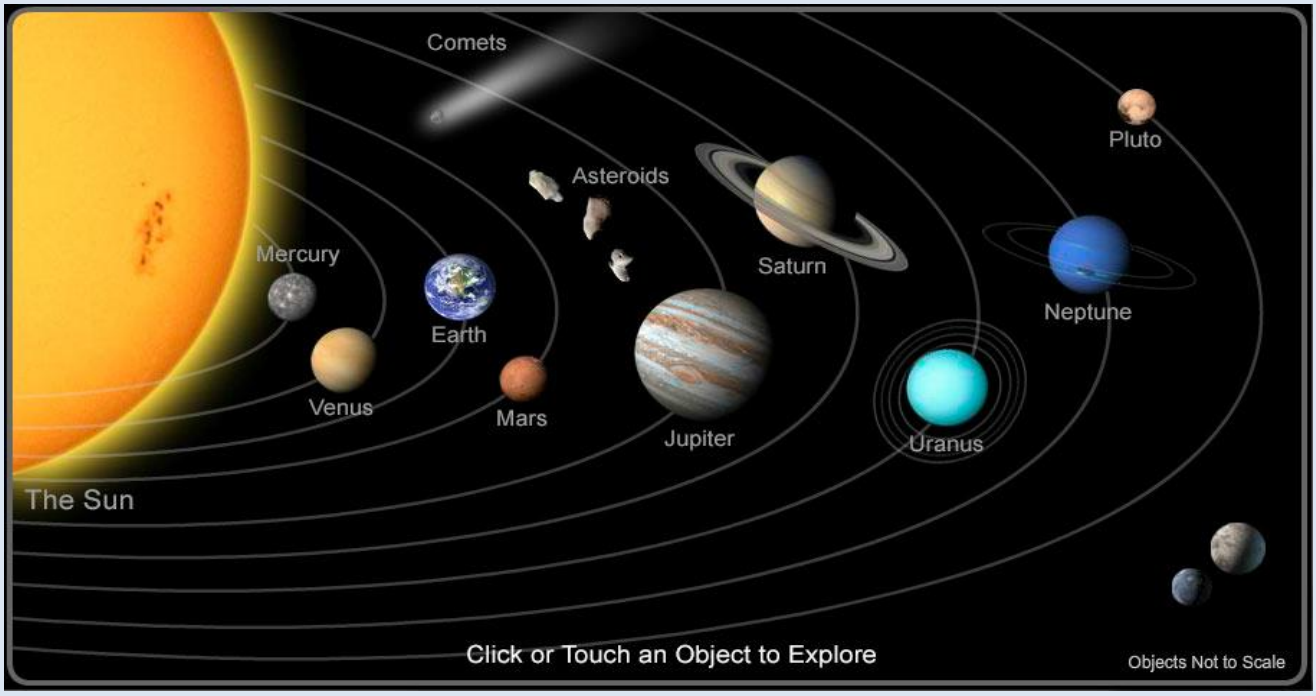
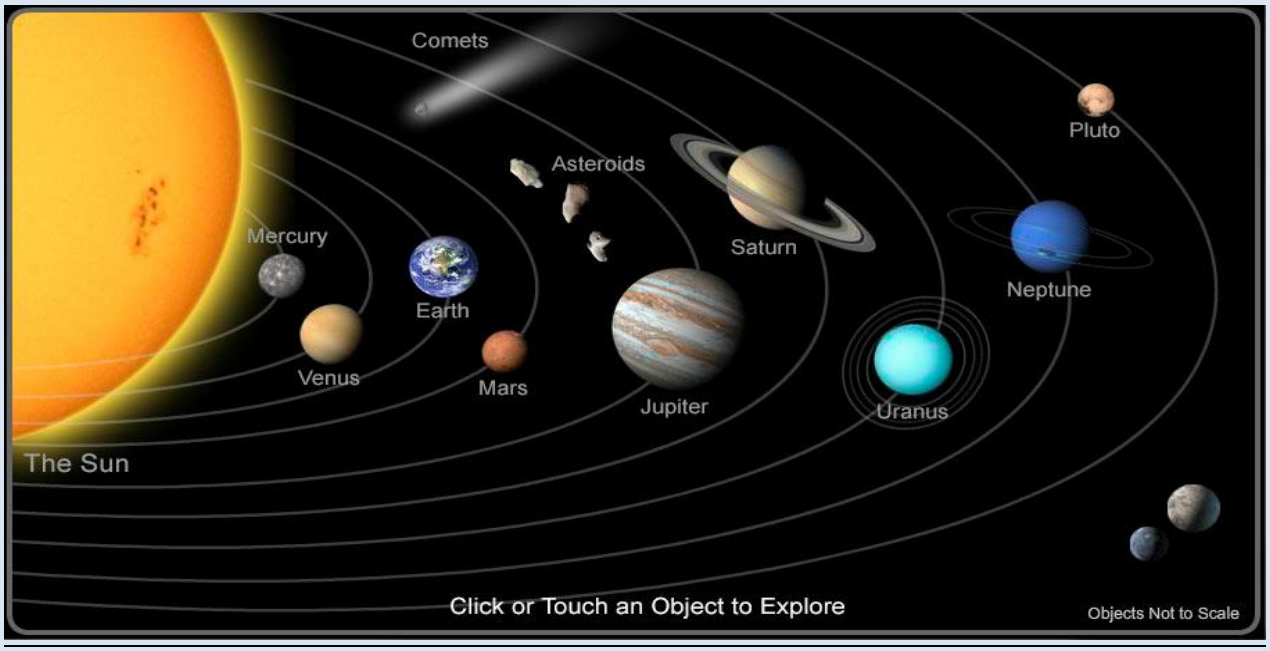
THE SOLAR SYSTEM, STARS, GALAXIES AND SATELLITE COMMUNICATION



THE SOLAR SYSTEM

The solar system is the gravitational bound system of the sun and the objects (planets) that orbit it.

The Earth is part of a bigger system called the solar system.



The Solar system consists of the Sun and the eight planets moving around the Sun in orbits by the force of gravity.

Qn. Identify the components of the Solar system.

- Sun
- Planets[such as Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune]
- Asteroids
- Comets, etc

Qn. Name the force you think holds the components together.

- Gravitational force.

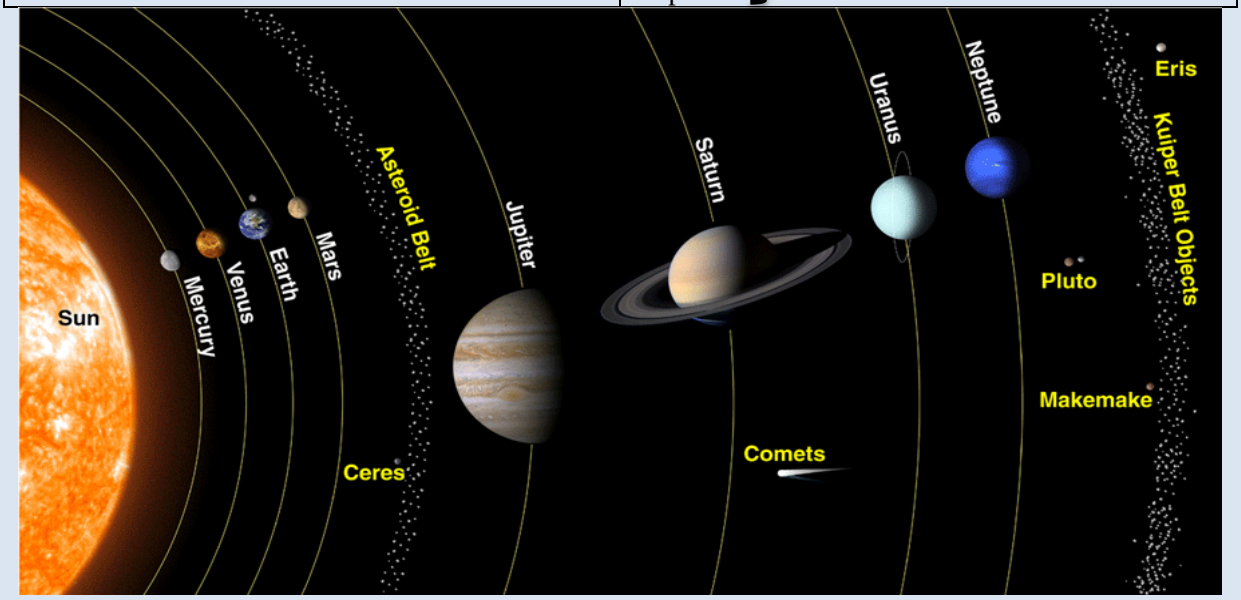
The Sun is one star that is orbited by planets and other terrestrial objects.

