

Unit 1:

The Earth in the Universe



1. The Universe

- 1.1. First ideas about the Universe
- 1.2. Components and origin
- 1.3. Sizes and distances

2. The Solar System

3. The planet Earth

- 3.1. Movements of the Earth
- 3.2. The seasons

4. The Earth and the Moon

Think and answer?

- a. What is the difference between a star and a planet?
- b. Name the planets of the Solar System
- c. What are the causes of the existence of the seasons?
- d. When does a solar eclipse occur?

UNIT OBJECTIVES

In this unit you will learn:

- To describe the ancient and modern model about the Universe
- To distinguish the components of the Solar System
- To enumerate the special characteristics of the Earth planet
- To identify the different spheres of the Earth
- To describe the effects of the Moon over the Earth

1. The universe

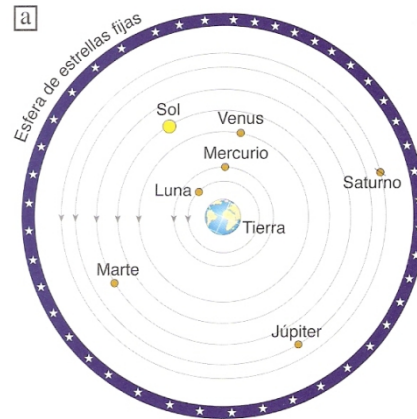
1.1. First ideas about the universe

Historical theories to explain the structure of the Universe are two:

- **Geocentric theory**

It was proposed by ancient greeks and later modified by Ptolomy in the 2nd century AD.

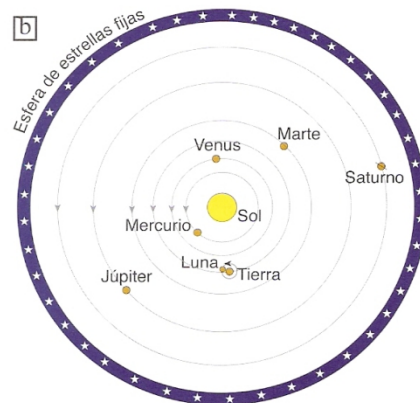
This theory says that the Earth stays in the center of the Universe and the stars, the Sun, the planets and the Moon revolve around it.



- **Heliocentric theory**

It was enunciated by Nicolas Copernicus in 1543.

This theory says that the Sun stays in the center of the Universe and the stars, the Earth and the planets revolve around it. The Moon revolves around the Earth.



Nowadays we know that both models are wrong.

Neither the Earth nor the Sun are in the center of the Universe at all, but it is true that the Earth and the rest of planets revolve around the Sun and the Moon revolves around the Earth.

READING ACTIVITIES

After read the text, copy and answer the following questions on your notebook:

Remember: you must make complete sentences.

1.1. What is the difference between the heliocentric theory and the geocentric theory?

1.2. Which of them is older? What is wrong in both?

1.3. Who enunciated the geocentric theory? And the heliocentric theory?

1.4. What celestial body does the Moon orbit in every theory?

1.2. Components and origin of the universe

The **Universe** is all the matter, energy and space that exist.

The theory which explains its origin is called the **Big Bang**. According to this theory a giant explosion created the Universe. Matter, at very high temperature, expanded and got cooler to form huge clouds of gases called **nebulae**.

Those nebulae developed into **galaxies** formed by thousands of millions of **stars**. The Universe is made up of **galaxies**. Galaxies are made up of stars, interstellar dust and gases. They are separated by enormous distances and are grouped in **galaxy clusters**.

Our galaxy is the **Milky Way**. It is a spiral galaxy with four arms. It belongs to the **Local Group** galaxy cluster.

Stars are celestial bodies which emit their own light. They are made up of hydrogen (H) and helium (He). Their temperature is very high and their nucleus suffers nuclear reactions which release a large amount of energy, light and heat into the space.

A galaxy can have between 100,000 and 500,000 millions of stars. Among them, there are huge clouds of gases and interstellar dust. Our star is the **Sun** and it is located in one of the arms of the Milky Way.

