before they succumbed to the harsh conditions on the surface. It takes Venus almost 225 days to complete one orbit of the Sun, but one revolution on its own axis is backwards and takes 243 days.

Earth (see above, terrestrial planet)

Mars (terrestrial planet)

Mars is the last inner planet but is the closest of the superior planets to the Earth and shines deep red in our sky. Mars has several characteristics similar to the Earth, a fact which led to early beliefs that the planet was home to alien life. Through large telescopes, Mars exhibits linear features which were speculated to be irrigation systems build by Martians, but we now know these features are natural landforms. The topography of Mars includes huge canyons, extinct volcanoes, craters and polar ice caps composed of ice and frozen carbon dioxide **(fig. 10).** The largest volcano on Mars is **Olympus Mons,** the largest mountain in the solar system with an altitude of 25 kilometres above the surrounding terrain, and a base of about 700 kilometres across. (The Earth's largest mountain, Mt. Everest, has an altitude of just under nine kilometres above sea level.)

Mars (fig.10)

The surface features of Mars are occasionally blanketed in huge dust storms which can hide vast regions from our view. The interior of Mars is believed to be composed of a small iron core, but the planet does not exhibit a magnetic field. Mars is the only interior planet other than the Earth to have satellites. Its two satellites, Phobos and Deimos, are only several kilometres across and appear to be captured asteroids. Mars appears as a small red disk through telescopes, and features on the surface -- especially the white ice caps -- are best viewed every two years during opposition, when it is at its closest to the Earth.

Mars has an average surface temperature of about -40 degrees Celsius (230K), and because Mars is tilted like the Earth it also experiences climactic and seasonal changes. The Martian atmosphere is extremely thin and is composed primarily of carbon dioxide, contributing to the belief that life forms needing oxygen to survive cannot currently exist on Mars.

Because of the **possibility of past life on Mars**, it has been studied extensively by telescopes and spacecraft which have orbited the planet and landed on its surface. Much of our knowledge of the red planet has come from spacecraft, and future probes to the planet may be able to answer more questions about its history and present.

Activity 4:

Fill in the Blank

Complete the statement using a terms from the list below. Write your answer in the spaces provided. Some words may be used more then once.

Mercury	Earth	Liquid
Venus	Mars	Viking
Terrestrial	Mariner	Moon

1. _____ is the closest planet to the Sun.
2. Mercury is similar to Earth's _____ .
3. Mercury, Venus, Earth and Mars are _____ planets.
4. _____ and _____ are about the same size.
5. _____ was a spacecraft that studied Mercury.
6. _____ has a very thick atmosphere.
7. _____ is the only planet known to have life on it.
8. On Earth, water is usually found as a _____.
9. _____ is a red planet.

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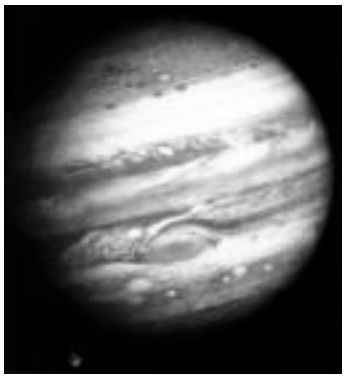
Jupiter (Jovian planet)



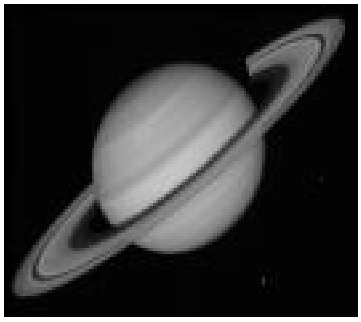
Jupiter (fig. 11)

The first of the gaseous giants is the largest planet in our solar system, Jupiter. Jupiter is over 11 times the diameter of the Earth and has a mass 2.5 times that of all the other planets combined **(fig. 11).** This giant is composed almost entirely of hydrogen (82%) and helium gas (17%). There is no solid surface on Jupiter; instead the surface consists of a dense atmosphere topped with a layer of colourful clouds about 100 kilometres thick. The clouds are made up of bands running parallel to the equator, ranging from white to dark reddish brown, their colour arising from chemical reactions within the clouds. Storms are constantly forming and dissipating, but the Great Red Spot has been a huge storm visible for hundreds of years. It is about three times the size of the Earth and is the most recognizable feature on Jupiter, visible even in amateur telescopes.

The interior of Jupiter is most likely composed of a small metallic core surrounded by liquid hydrogen. Currents within the layer of liquid hydrogen cause a strong magnetic field which shields Jupiter from the solar wind. Jupiter's core is most likely around 25000K and is slowly cooling, compared to only about 110K at the surface.