Categories Of Planets.

- The rocky planets[terrestrial/inner planets]: These have a rocky surface where astronauts are able to walk. Earth and Mars are both rocky/ terrestrial planets
- Jovian/ outer planets: These are made of various condensed gases (mainly hydrogen and helium) and some ice particles and do not have a hard rocky surface. Astronauts are not able to walk on them. E.g Jupiter and Saturn

Inner And Outer Planets

Inner planets [Terrestrial planets]	Outer planets [Jovian planets]	
Mercury	Jupiter	Gas giants
Venus	Saturn	
Earth	Uranus	Ice giants
Mars	Neptune	



- **Asteroids;** these are thousands [millions] of small pieces of rocks similar to those found in the planets that orbit the sun mostly between the orbits of the mars and Jupiter.
- The largest asteroid is called **cera**.
- This orbit is called **the asteroid belt.**

Asteroid belt: This lies between the orbits of Mars and Jupiter and is composed of rock and metal

Kuiper belt: This is beyond Neptune's orbit.

NB:

1) Before 2006, Pluto, the farthest object orbiting the sun, was considered a planet. Because of its very small size compared to the other planets, it was removed from the list of planets.
2) In 2006 the international astronomical union [**IAU**] changed the definition of a planet which disqualified PLUTO from being a planet to a **dwarf planet**.
3) The dwarf planets identified by **IAU** are **ceres, Pluto, haumea, makemake and Eris.**
4) The sun and all planets that orbit around it are spherical.
5) In the solar system, a planet is a celestial body that orbits around the Sun and has sufficient mass to keep it in a round(spherical) shape.

Properties Of The Planets In The Solar System.

1. Mercury

- Is the closest planet to the sun and the smallest in the solar system.
- One day in Mercury is equal to 59 days on Earth.
- It takes 89.97 earth days for mercury to orbit the S
- It has a very thin atmosphere due to this, its temperature reach 427°C at mid-day and drops to -183^0C immediately after night fall.

2. Venus

- This is the 2nd planet from the sun.
- It is the brightest body in the Sky after the moon and Sun.
- Its atmosphere is very dense and mainly composed of CO_2 .
- It is the hottest planet in the solar system of temperature about 460^0C
- A day on Venus is equivalent to 243 earth days and its year is 225 earth days.
- Has no natural satellites.

3. Earth

- Is the 3rd distant planet from the Sun.
- It is the more dense and 5th largest planet in the solar system.
- It is the only planet where life was able to adopt.
- 70% of its surface is covered with water and the rest is solid.
- It takes about 24hours for the earth complete a rotation about its axis and 365.26days to orbit the sun.

4. Mars

- Is the 4th planet from the Sun and the 2nd smallest planet after Mercury.
- One day on Mars is 246 hours on earth while a year is 669.6 earth days
- Has two moons ie Phobos and Deimus.
- Has a steep relief with the tallest mountain in the Solar system known as **Olympus**

5. Jupiter

- Is the 5th planet from the sun and the largest in the solar system.
- One day on Jupiter is 9.9 earth hours and its year is 12 Earth years.

6. Saturn

- Is the 6th planet from the Sun.
- Giant gas planet and 2nd largest after Jupiter.
- Composed of ice particles and dust
- Has more than 82 natural satellites

7. Uranus

- 7th planet from the Sun and 3rd largest.
- The blue-green colour is mainly due to presence of methane in its atmosphere
- One Uraniun day is 17.2 hours and its year is 84 Earth years.
- Has over 27 natural satellites some of which include Titania, Oberon, Miranda and Ariel.

8. Neptune

- Is 8th and farthest planet from the Sun.
- Its bluish- colour is as a result of atmospheric methane which absorbs red light.
- One day one day on Neptune is 16.1 hours while its years is 165Earth years.
- Has 14 natural satellites with Triton as the largest.

Life exists on Earth due to the following:

- Sufficient atmosphere.
- Existence of fresh water.
- Presence of oxygen which supports life and many others.

Presence of sufficient atmosphere, oxygen and water on Earth's surface are supported by the gravitational pull which does not allow them to escape.

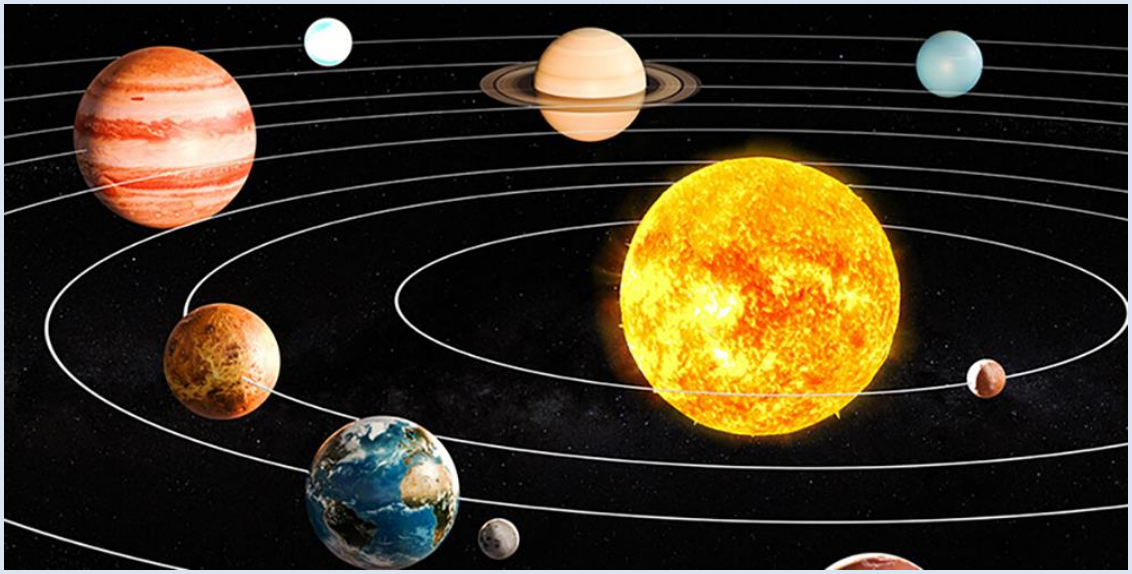
MOTION OF PLANETS AROUND THE SUN.

All planets have almost circular orbits which lie with in a nearly flat disc referred to as the Elliptical plane. The motion of planets is both rotational and revolutional.

Rotation involves the planet spinning about a fixed axis and

Revolution involves a planet travelling around the Sun.

One complete rotation is equal to one day and one complete revolution is equal to a year. e.g one day on Earth is about 24hours and a year is 365days.



The orbital motion is facilitated by the gravitational force between the planets and the Sun.

The speed of rotation/revolution of the planets reduces as their distance from the sun increase due to the reducing force of gravity from the Sun as their distance increases .