Many stars have **planetary systems**. Our planetary system is the **Solar System**. It is made up of eight planets. **Planets** are bodies which orbit a star. Our planet is the **Earth**.

Some planets have **satellites**. They are bodies which orbit a planet. The Earth has one natural satellite, the **Moon**.

READING ACTIVITIES

After read the text, copy and answer the following questions on your notebook.

Remember: you must make complete sentences.

1.5. Which are the main components of the Universe?

The main components of the universe are...

1.6. Indicate the name of:

- Our galaxy *The name of our galaxy is...*
- Our star
- Our planetary system....
- Our planet
- Our satellite

1.7. Define:

- Universe *The Universe is...*
- Star
- Planet
- Satellite

1.8. What is the theory that explains the origin of the Universe?

How it do it?

1.3. Sizes and distances in the Universe

Distances in the Universe are so large that astronomers have to use special units to measure them.

Usually they use one of these units:

- **Astronomical unit (AU)**

This is the distance from the Earth to the Sun.

It is approximately 150 million kilometers.

It is used to measure distances within the Solar System.

- **Light-year**

This is the distance that light travels in one year.

Speed of light is 300.000 km/s.

It is used to measure distances between stars or galaxies.

CALCULATING ACTIVITIES

After read the text, copy and answer the following questions on your notebook.

Remember: you must extract *data*, develop *operations* and give a *solution*.

1.9. Calculate how many kilometers is one light-year.

**1.10. Alpha-centauri is the closest star to the Sun. It is 4.2 light-years from it.
Express this distance in kilometers.**

1.11. Mercury is 0'39 AU from the Sun. How many kilometers is this distance?

2. The Solar System

The Solar System was formed approximately 4,500 million years ago, when a nebula collapsed by gravity. It is made up of the **Sun**, eight **planets** with their **satellites**, **dwarf planets** and small bodies called **asteroids** and **comets**.



a) The Sun

The Sun is a yellowish medium-sized star. It is made up of hydrogen and helium. The nuclear reactions taking place in its core produce a huge amount of energy, light and heat.

b) The planets

They are spherical-shaped celestial bodies which revolve around the Sun. They are divided into two groups:

- **The inner planets**

They are the four planets closest to the Sun: **Mercury, Venus, the Earth and Mars**.

They are also known as terrestrial or rocky planets because of their composition and structure.

They have a crust and a mantle of rock and a core of metal. Their atmospheres are very light.

The Earth and Mars have one and two satellites respectively, while Mercury and Venus do not have any.

- **The outer planets**

They are the four planets farthest from the Sun: **Jupiter, Saturn, Uranus and Neptune**.

They are also known as gas giants because they have a very thick and dense atmosphere with a small nucleus.

All of them have many satellites.

c) Other celestial bodies

There are other celestial bodies orbiting the Sun:

- **Satellites**

They are rocky bodies which revolve around a planet.

They can be very large or very small and their shape can be spherical or irregular

Dwarf planets

They are small and round rocky bodies which have not cleared their orbit around the Sun of other similar bodies. Some of them are Pluto, Ceres, Eris, etc.

Asteroids

They are rocky and irregular shaped bodies. Their size goes from few meters to hundred kilometers in diameter. Some asteroids orbit around the Sun between the orbits of Mars and Jupiter and form the *Asteroid belt* and others orbit beyond the orbit of Neptune and form the *Kuiper belt*.

Comets

They are small and irregular bodies which travel around the Sun in highly elliptical orbits. They are formed in a very far region around the Solar System called the *Oort cloud*. They have a nucleus of ice, dust and gas. When comets travel close to the Sun, ice starts to evaporate, creating a long and bright tail.

READING ACTIVITIES

After read the text, copy and answer the following questions on your notebook.