Four spacecraft have visited Jupiter, two fly-bys by Pioneer in 1974 and two by Voyager in 1979. The probes obtained high resolution images of Jupiter and gave scientists valuable information about the planet and its intricate atmosphere of clouds. One discovery was that Jupiter has a thin and delicate ring structure which is not visible from the Earth. The probes also detected many satellites, and we now know of 28 moons in orbit around Jupiter. Many of the satellites are very small and resemble asteroids, but four of the moons are among the largest in the solar system and were discovered by Galileo Galilei in 1610. These are the four Galilean moons, **Ganymede, Callisto, Europa and Io.**

Saturn (Jovian planet)



Saturn (fig. 12)

The second largest planet and the second gaseous planet is Saturn, best known for its beautiful ring system. Saturn's rings are composed of millions of highly reflective pieces of ice and rock measuring between a millimetre and several metres across **(fig. 12).** The rings are less than a hundred metres thick but extend thousands of kilometres from Saturn's surface. Earth-based telescopes clearly show the rings, but it was not until Voyager 2 passed by that scientists learned the rings were composed of thousands of small and narrow rings, known as ringlets. The ring system extends from the cloud tops of Saturn's atmosphere to hundreds of thousands of kilometres beyond the planet, but only two broad portions of the rings are bright enough to be clearly visible from the Earth. It is believed that the rings were formed when a large rocky object or comet came too close to Saturn, and its gravity broke the object apart into millions of pieces.

Saturn is composed mostly of hydrogen and helium gas (88% and 11% respectively), and appears pale yellow in colour. Saturn has few atmospheric features because the temperature is too low to induce the chemical reactions that produce the colours on Jupiter, and is also covered in a thin layer of haze which obstructs our view of any detail. Like Jupiter, Saturn has a rapid rate of rotation which contributes to the formation of severe storms in its cloud layer, with wind speeds of up to 1400 kilometres per hour. Saturn has the lowest density of all the planets -- so low, in fact, that **Saturn could float in water!** It is because of its low density that a person would weigh less on the surface of Saturn than on Earth, despite its high mass. In addition to its ring system, Saturn has a vast number of satellites. A few of Saturn's 30 known moons orbit within the rings, the largest is **Titan**.

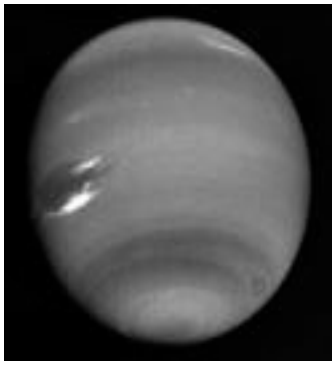
Uranus (Jovian planet)

Uranus (fig. 13)

The solar system was thought to end at Saturn until Uranus was discovered with a telescope in 1781. Uranus is barely visible to the naked eye under ideal conditions, and although plotted on several earlier star maps it was mistaken as a star **(fig. 13).** Uranus is about four times the size of the Earth and has a large mass, but also has a low density. It is composed mainly of hydrogen and helium gas with an upper atmosphere containing hazy clouds of frozen water and methane, giving the planet a greenish-blue colour. The observations of Voyager 2 in 1986 did not reveal any surface features or cloud formations, showing Uranus as a plain sphere of gas.

Uranus is very unique in that its axis is tilted 98 degrees from vertical, meaning it rotates on its side. The orbital period of Uranus is nearly 84 years, meaning that although the planet rotates on its own axis in 17 hours, it is almost 84 years between sunrises at the poles. Uranus also has nine thin rings around it, which were discovered in 1977 from the Earth. They are not visible from the Earth, but caused a background star to flicker as the rings passed in front of it, allowing astronomers to detect their presence. There are 21 known satellites in orbit around Uranus, the largest being **Titania**. The large moons have interesting landforms and show evidence of geological formation in the past, as well as lava flows which have partially covered numerous impact craters.

Neptune (Jovian planet)



Neptune (fig. 14)

The last of the Jovian planets is Neptune, which was discovered in 1846. Neptune is in many ways very similar to Uranus; the two planets have nearly the same size and mass, and both appear greenish-blue because of the methane in their upper atmospheres, although Neptune is a deeper blue **(fig. 14).** Neither Uranus nor Neptune can be viewed in any detail from the Earth, so our knowledge of these outer gaseous planets is limited.

Much of the information we have was also gathered from the spacecraft Voyager 2. The clouds on Neptune had slight patterns of blue bands when Voyager passed the planet in 1989, and like all gaseous planets, Neptune experiences a high wind speed in its upper atmosphere. Voyager photographed a large storm on Neptune much like the Great Red Spot on Jupiter, which has been called the Great Dark Spot and may still be an active storm. Neptune has a clumpy and thin ring system of a few rings, discovered by the Voyager probe and undetectable from Earth. Neptune has 15 known satellites, **Triton** being one of the largest in the solar system. Triton has a small atmosphere of nitrogen and is geologically active with volcanoes on its surface.