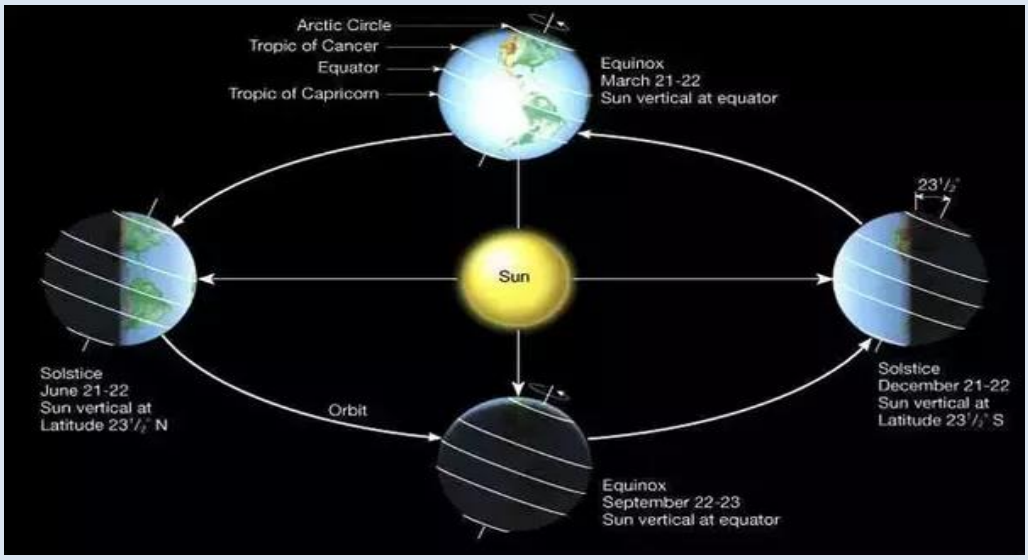
Days and Nights.

The Earth is a spherical body which spins on its axis as it moves around the Sun. One part of the Earth faces the Sun while the other faces away into space.

As the Earth rotates on its axis, the side which faces the Sun receives light and heat from it, this side therefore experiences day time. The part of the earth which faces away into space is cooler and darker, and is therefore experiencing night time. This is the reason why it is day time in Uganda ,it is night time in some other countries. e.g China, USA, etc.

Causes of Change in Seasons.

- This is due to the revolution of the Earth and the earth's tilt about its axis. It is this tilt that causes the changes in seasons. The number of daylight hours is greater for the hemisphere that is tilted towards the sun. The hemisphere that is tilted towards the sun receives more hours of sunlight each day than the hemisphere that is tilted away from the sun. When the northern hemisphere faces the sun, it experiences summer while the southern hemisphere experiences winter.
- In the northern and southern hemisphere spring start on the day of the vernal equinox. A vernal equinox has a balance of hours between daylight and night.
- **Equinoxes** are days in which days and nights are of equal duration. The two yearly equinoxes occur when the sun crosses the equator.

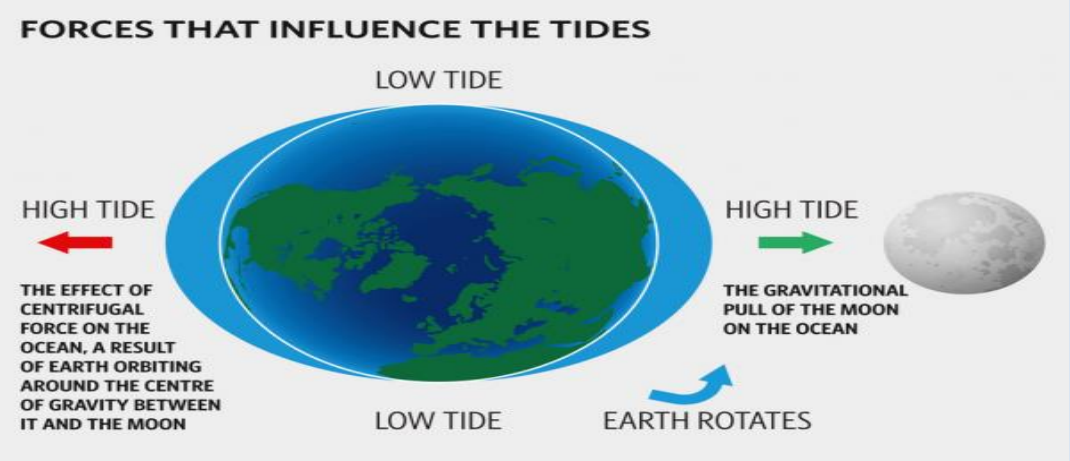


NB;

On earth we experience four seasons that is winter simmer autumn and spring. However, Equatorial countries e.g. Uganda only experiences only two seasons [**dry** and **wet**] which represents summer and winter.

Causes of Sea/Ocean tides

- Tides are periodic rise and fall in the level of water in large bodies like oceans and seas.
- Tides are caused due to gravitational pull [force] of the moon on the earth this generates a tidal force which causes the earth and its water bulge out on the side of the moon.
- Another bulge occurs on the opposite side since the earth is also pulled towards the moon [away from the water body on the far side]. These bulges are high tides.
- The side of the earth that are not facing the moon experiences low tides



Tides can be helpful in the following ways:

- High tides help in navigation over the oceans or sea.
- Tides bring more fishes closer to the shores for the fishermen.
- Tides can be used to generate electricity.

However tides can be dangerous in the following ways;

- Tides cause floods for the people leaving near the shores.
- Tides cause accidents to people moving on the sea.
- Tides danger the file of the marines

THE MOON

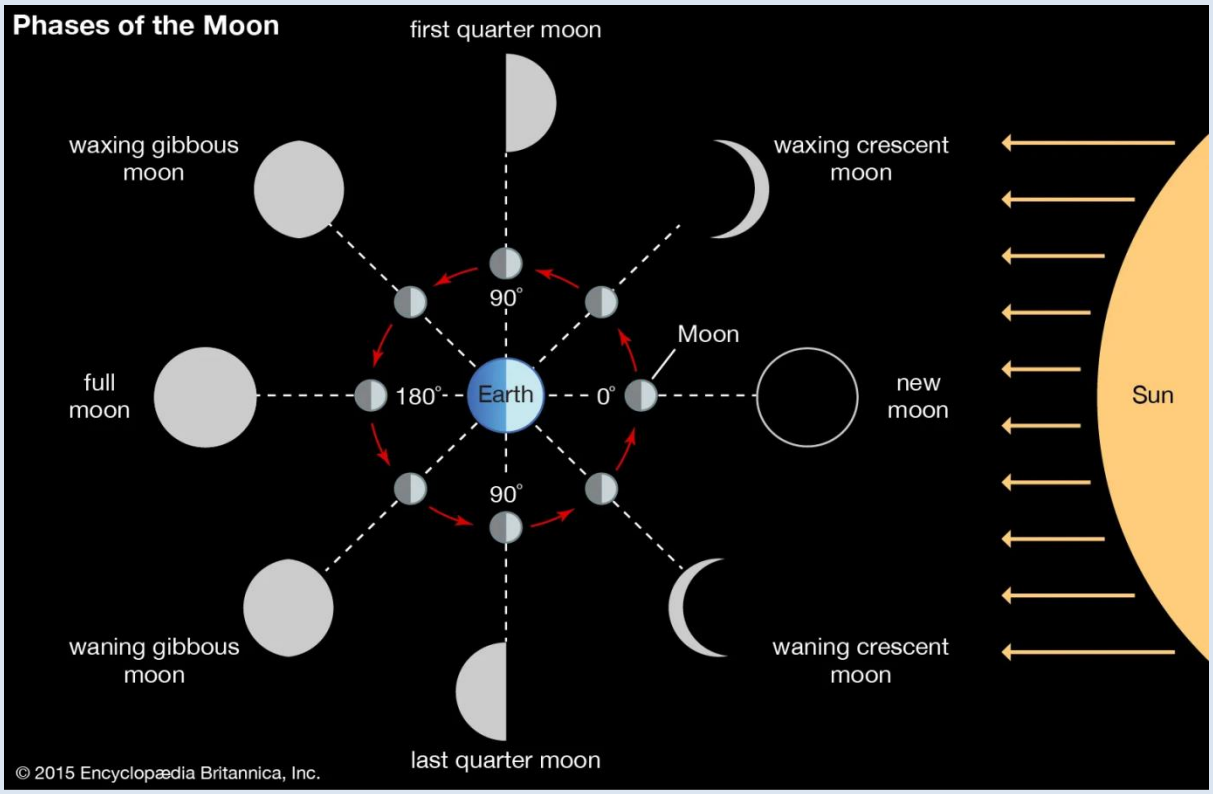
The Moon doesn't emit (give off) light itself, the 'moonlight' we see is actually the Sun's light reflected off the lunar surface. So, as the Moon orbits the Earth, the Sun lights up different parts of it, making it seem as if the Moon is changing shape. It is a universal fact the Moon does not produce light itself. It is the Sun who produces the light and the Moon brightens from the Sun's light. Because of the Moon's changing position as it orbits our planet, the Sun's light focus on different parts of it, giving the illusion that the Moon is changing shape over time. But the fact is that the Moon never changes its shape. The shape of the Moon that appears at night, is the only part of the Moon which is facing us and in sunlight.