2.1. Explain which is the main difference between:

- the inner and the outer planets
- asteroids and comets
- planets and dwarf planets

2.2. Look at the following chart about the main characteristics of the planets of the Solar System and answer the questions:

	INNER PLANETS			
	Terrestrial or rocky planets: the crust and mantle are made of rock. The core is metallic			
	Mercury	Venus	Earth	Mars
Diameter (Earth = 1)	0.382	0.949	1	0.532
Diameter (km)	4,880	12,104	12,740	6,794
Average surface temperature (°C)	-180 to 430 °C	465 °C	-89 to 58 °C	-82 to 0 °C
Atmosphere	none	CO ₂	N ₂ +O ₂	CO ₂
Satellites	0	0	1	2
Rings	no	no	no	no
Interesting characteristics	the smallest and closest to the Sun	rotates in opposite direction	the only planet with life	very thin atmosphere

OUTER PLANETS			
Gas giants: they consist mainly of gases			
Jupiter	Saturn	Uranus	Neptune
11.209	9.44	4.007	3.883
142,984	120,536	51,118	49,492
-150 °C	-170 °C	-200 °C	-210 °C
H ₂ +He	H ₂ +He	H ₂ +He	H ₂ +He
67	62	27	14
yes	yes	yes	yes
largest planet, most satellites	system of rings	rotational axis is almost horizontal	greatest distance from the Sun

CO₂ = carbon dioxide

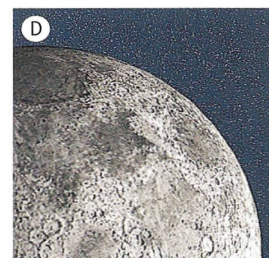
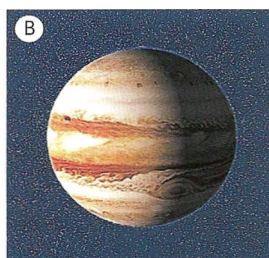
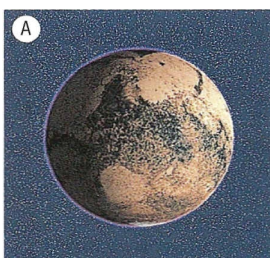
N₂ + O₂ = nitrogen + oxygen

H₂ = hydrogen He = helium

- Which planet is the smallest?
- Which planet has the least satellites?
- Which planet has a horizontal axis?
- Which planet is the farthest to the Sun?

- Which planet has an atmosphere with oxygen?
- Which planet has the lowest surface temperature?
- Which planet has the highest surface temperature?
- Which planet has the biggest rings?

2.3. Identify the following pictures:



3. The Earth planet

The Earth is a very special planet. It is the only planet that is able to support life, because it has some unique characteristics:

- Its **atmosphere** contains oxygen (O₂) and carbon dioxide (CO₂) that are essential gases of photosynthesis and respiration.
- The **temperature** on its surface is about 15°C, because of the distance from the Sun and the composition of the atmosphere.
- Water exists as ice, liquid water and water vapour. It makes the **water cycle** possible.
- The Earth has a **magnetic field** which protects the surface from solar radiation.
- The **Moon** is a very large satellite that is responsible for tides.
- It has **geological activity** (volcanos, earthquakes, etc)

READING ACTIVITIES

After read the text, copy and answer the following questions on your notebook:

Remember: you must make complete sentences.

3.1. Mark the characteristics that make the Earth a habitable planet.

- a. There is liquid water.
- b. It is near the Sun.
- c. Most of the planet is covered by water.
- d. The atmosphere is rich in nitrogen.
- e. There are night and day, and seasons.
- f. The temperature is about 15°C
- g. It is very big.
- h. There is solar radiation that gives light and heat.
- i. It has a magnetic field that protects it.
- j. It has an atmosphere with oxygen and carbon dioxide

3.2. The distance of Venus and Mars from the Sun makes life possible, but neither have living beings. Look the chart that summarises the characteristics of both planets in the activity 2.2. and explain why they do not support life.