Pluto (Jovian planet)

Pluto is a distant and unique planet that was discovered in 1930. Pluto is usually the furthest planet from the Sun, but because it has an elliptical (non-circular) orbit, it was actually closer to the Sun than Neptune between 1979 and 1999. Pluto is on average 40 times further from the Sun than the Earth, but at its furthest will be nearly 50 times further. The orbital period of Pluto is **248 years**.

Pluto is a small, rocky planet composed mainly of ice, and resembles the icy satellites of the Jovian planets **(fig. 15).** From the Earth, Pluto does not appear as anything other than a point of light except in the largest telescopes in the world, which resolve a fuzzy dot. Pluto is the smallest planet, even smaller than Earth's moon, and because it is furthest from the Sun it is the coldest planet with a surface temperature of only about 50K. Despite its small size, Pluto has a relatively large moon which was detected in 1978. **Charon** is half the size of Pluto and the two bodies orbit extremely close to each other. It could be said that Pluto and Charon are a double planet system because they are in an orbit around each other rather than Charon being in orbit around Pluto.

Pluto (fig. 15)

Because of Pluto's unique characteristics, it is believed that it may be a captured comet or a satellite of one of the planets that possibly escaped in a collision with another object. It has been widely debated as to whether Pluto should remain a planet, or whether it should be reclassified. Pluto has yet to lose its status as a planet, due possibly to the daunting task of rewriting astronomy books everywhere.

Activity 5:

Fill in the Blank

Complete the statement using a terms from the list below. Write your answer in the spaces provided. Some words may be used more then once.

Pioneer	Jupiter	Neptune	gaseous planets
Voyager 2	Saturn	Uranus	Pluto

1. _____ is the largest planet.
2. The first planet known to have rings was _____ .
3. _____ and _____ are bluish in colour.
4. Neptune, Uranus, Jupiter and Saturn are _____ .
5. In 1998,_____ was the farthest planet from the Sun.
6. _____ is usually the farthest planet from the Sun.

7. _____ and _____ are spacecraft that flew by Jupiter and Saturn.

8. _____ also flew by Uranus and Neptune.

9. _____ is the smallest planet.

Summary

Ancient civilizations knew of six planets that traveled among the stars in the sky. They took detailed observations of their motions and knew a great deal about them. They realized that the planets did not generate their own light, but simply reflected sunlight. The distances and masses of the planets were accurately calculated using Newtonian physics, and many of the physical properties of the planets could be calculated mathematically. It wasn't until the invention of the telescope, however, that details of the planet's appearances became known. The telescope allowed astronomers to discover the two planetary types: terrestrial and Jovian. Three new planets were discovered and with the discovery of the Galilean satellites of Jupiter, it was revealed that other planets had moons like the Earth. As technology was enhanced, telescopes became more powerful and we learned more about the solar system.

Mercury is the closest planet to the Sun, and although it has the greatest temperature range of any planet, it is not the hottest. Venus, the brightest planet in our sky, has a thick atmosphere which traps radiation from the Sun and causes the surface temperature to raise high enough to melt lead. Venus also rotates backwards and has the slowest rotation rate of any planet. Mars, whose red surface covered in subtle landforms, was long thought to harbour life forms. With the landing of probes on the surface, we realize that this red planet does not support intelligent life, but there is the possibility of bacterial organisms in the layer of permafrost under the surface. Jupiter is the largest planet, a huge sphere of gas that has a surface of active and colourful bands of cloud. There are many storms on Jupiter, including the **Great Red Spot**, a massive storm that has been raging for years. The first satellites to be discovered in orbit around another planet were the four Galilean satellites around Jupiter, discovered by Galileo in 1610. Also discovered by Galileo and his telescope (although not understood) were the rings of Saturn. The extensive arrangement of thousands of ringlets around Saturn is an incredible sight in any telescope. Although only about a hundred metres thick, two of the broad rings can be detected easily from the Earth. In addition to its rings, Saturn currently has the most satellites of any planet with 30, the largest being the clouded Titan. Uranus and Neptune both appear greenish blue, and are very similar in size and composition. The furthest planet from the Sun, Pluto, is a small and cold world. It has a very irregular orbit, and could be a dead comet or an escaped moon from one of the Jovian planets.

Assessment and Evaluation: Unit 4 Lesson 2

Determine the scaled down value in column C, round up or down your new planet diameters. Choose a common object of similar size, and place your answer in column D. An example is given for Mercury.