Phases of the moon

There are eight total phases of the moon cycle, four primary phases, and four secondary phases. The primary phases are the new moon, first quarter, full moon, and last quarter. The secondary phases are waxing crescent, waxing gibbous, waning crescent, and waning gibbous.

1. **New moon**: The moon is between the sun and the earth causing none of the illuminated side of the moon to be visible to the earth.
2. **Waxing crescent**: After a new moon, A small illuminated crescent becomes visible. The moon is now said to be waxing.
3. **First quarter (Half-moon):** When the moon reaches the first quarter of its phases, it appears as a half-moon. One half of the moon is now lit up by sunlight.

4. **Waxing Gibbous:** After the first quarter, the moon moves towards full moon. As more of its half but less than its full is lit up. The illuminated portion continues to grow as the moon moves towards full moon.
5. **Full Moon:** When the Moon appears as a full moon, the entire side (face) of the moon is illuminated and visible from the Earth.
6. **Waning gibbous**: After a full moon, the moon begins to decrease again. The moon is now Said to be waning.
7. **Last quarter**: The moon continues waning until it reaches its last quarter, also known as half-moon.
8. **Warning crescent** : A small, illuminated crescent is visible, decreasing in size. The moon is transiting back to the new moon.



NOTE

The term **waxing** refers to the growth of the moon's image, while the term **waning** refers to a shrinking of the moon's image.

Gibbous means between semi-circle and a full circle in shape.

ECLIPSES.

This is the total or partial obscuring of one celestial body by another.

In astronomy, it is the obscuring of one celestial body by another, particularly that of the sun or a planetary satellite.

Types of eclipse:

I. Lunar eclipses and/eclipse of the moon

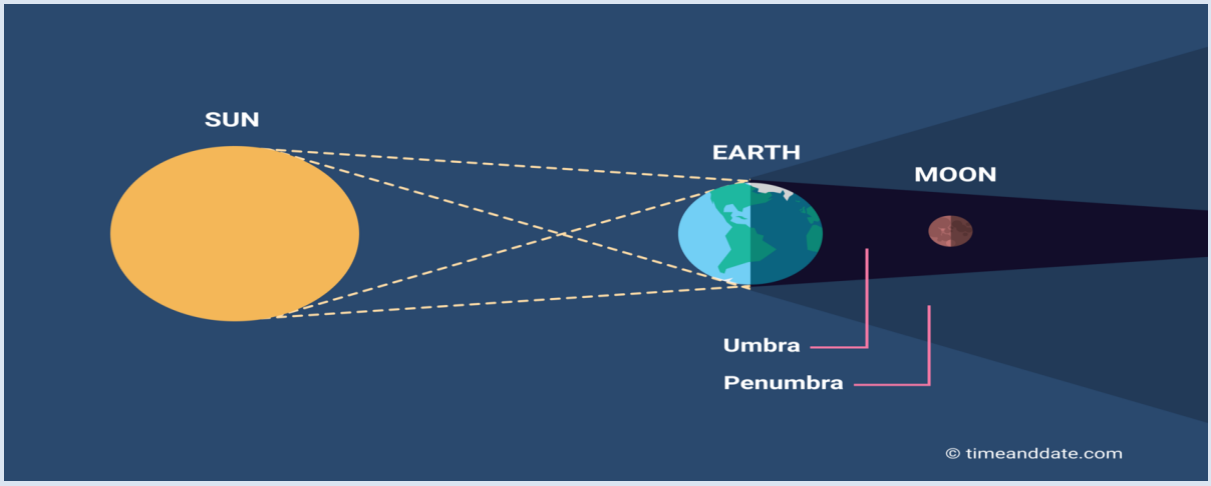
II. Solar Eclipses/ eclipse of the sun.

i. **A Lunar Eclipse** occurs when the earth is between the sun and the moon and its shadow darkens the moon. **A solar eclipse** occurs when the moon is between the sun and the earth and its shadow moves across the face of the earth.

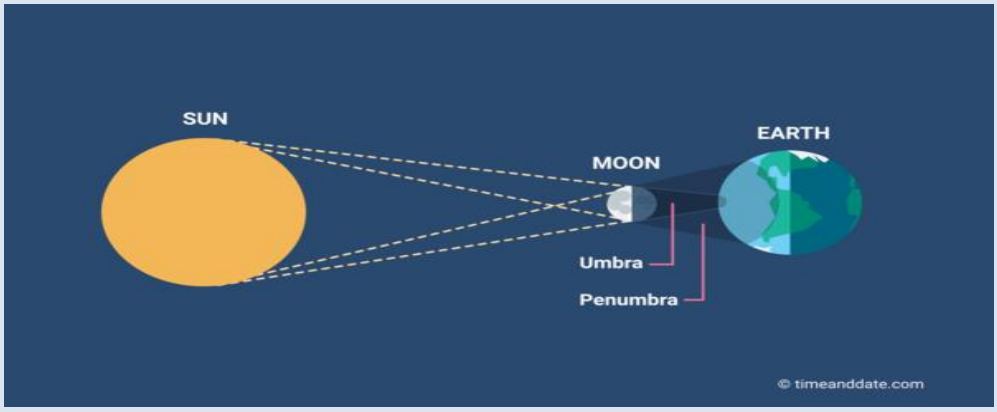
Lunar eclipse: This is when the earth is between the sun and the moon. The earth, lit by the sun, casts a long, conical shadow in space. At any point within that cone, the light of the sun is wholly obscured. Surrounding the shadow cone, also called the umbra, is an area Of partial shadow called the penumbra.

A total lunar eclipse occurs when the moon passes completely into the umbra.

A partial lunar eclipse occurs when only a part of the moon enters the umbra and is obscured. The extent of a partial eclipse can range from near totality, when most of the moon is obscured, to a slight or minor eclipse, when only a small portion of the earth's shadow is seen on the passing moon.



ii. **Solar eclipse:** This is when the moon is between the earth and the sun. Total solar eclipses occur when the moon's umbra reaches the earth



At certain times when the moon passes between the earth and the sun, its shadow does not reach the earth. At such times, an annular eclipse occurs in which an annulus or bright ring of the solar disk appears around the black disk of the moon.

THE Origin of the Universe.

The universe is everything that is in space, matter and energy the space contains. The earth and the moon are part of the universe as well as other planets. The universe therefore contains everything that exists including stars, galaxies, satellites etc.

There are many theories that talk about the universe and these include;

The Big Bang theory: It states that the universe began as just a single point that expanded and stretched to grow as a large entity and is still stretching up to now. The universe is therefore a very big place and it has been around for a very long time hence thinking about how it started may not be so easy. It was observed that the galaxies far away from us are moving faster than the galaxies very close to us and this shows that the universe is still expanding.