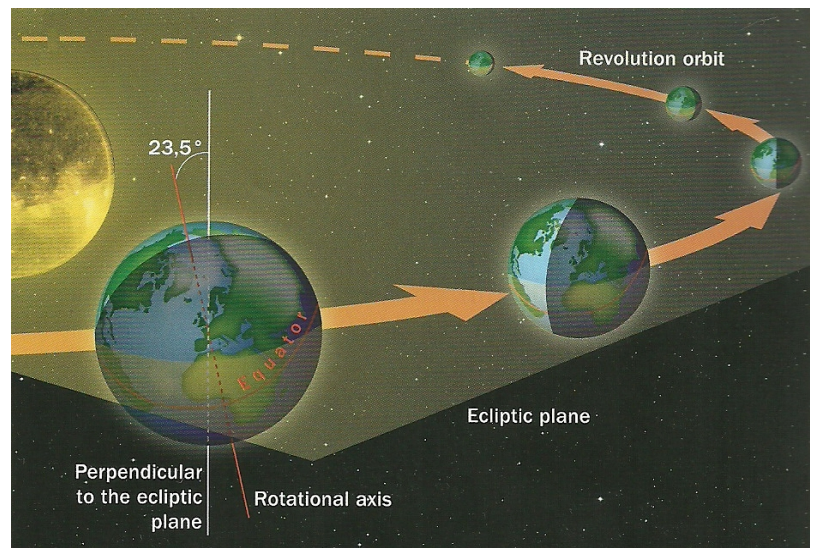
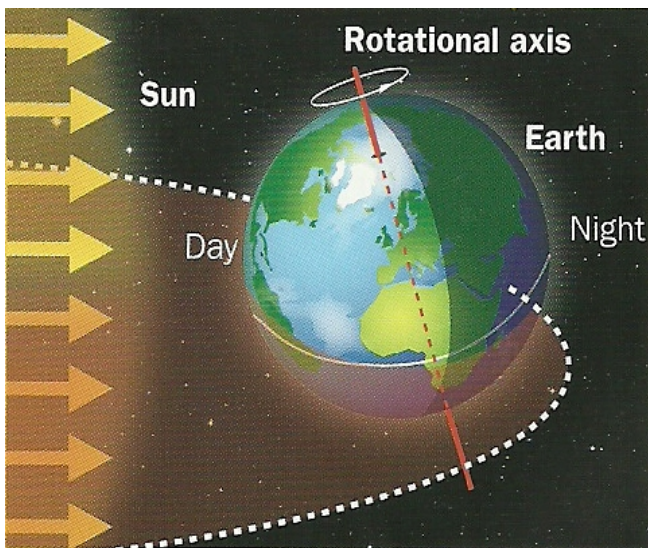
3.1. Movements of the Earth

The Earth is not static. Our planet makes two different movements:

- **Rotation:**
The Earth moves around its own axis from West to East (anti-clockwise)
It takes 24 hours, a day, to complete one rotation.
This movement causes the alternation of **day** and **night**.
The Earth's axis is tilted at an angle of about 23.5° .
- **Revolution**
The Earth moves around the Sun.
It takes 365 days and a quarter, a year, to complete one revolution.
This movement and the tilt of the rotational axis cause the **seasons**.

The imaginary plane that contains the Earth's orbit is called **ecliptic plane**. The Earth's orbit around the Sun is elliptic. For this reason, the distance between the Sun and the Earth varies slightly throughout the year.

- The **aphelion** is the point of the Earth's orbit farthest from the Sun.
- The **perihelion** is the point of the Earth's orbit closest to the Sun.



READING ACTIVITIES

After read the text, copy and answer the following questions on your notebook:

Remember: you must make complete sentences.