A	B	C	D
Planet	**Actual Diameter (km)**	**Scale diameter (mm) 1000km = 1mm**	**Choose a common object of similar size**
1. Mercury **(example)**	4880 km	4880 divided by 1000 = **5 mm**	**Diameter of green pea**
2. Venus	12 100 km		
3. Earth	12 750 km		
5. Mars	6790 km		
6. Jupiter	142 800 km		
7. Saturn	120 700 km		
8. Uranus	50 800 km		
9. Neptune	48 600 km		
10. Pluto	2300 km		
11. Sun	1 400 000 km		

Questions

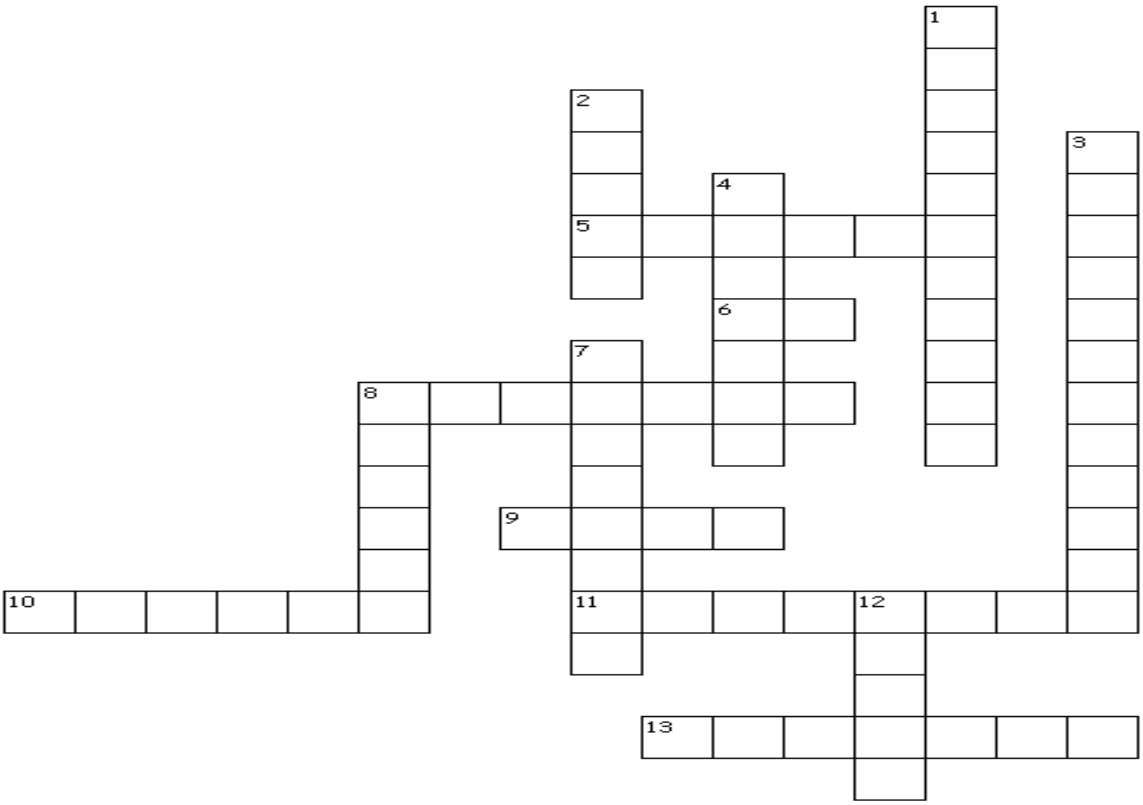
1. How many times larger is Jupiter than Earth? _____.
2. Which planet is closest in diameter to Earth? _____.

While using the reading, match each term in column A with its description in column B. Write the correct answer in the space provided.

Answer	Column A	Column B
	1. Titan	A. Saturn
	2. Titania	B. Mars
	3. Charon	C. Saturn
	4. Ganymede, Callisto, Europa and Io	D. Pluto
	5. Beautiful ring system	E. Moon of Uranus
	6. Possibility of life	F. Moon of Neptune
	7. Orbital period of 248 years	G. Largest mountain in solar system
	8. Triton	H. Moon of Pluto
	9. Planet could float in water	I. Four Galilean moons
	10. Olympus Mons	J. Moon of Saturn

Earth, Moon and our Solar System

Complete the following crossword based on the reading from the lesson:



Across
5. plain sphere of gas
6. Moon of Jupiter
8. 11 times the mass of Earth
9. 80% less mass than Earth
10. planet with the most satellites
11. tilted 23.5 degrees
13. deep blue planet

Down
1. grouping of rocky planets
2. Earth's sister planet
3. Sun centered model
4. first detailed images of Mercury
7. 77% of Earth's atmosphere
8. grouping of gaseous planets