The Big Bang theory is based on the following basic assumptions that is;

- The universe is constant
- The universe has the beginning
- The universe is homogenous
- The universe is not centered around us

The steady state theory: It states that the counting of the galaxies in our universe is constant and the new galaxies being formed continuously fill the empty spaces that are created by those heavenly bodies that have crossed the boundary lines of the universe.

The pulsating theory: It states that there is a possibility that after some passage of the time the expansion of the universe may top. This may result into the contraction of the universe to a certain size and the explosion will take place and as a result the universe will start expanding again.

STARS

Most stars are clearly visible to us at night.

The sun is one star that is visible even during day. It appears very bright to us because it is very near to the Earth. But there are many other stars; some of which are brighter and bigger than the sun, only that these stars are too far away from the Earth.

The sun produces too much energy but only a small proportion of it reaches the Earth. Of this proportion a small percentage is put to use and the bigger portion is reflected back into the atmosphere.

The star's brightness greatly depends on its stage in life and the amount of fuel it has at a time.

Stars

Stars are luminous balls of gas, mostly hydrogen and helium, held together by its own gravity.

Stars are found in clouds of dust and gas at high concentrations. There are about 200 billion stars in our galaxy, the Milky Way. There are also billions of stars in other galaxies. Thus the number of stars in space is very big.

The distance of the stars from the earth varies, some are closer and some are farther away. The distance determines the brightness of the stars,

Stars become visible to humans at night

Importance Of The Stars To Humans.

- They provide light to people during darkness.
- They help in navigation through the Earth e.g ancient sailors used the stars to help guide them while they were at sea.
- Stars since ancient times are described as forever, hope, destiny, heaven and freedom. most of the stars that are the brightest are the closest to earth while those that are fainter are far away.

Variation In Brightness And Colour Of Stars

❖ Brightness

The apparent brightness of a star depends on distance from that star and its size, some are closer and some are farther away. Most of the stars that are the brightest are the closest to earth while those that are fainter are far away for instance, the Sun appears brighter and is actually hotter when viewed from the Venus than from the Earth because Venus is closer to the sun than the Earth.

The brightness of a star is defined by two characteristics; luminosity and magnitude.

Luminosity is the amount of light that a star radiates/emits. This is mainly determined by the size and surface temperature of the star. The more energy emitted the higher the brightness.

Apparent magnitude of a star is its perceived brightness

DID YOU KNOW? The brightest star in the Sky is Sirius, also known as "Dog Star" or the Alpha Canis Majoris, because of its position in the constellation Canis Major.

❖ Colour

A star's colour depends on its surface temperature. Cooler stars appear reddish in colour while hotter stars appear bluish. Medium-temperature stars appear yellow, such as our sun.

The coolest stars are approximately 2,500K, while the hottest stars can reach 50,00K. Our Sun is about 5,500K.

Why stars appear to twinkle?

This appearance is due to the effect of the atmosphere. When light from the stars enter the atmosphere, it is continuously refracted by regions with different temperatures and optical densities. When light rays are refracted towards the observer, a star is seen and when the rays are are refracted away from the observer, the star disappears. This is explains why stars appear to twinkle.

Source Of Energy In Stars.

❖ The Sun as the Source of Earth's Energy

The Sun is the main source of almost all the energy on earth. It produces too much energy and the Earth only receives about one billionth of the Sun's total energy output. The Earth reflects back a bigger percentage to the space.

The Source of Energy that the Sun Produces

The Sun generates energy from a process called **nuclear fusion**. Nuclear fusion is the process by which light elements combine to form heavier elements giving off energy. This happens in a star's core at extremely high pressure and temperature. Hydrogen nuclei fuse to form one helium atom. During the fusion process, a large amount of energy in the form of light and heat is released which travels through space and reaches the Earth. This life is important for life on our planet.

Importance Of Solar Energy

Solar energy provides necessary light energy for plants during photosynthesis.

Provides warmth necessary energy for seeds to sprout and begin growing.

etc

Qn. How does nuclear fission bring about energy production in a star?

Nuclear fission is the process by which heavy elements split to form lighter elements giving off energy. It happens when a low speed neutron is absorbed by a heavy molecule causing it to destabilize and split into various nuclear fission products and energy.

Qn. Discuss the different energy changes that take place in the sun

Chemical energy to nuclear energy to thermal energy and light energy

Discussion Qn. What are importance of the energy produced by the sun

Classification Of Stars.

The stars are classified as **average stars** and **massive stars.**

(a) Average stars: These are stars whose mass is 0.5 to 8 times the mass of the sun. The mass of the sun is about $1.989X10^{30}$Kg . Our sun is an average star. Average stars have a longer life than massive stars .

Average stars include; Proxima centauri, Bernard's star and Luyten's Star.

(b) Massive stars: These stars are extremely heavy, hot and bright. Their mass can be as many as thirty times the mass of the sun and more than 100,000 times brighter than the sun. The Carina Nebula, at a distance of 8,500 light years, contains dozens of hot , massive stars

Star Formation

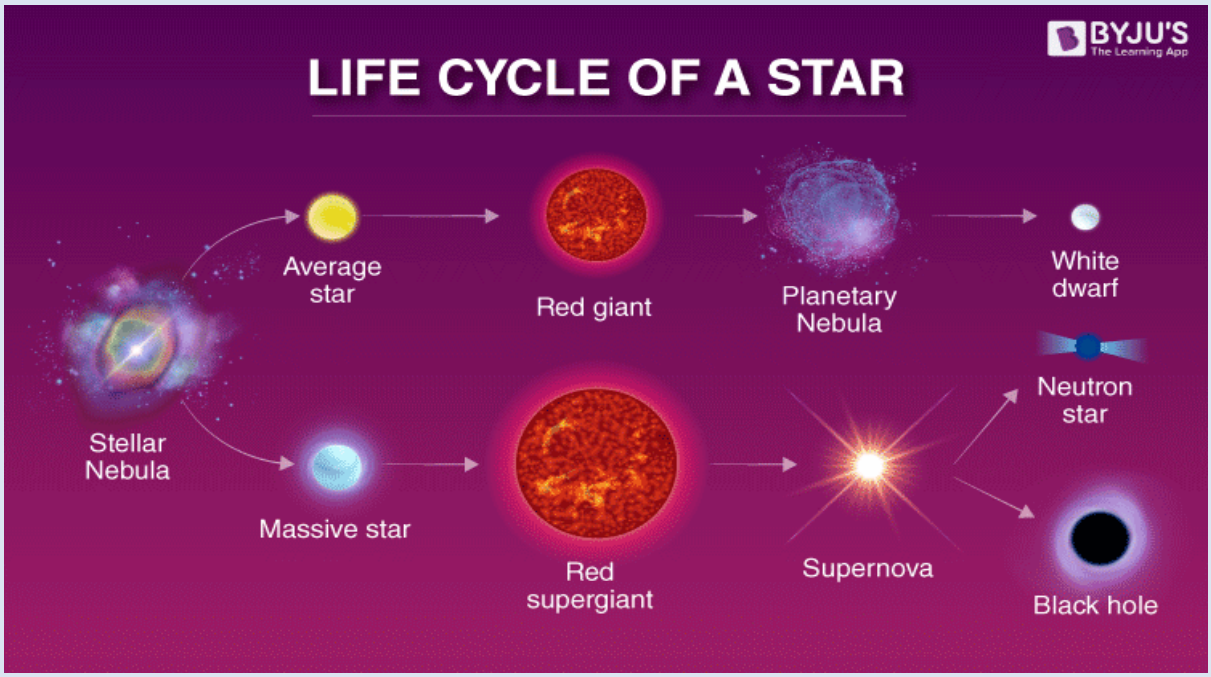
In space, there are trillions and trillions of free atoms and dust particles.

When huge amounts of atoms of lighter elements (hydrogen and helium) collect together, they create a gravitational force that holds them together.