3.3. Where does the Sun rise? Where does it set? Why do you think we see it that way?

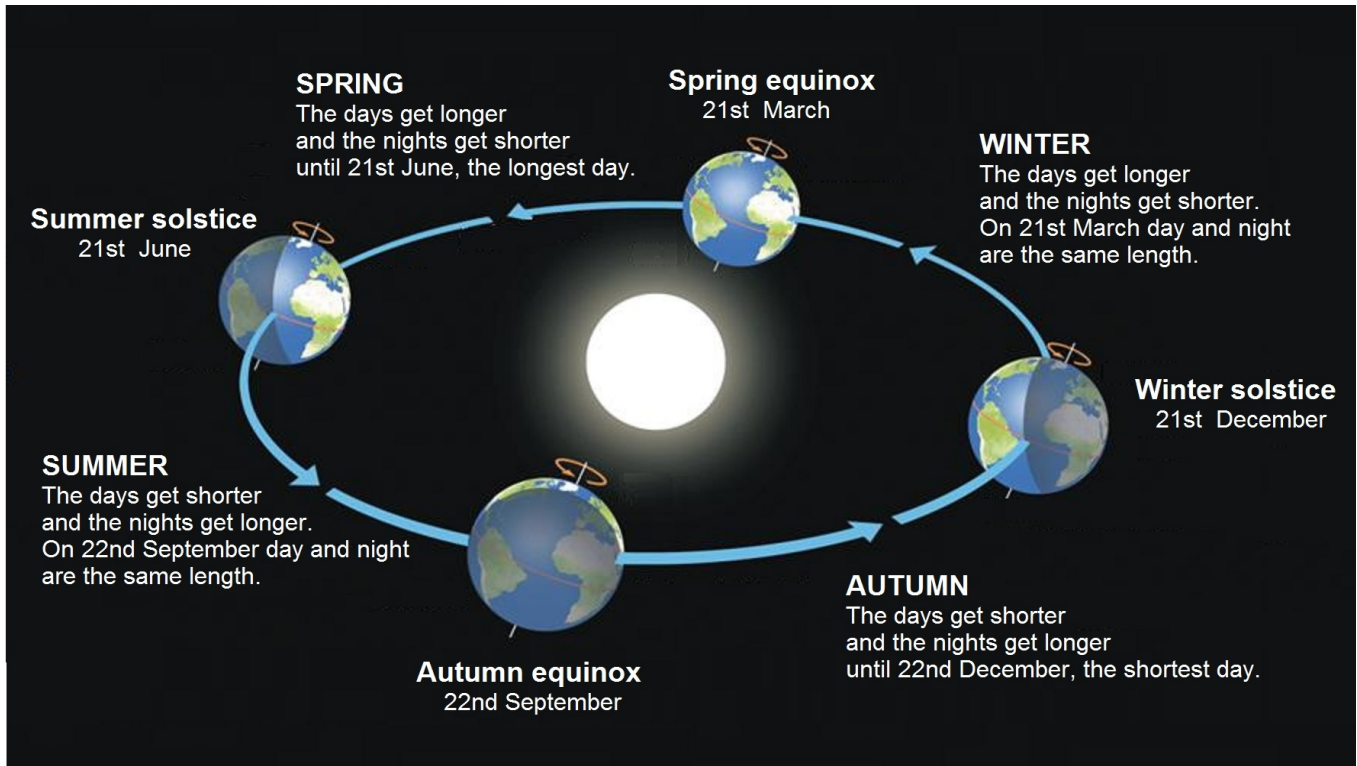
3.4. What are the consequences of rotation and revolution of the Earth?

3.2. The seasons

The seasons are due to the different amount of solar radiation that reaches the Earth's surface. This energy changes throughout the year due to the revolution of the Earth around the Sun and the fact that its rotational axis is tilted.

The seasons are divided according to the length of the day and their beginning and end are marked by particular days:

- **Equinoxes** are the two days of the year when day and night last the same time (12 hours).
- **Solstices** are the two days of the year when there is more difference between the duration of day and night.



The Earth is furthest from the Sun (aphelion) during summer in Northern hemisphere. However, it is hotter because there are more hours of sunlight per day and the Sun's rays strike the Earth's surface at a more direct angle providing more heat.

The inverse situation takes place in the Southern hemisphere where it is winter.

READING ACTIVITIES

After read the text, copy and answer the following questions on your notebook:

Remember: you must make complete sentences.

3.5. Change the following sentences to make them true:

- During the *spring equinox*, the Sun illuminates the *northern hemisphere* more than the *southern hemisphere*.
- During *autumn equinox*, days are long and nights are short in the *northern hemisphere*.
- Summer solstice* is on 22nd September.
- Winter solstice* is when day and night have the same length.

4. The Earth and the Moon

The Moon is the only natural satellite of the Earth.

Its surface is full of craters due to the impact of a huge number of meteorites. It neither has atmosphere nor water. The Moon is smaller than the Earth but is very close (384,000 km). This provokes two important phenomena: tides and eclipses.

It has two different movements:

- Rotation

The Moon rotates around its own axis.
This movement takes 29.5 days to complete.

- Revolution

The Moon moves around the Earth.
This movement takes about 29.5 days to complete.

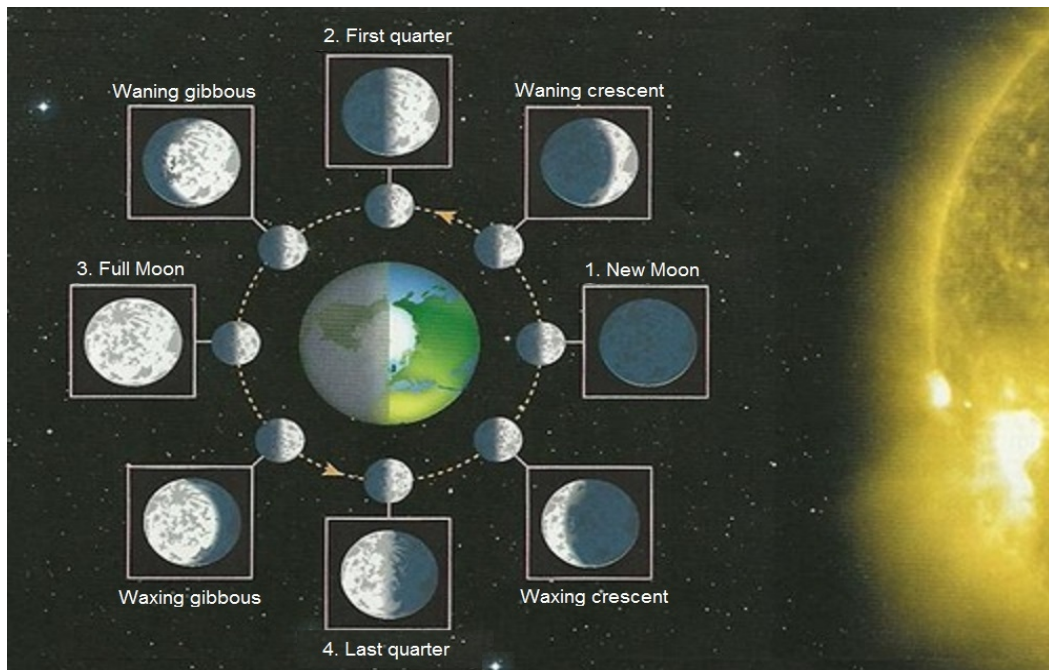
The fact that these two movements take the same time has as a consequence that we always see the same side of the Moon.

4.1. The phases of the Moon

The Moon is illuminated by the Sun. But it is not always in the same position, so that the aspect of the Moon saw from the Earth is different in different moments.

The several ways we can see it are called "**phases of the Moon**":

- **New Moon.** The Sun does not illuminate the Moon's side that faces the Earth.
- **First quarter.** The Sun illuminates the right side of the Moon. It is D-shaped.
- **Full Moon.** The Sun illuminates the whole Moon.
- **Last quarter.** The Sun illuminates the left side of the Moon. It is C-shaped.