This gravitational force continues to grow as more elements are pulled to his collection. This creates pressure on the nuclei of the elements and forces the nuclei to start to undergo nuclear fusion.

When the fusion reactions begin, a star is born. As long as the outward pressure on the gas collections due to nuclear fusion are balanced by the inward gravitational force due to the mass of the gas collection, the star is said to be stable.

The Life Cycle Of A Star



The lifecycle of a star varies depending on its mass, but it generally follows these stages:

1. **Nebula:** Stars begin their lives in vast form of gas and dust known as nebulae. Gravitational forces causes these clouds to collapse and form protostars.
2. **Protostar:** As the gas and dust continue to collapse, they heat up and form a protostar. When the core temperature becomes high enough, nuclear fusion begins.

3.Main sequence: The star begins fusing hydrogen into helium in its core spending most of its life in this stable phase and stars steadily release of energy. Our Sun is currently in this stage.

For average stars[Low mass stars]	***For Massive stars[High mass stars]***
4.Red giant: When hydrogen in the core exhausts, outer layers expand and cool.	**4. Red Supergiant:** When hydrogen in the core exhausts, the star expands fusing heavier elements in successive stages in the core.
5. Planetary Nebula: The outer layers are ejected, creating a glowing shell of gas and dust around the contracting core	**5. Supernova:** When the core accumulates iron, it cannot sustain fusion and collapses, causing a catastrophic supernova explosion that disperses the outer layers into space
6. White dwarf: The remaining core becomes a white dwarf, a small, dense, hot object that will gradually cool over billions of years.	**6.Neutron star:** If the core's remnant is between about 1.4 and 3times the mass of the sun, it becomes a neutron star, an incredibly dense object composed mostly of neutrons.
7. Black dwarf: Over an extremely long period, the white dwarf will cool and fade to become a black dwarf. However, this stage has not been observed since the universe is not old enough.	

QN. What is the difference between:

(a) Red giant and Red Super giant?
(b) White dwarf, neutron star and black hole?

solutions

(a). Red giants form when a star with mass of about one solar mass runs out of fuel while red super giants form when stars form more 10 solar masses run out of fuel.

(b). White dwarfs are the end products of average stars while neutron stars and black holes are end products of massive stars.

Take Note;

Stars and humans share similar phases in their life cycles. Stars begin their lives as dense clouds of gas and dust.

Like humans, stars spend most of their life in the Main Sequence Stage(adulthood). If a star begins its life with a great amount of mass, it burns hot and fast to maintain equilibrium. So fuel runs out quickly. The star dies young with a super massive explosion.

An average-sized star lives longer(about 1 billion light years) and dies a quite peaceful death.

A star's life cycle is determined by its mass. The larger its mass, the shorter its lifecycle. A star's mass is determined by the amount of matter that is available in its nebula(the giant cloud of gas from which it was

A galaxy is a huge collection of billions of stars, gas and dust. It is held together by gravity.

In a galaxy, there are very many stars arranged in recognizable shapes called **Constellations.**

There are millions of galaxies in the universe

Galaxies are classified on their shape

Types of Galaxies

SPIRAL GALAXIES	ELLIPTICAL GALAXIES	IRREGULAR GALAXIES
e.g Andromeda and the Milky way	**e.g** Ursa Major and Messier 87	**e.g** Small Magellanic cloud and Large Magellanic cloud

Our galaxy, the **Milky Way** also has a supermassive black hole. The nearest galaxy to us is the Andromeda galaxy.

Characteristics of Galaxies

Spiral Galaxies	Elliptical Galaxies	Irregular Galaxies
1. **Disc** shaped with spiral arms. 2. Consists of old dimmer stars at its Centre and young hot stars at the arms 3. Brighter than other types of galaxy 4. Normally larger than elliptical and irregular galaxies	1. Oval(elliptical) or round shaped 2. Consists of old and dimmer yellow stars 3. Lower temperature 4. Contains subtle gas or dust 5. Normally smaller than spiral and irregular galaxies	1. No definite pattern or shape 2. Consists of young stars 3. Normally larger than elliptical galaxies but smaller than spiral galaxies

Measurement of the stars and galaxies.

Physical quantities such as mass and distance of the stars and galaxies are very huge. This makes it hard to measure them with the conventional (S.I) units of the quantities. For this reason, the scientists came up with other larger units that can easily accommodate these large quantities as shown below;

Light year

A light year is a unit of astronomical distance equivalent to the distance light travels in one year.

1 ly = 3.0x108365.25x24x3600 = $9.5x10^{15}$ m

Astronomical year, Au

An Astronomical Unit [**AU**] is the average [mean] distance between the earth and the sun and it's about 150 million km;

- 1AU=1.5 x 10^{8} km.

How galaxies are formed

The big bang theory posits that the universe began as a singularity approximately 13.billion years ago. This singularity was an infinitely small, infinitely hot, and infinitely dense point.

The singularity began to expand rapidly in a process known as cosmic inflation. This caused space itself to stretch and expand, leading to the cooling of the universe.

As the universe expanded and cooled, energy transformed into particles such as quarks, electrons and neutrinos. Quarks combined to form protons and neutrons leading to the formation of the first atomic nuclei.

About 380,000 years after the big bang, the universe had cooled enough for protons and electrons to combine and form neutral hydrogen atoms.

Over time, gravitational attraction caused matter to coalescence into clouds of gas and dust, leading to the formation of the first stars and galaxies.

SATELLITES AND COMMUNICATION

Applications of satellites are very common in our community. The telephones we use, Tvs we watch , etc are supported by satellites. Today we have the global positioning system(GPS) which enables us to locate positions of places. There is a giant satellite in space; the International Space Station that serves as a laboratory for space research.

A Satellite refers to an object moving in a curved path (orbiting) around a larger object in space .The moon is a satellite because it moves around Earth.

The satellites are primarily grouped into;

- **Natural satellites:** These are God made objects or celestial objects orbiting a planet in space

  and

- **Artificial satellites:** Artificial satellites are machines that are launched into space and orbit around a planet in space to do a specific purpose.

Types of artificial Satellites & their uses

Artificial satellites are classified based on their purpose

1. **Communication Satellites:** These are used to transmit and receive signals for communication purposes. E.g GPS sa tellites for navigation, weather satellites for forecasting, and TV satellites for broadcasting programs.

2. Navigation Satellites: These are used to Provide accurate positioning and navigation services. E.g GPS (Global Positioning System) satellites used in smartphones and navigation devices,Global satellite Navigation system(GLONASS) launched by Russia, BeiDou Navigation Satellite(BDS) launched by China, etc

3. Weather Satellites: These are used to Monitor weather patterns, track storms, and provide data for weather forecasts. E.g GOES (Geostationary Operational Environmental Satellite) series used by meteorologists.

More on the uses of satellites

- Research: Satellites help scientists study Earth's atmosphere, climate changes, and natural disasters.
- Observation Satellites: These are used to observe and gather data about Earth's surface, weather patterns, and environmental changes. E.g Environmental monitoring satellites.
- Disaster Management: They provide early warnings for natural disasters like hurricanes, earthquakes, and wildfires, aiding in evacuation and rescue operations.
- Spy Satellites: These are used to gather intelligence and surveillance information for military and security purposes. E.g KH-11 series used for reconnaissance by governments
- Agricultural Monitoring: Satellites monitor crop health, soil moisture, and land use, assisting farmers in improving crop yield and resource management.
- Telecommunication: Satellites enable global communication networks, supporting internet services, phone calls, television and data transmission for businesses and individuals worldwide

Sizes and altitudes of Artificial satellites

The satellites follow different paths (orbit) at varying altitudes. These are determined by the purpose of a satellite.

The Satellite Orbits Are Largely Categorized Into :

(a). Basing on altitudes;

1. Low Earth Orbit (LEO): This is an orbit positioned relative to the Centre of the earth within an altitude range of 2000 Km or less. Here space objects are fast moving which enable them to overcome the gravitation pull.

2. Medium Earth Orbit (MEO): Most Medium Earth orbit satellites are at an altitude of about 20000 Km. It is above the low earth orbit but below geosynchronous orbit. This is where most artificial satellites are stationed.

3. Geostationary Orbit (GEO): These satellites orbit the earth at about 36000Km above the earth. The time taken by the GEO satellites to make one complete orbit around the earth is 24hours.This is to match the rotation of the earth so that the satellite appears to stay above the same point above the Earth's surface all the time. Many GEO satellites are used for communications and meteorogical purposes.

(b).Basing on inclination

1. Equatorial orbit: When the satellite rotates in an orbit directly above the equator, usually in a circular path.

2. Polar orbits: The satellite rotates in a path that takes it over the North and South poles in an orbital pattern that perpendicular to the equatorial plane.

3. Inclined orbit: These are virtually all orbits except those that travel directly above the North and South poles.

Question.

How satellites hold in their positions in the space without falling back to the earth?

Satellites In Modern Technology

Operation of Satellite Communications

Microwave signals are transmitted from the ground station to a geostationary satellite in space. The microwave signals picked by the geostationary satellite in space(uplink) are weak due to the distance travelled. The geostationary satellite in space then amplifies (boosts) the signals. The signals are then retransmitted and received by a receiver on the earth

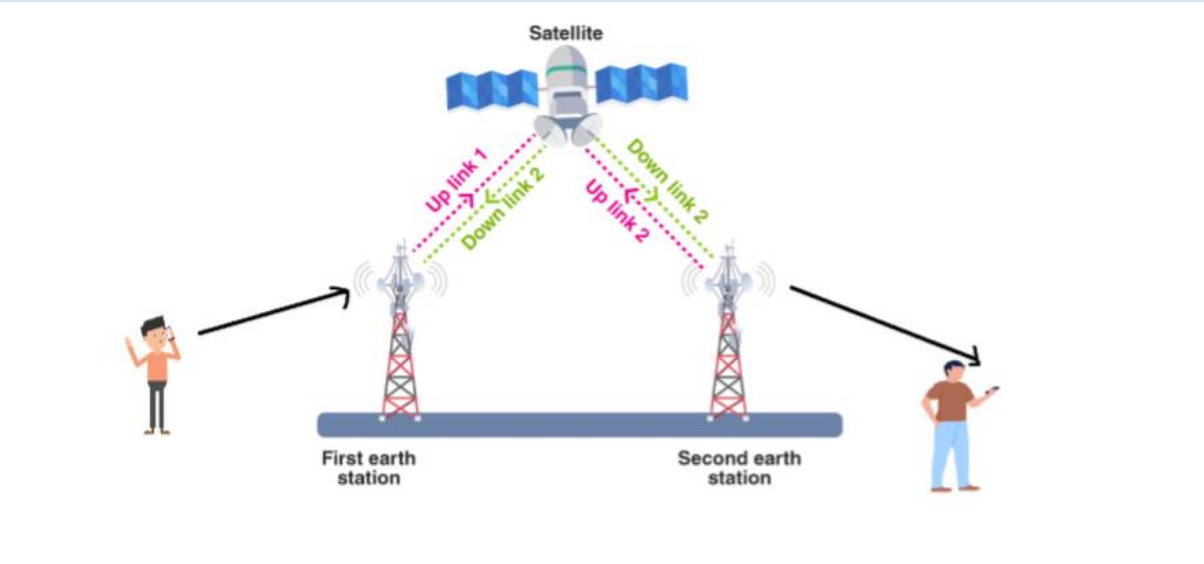
Application of Satellite Communication

1. **Telecommunication (Long Distance Telephone Calls):**

Satellites allow us to make long-distance phone calls without wires, connecting people all over the world.

How it Works:

When you make a phone call, your voice is turned into microwave signals and sent to a satellite in space. The microwave signals picked by the geostationary satellite in space (uplink) are weak due to the distance travelled. The geostationary satellite in space then amplifies (boosts) the signals. The signals are then retransmitted to the person's phone. This process happens quickly, allowing us to talk to anyone, anywhere.

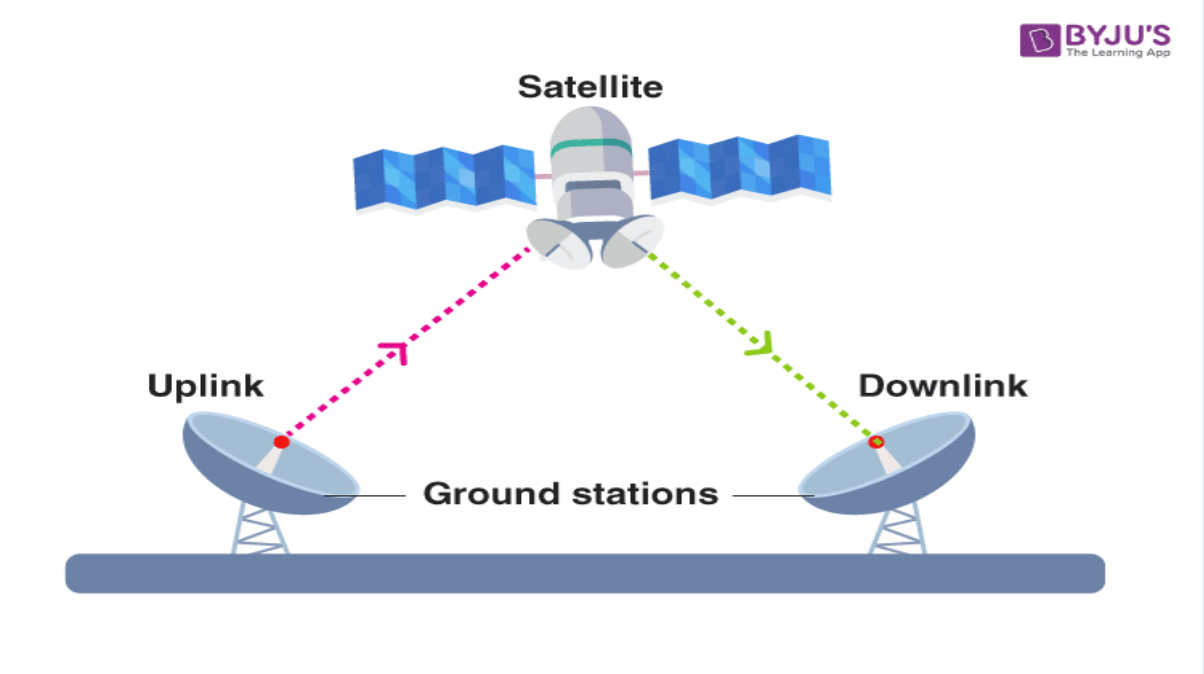


2. Satellite TV (e.g., DStv):

Satellite TV services like DStv use satellites to broadcast television programs.

How it Works

TV stations or providers transmit their programs in form of microwaves. Ground stations transmit signals to communication satellites using radio waves. The signals picked by the geostationary satellite in space (uplink) are weak due to the distance travelled. The geostationary satellite in space then amplifies (boosts) the signals. The signals are then retransmitted and received by the satellite dishes installed at subscribers' homes. These Signals can carry various types of data, including voice, video, internet, and broadcast television.



Advantages of Satellite Communication

- Global Coverage: Satellites can reach remote and inaccessible areas where traditional infrastructure is impractical.
- Reliability: Satellite communication is less susceptible to natural disasters and infrastructure damage.
- Scalability: Satellite networks can be easily expanded to accommodate growing demand for connectivity**.**

Challenges of Satellite Communication

- Latency: Signals traveling to and from satellites experience some delay, impacting real- time applications like online gaming.
- Cost: Building and launching satellites is expensive, leading to higher service costs compared to terrestrial networks.

- Spectrum Allocation: Limited spectrum availability can constrain the number of users and services that satellite networks can support.