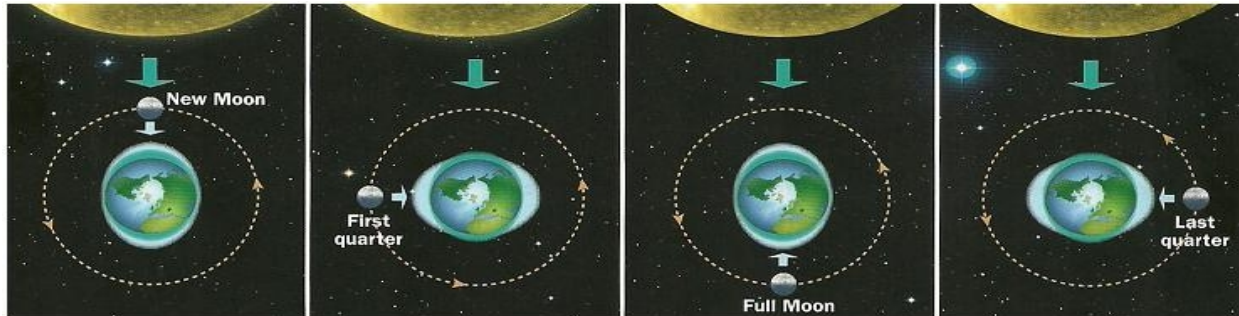
4.2. Tides

Tides are periodic movements of the level of the sea due to the gravitational attraction that the Moon and the Sun have on the Earth.

- The level of water rises on the part of the Earth nearest the Moon and in the opposite side too. It is called "**high tide**"
- The water level goes down on the rest of the Earth. It is "**low tide**"

Every place on the surface of the Earth changes twice a day that is once every 12 hours, causing two high tides and two low tides.

- When the Earth, the Sun, and the Moon are in a line, the gravitational forces of the Moon and the Sun add and the tides are larger. This very high tide is called **spring tide**.
- When the Earth, the Sun, and the Moon are in angle of 90°, the attractions of both are reduced a bit and the tides are smaller. This tide is called **neap tide**.

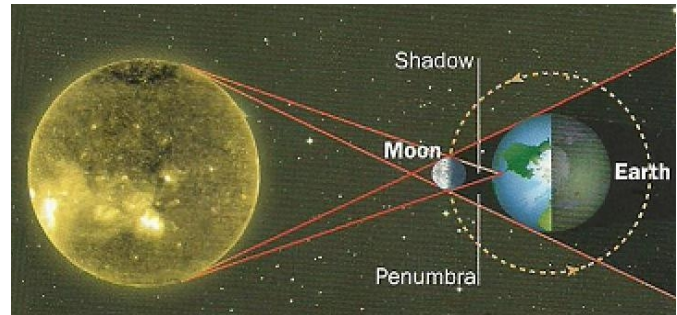
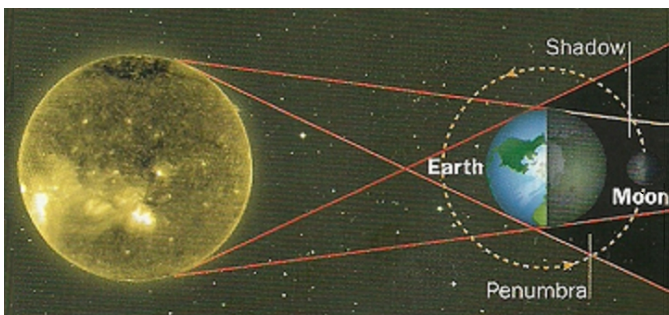


4.3. Eclipses

The Moon, the Earth and the Sun change their relative position in the space because of their movements.

An **eclipse** occurs when one of them hides another temporarily, in a partial or in a complete way.

- **Solar eclipse**
The Moon passes between the Sun and the Earth projecting its shadow onto the Earth.
- **Lunar eclipse**
The Earth is between the Sun and the Moon, projecting its shadow onto the moon.



READING ACTIVITIES

After read the text, copy and answer the following questions on your notebook:
Remember: you must make complete sentences.

4.1. Answer the following questions:

- Why cannot we see the Moon during the period of "New moon"?
- Which has more influence on tides, the Moon or the Sun? Why?
- Why we always see the same side of the Moon?
- When does an eclipse occur?

4.2. The following sentences are wrong. Correct them:

- The Moon takes more time during its *revolution* than during its *rotation*.
- When in a place of the Earth it has *high tide*, in the opposite place it has *low tide*.
- Last quarter* is the phase of the Moon between *Full* and *New moon* when we see the right side of del Moon illuminated.
- A *solar eclipse* occurs when the Earth pass between the Sun and the Moon.