Global positioning system (GPS)

A global positioning system (GPS) is a network of satellites and receiving devices used to determine the location of something on Earth. Some GPS receivers are so accurate they can establish their location within1 centimetre.

GPS receivers provide location in latitude, longitude, and altitude. They also provide the accurate time.

GPS is a system made up of three parts i.e satellite, ground stations and receivers.

How GPS Works:

The GPS system consists of a group of 24 to 32 satellites orbiting the Earth. These satellites are positioned in such a way that at least four satellites are visible from any point on the Earth's surface at any given time.

Each GPS satellite continuously broadcasts signals containing information about its position and the precise time the signal was sent. The signals are transmitted in the form of radio waves at specific frequencies.

A GPS receiver, such as those found in smartphones, car navigation systems, or standalone GPS devices, picks up these signals. The receiver needs to have a clear view of the sky to receive signals from multiple satellites.

The GPS receiver calculates its distance from each satellite by measuring the time it takes for the signals to travel from the satellites to the receiver. Since the speed of electromagnetic waves is known, the receiver can determine how far away each satellite is based on the time delay of the signals.

By knowing the distances to at least four satellites, the GPS receiver uses some special geometry (known as trilateration) to determine its precise position on Earth in 2 or 3 dimensions.

Uses Of Global Positioning System (GPS)

1. Surveyors use the GPS information to help them carry out accurate surveys and mappings
2. Navigation, It helps people to easily move from one place to another.
3. Tracking of Objects. Wildlife organizations often use this technology to locate where abouts of some wildlife when carrying out population counts.
4. Determining location of people. Smartphone being GPS device has often been used to precisely locate whereabouts of individuals.
5. Timing. GPS is useful aid in taking accurate time measurements.

SPACE EXPLORATION

Space exploration represents humanity's desire and quest for knowledge about the universe we inhabit.

From the first satellites launched into orbit to the monumental achievements of manned missions to the Moon and robotic probes exploring distant planets, space exploration has expanded our understanding of celestial bodies, their origins, and the vastness of space.

Reasons As To Why Space Exploration Remains An Important Element Of Science;

1. Discovering New Frontiers: Space exploration helps us learn about other planets, stars, and galaxies, expanding our understanding of the universe.
2. Technological Advancements: Developing and launching satellites requires advanced technology, which leads to innovations in science and engineering.
3. Global Connectivity: Satellites play a vital role in global communication, making the world more connected and accessible.
4. Origins of the universe: Space exploration helps us to understand how certain objects in the universe such as stars and planets form, by harnessing this knowledge, we can best understand the planet on which we live.
5. Environmental Monitoring: Satellites help monitor Earth's environment, contributing to conservation efforts and disaster management.

Space stations

These are artificial orbital structures designed in such a way that they can support human life when on exploration in the outer space. i.e the International Space Station

International Space Station (ISS)

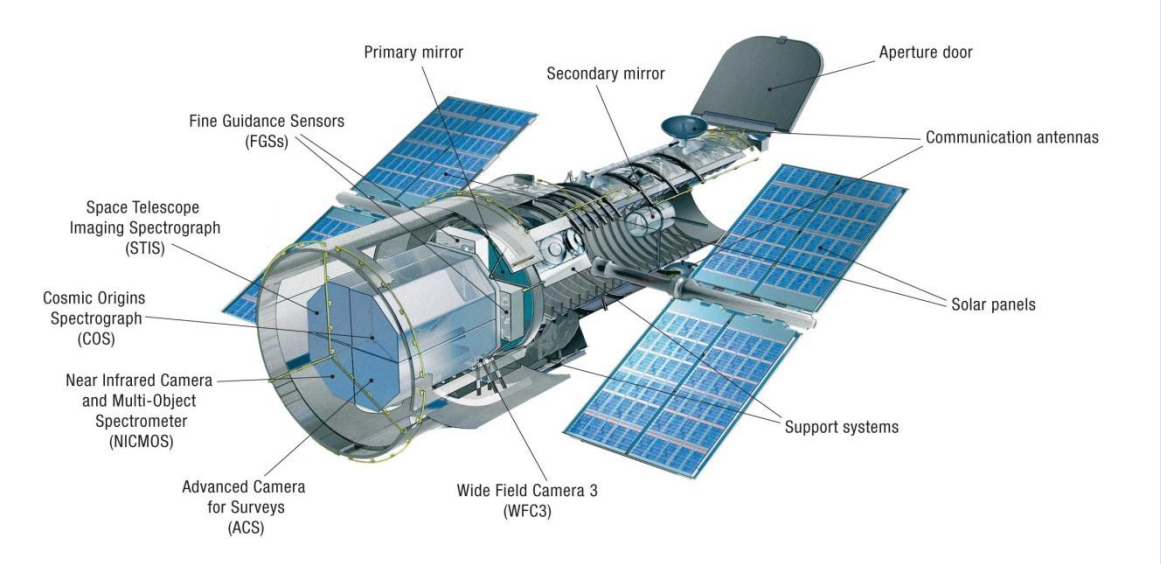
International Space Station is a habitable space laboratory. It orbits the Earth once every 92minutes. Scientists inside the ISS are able to many valuable experiments in a microgravity environment. NASA is using the Space Station to learn more about living and working in space.

Role of International Space Station.

- Remote sensing ISS can be used as a platform for earth observation and remote sensing. This facilitates broad range studies in basic and applied science across many fields including the study of earth's surface and atmosphere.
- The ISS provides a suitable platform for researchers to validate technologies for space crafts, satellites and materials which require to withstand harsh conditions on earth.
- It serves as a symbol of international coloration with contributions from space agencies like NASA, Roscosmos, ESA, JAXA and CSA

Hubble Space Telescope

Hubble Space Telescope is a space telescope that was launched into low Earth orbit that has played as a vital research tool. It faces towards space and takes photograph of planets, stars, comets and galaxies. It only takes images in black and white. It has seen galaxies that are trillions of miles away. Scientists are learning a lot about space from Hubble Pictures. The Hubble space telescope does not travel to stars, planets or galaxies. It takes pictures of them as it whirls around the earth at about 17000 meters per hour



Uses of the Hubble space telescope.

- **Studying the Universe's History:** Hubble has been instrumental in determining the age of the universe, helping to refine estimates of the Hubble constant, which describes the rate of expansion of the universe. By observing distant galaxies and measuring their redshift, Hubble has provided crucial data for understanding the universe's past and its future.
- **Exploring Galaxies:** Hubble has captured stunning images of galaxies at various stages of their evolution, shedding light on their structures, formation, and interactions. It has contributed to our understanding of galaxy mergers, the role of supermassive black holes at galactic centres, and the distribution of dark matter within galaxies.
- **Studying Exoplanets:** While Hubble wasn't specifically designed to detect exoplanets, it has been used to study their atmospheres indirectly through techniques like transit spectroscopy. By analysing the light that passes through the atmospheres of exoplanets as they transit in front of their parent stars, scientists can infer their composition and properties.
- **Investigating Star Formation:** Hubble's high-resolution images have provided insights into the processes of star formation within our own Milky Way galaxy and in nearby star- forming regions. It has observed protoplanetary disks around young stars, capturing the birthplaces of new planetary systems.
- **Probing the Early Universe:** Hubble's ability to observe distant objects has allowed astronomers to study the early universe shortly after the Big Bang. It has detected some of the most distant galaxies ever observed, providing clues about the conditions in the early universe and the formation of the first stars and galaxies.

QUESTION

1.(a) What are the uses of artificial satellites?

(b) Discus how people’s lives would be disrupted in the absence of satellites.

2.(a) What is GPS and how does it work? (b)What are the uses of GPS?

3.(a) What is Hubble space telescope?

(b) What makes Hubble Space telescope different from telescopes on earth?

(c) What is NASA and other space agencies learning from the Hubble Space Telescope?

4.(a) Describe any three areas of research on the International Space station?

(b) Why is the Space Station important?