

ELEMENTARY ASTRONOMY

What is Astronomy?

- Astronomy is the study of Universe and celestial bodies.
OR
- Astronomy is a science that deals with the study of objects and phenomena beyond the Earth's atmosphere.
OR
- Astronomy is the branch of Science that deals with the study of origin, evolution, composition, distance and the motion of all bodies and scattered matters in the Universe.

HISTORICAL BACKGROUND OF ASTRONOMY

- The Word Astronomy is derived from two Greek words "Astron" and "nomos".
 - (i) Astron means star.
 - (ii) Nomos means law or cultures.

thus: Astronomy deals with the study of Universe (Cosmos) and everything contained in it.

UNIVERSE

What is Universe?

- Universe is the totality of Space and Time together with Matter and Energy.

ASTRONOMERS

- Astronomers are the people who are involved in astronomy.

YOGI NOTES

IMPORTANCE OF ASTRONOMY

- Astronomy is important in many ways. The following are some uses of astronomy.
 - i) Astronomy can be used for navigation
 - ii) The knowledge of astronomy helps us to predict changes of weather.
 - iii) Expand our employment opportunities.
 - iv) Enables us to understand the occurrence of eclipses of the Sun and the Moon.
 - v) Development of Astro-tourism including Space tourism.

IMPORTANCE OF ASTRONOMY IN THE ANCIENT TIME

- In the Ancient time, astronomy was important in the following way
 - i) It was the earliest method of measuring time
 - ii) It was used to develop Calendars.
 - iii) It was used in both land and sea navigation
 - iv) Used in space exploration
 - v) To study the origin of the earth and life

SAMPLE QUESTIONS

- a) Explain the term Astronomy and state its importance.
- b) Briefly explain the composition of the Universe.
- c) a) Mention and describe briefly the galaxy to which our Solar System belongs.
b) What is the shape of the galaxy described in part (a)?

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ASTRONOMICAL THEORIES

- There are two theories
 - (a) Geocentric theory
 - (b) Heliocentric theory
- theories of the solar system

(A) GEOCENTRIC THEORY

- Is the theory which considers that the earth is at the centre and other heavenly bodies are orbiting around it.
- It was based on religious beliefs, observation and common-sense.

(B) HELIOCENTRIC THEORY

- This is the astronomical model in which the earth and planets revolve around the sun at the centre of the solar system.
- It was put forward by Nicolaus Copernicus to replace the geocentric theory.
- Heliocentric theory opposes the geocentric theory and it is able to explain many observations made by Astronomers.

OBSERVATIONS MADE BY ASTRONOMERS

- Rotation of the earth about its own axis and its revolution around the sun.
- Variations in brightness of Venus and Mars.
- Clarifications for the positions of Venus and Mars with respect to the Sun.
- Logical estimation of the size of the Sun with respect to that of the Earth.

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SHORTFALLS OF HELIOCENTRIC THEORY

- (i) The Sun was thought to be the centre of the Universe but it is Only the centre of the Solar System.
- (ii) Orbits of the planets were thought to have circular shapes, but nowadays they are known to have elliptical shapes.
- (iii) The relative positions of the stars seemed to remain the same despite the Earth's changing view points as it moved around the Sun.

BASIC CONCEPTS OF SOLAR SYSTEM

What is Solar System?

- Solar system is the collection of heavenly bodies that revolve around the Sun.
- The Solar system Composed of dwarf planets, eight planets and their moons, as well as asteroids, comets and meteors.

STARS

What is star?

- A star is a large celestial body made up of hot gases known as plasma.

Plasma: Refers to an ionized gas in which a certain proportion of electrons are free rather than bound to an atom or molecule.

Hobby R

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GALAXY

What is galaxy?

- A galaxy is a giant collection of stars, gas and dust.
- Most of stars in the Universe are in the galaxies
- Our Solar System belongs in the Milky Way galaxy

MILKY WAY

What is Milky Way?

- Milky Way is the galaxy that contains our Solar System

PLANETS

A Planet : Is a celestial object which orbits a star.

- The planets revolve around the Sun, they are held in orbit by the gravitational pull of the Sun.
- Planets do not give their own light, but rather reflects the Sun's light.

NUMBER OF PLANETS

- Currently, there are eight planets orbiting the Sun. Starting with the closest planet from the Sun, these are .

1 (05)

- (I) Mercury
- (ii) Venus
- (III) Earth
- (IV) Mars
- (V) Jupiter
- (VI) Saturn
- (VII) Uranus
- (VIII) Neptune

TYPES OF PLANETS

- The planets in the Solar System are divided into two types namely:-
 - (a) Rocky-terrestrial (Earth-like) planets
 - (b) Jovian planets

(A) ROCKY TERRESTRIAL PLANETS

- These planets are nearer to the Sun
 - i) Mercury
 - ii) Venus
 - iii) Earth
 - iv) Mars
- They are also known as innermost planets.

(B) JOVIAN PLANETS

- These planets are further away from the sun
 - i) Jupiter
 - ii) Saturn
 - iii) Uranus
 - iv) Neptune
- These are outer planets (Gas Giants)

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DIFFERENCES BETWEEN ROCKY TERRESTRIAL AND JOVIAN PLANETS.

ROCKY TERRESTRIAL PLANETS	JOVIAN PLANETS
They are mostly made up of solid materials	They are mostly made up of gases or ice
They are closer to the Sun	They are far away from the Sun
They are denser than Jovian planets	They are less dense
They have fewer moons	They have many moons
They are small in size	They are large in size

CHARACTERISTICS OF PLANETS.

- i) It is a celestial body that orbits a star
- ii) It has cleared the neighborhood around its orbit.
- iii) It is massive enough so that its own gravity causes it to assume a spherical shape.

NOTE : Pluto fails to meet the second characteristics, that is, it has not cleared neighborhood around it. Therefore, it is termed as a dwarf planet.

DWARF PLANET

What is dwarf planet?

- Dwarf planet is a celestial body orbiting the Sun that is massive enough to be rounded by its own gravity but has not cleared its neighboring region and hasn't satellite.

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DIFFERENCE BETWEEN STARS AND PLANETS

STARS	PLANETS
• Emit their own light	• Do not emit their own light
• Twinkle at night	• Do not twinkle at night
• Appear to be moving from East to west	• Move around the Sun from West to east
• Countless in number	• There are eight in the solar system
• Very big in size but they appear small because they are very far away	• Very small in size as compared to stars
• Are in gaseous form	• Are in solid form

Problem - 04

- Astronomy in general is the study of the Universe and all heavenly bodies, analyse four (4) bodies that compose the physical universe

ANSWER

- The four bodies that compose the physical Universe are
 - i) Stars (including Sun)
 - ii) Planets
 - iii) Moon
 - iv) Galaxy

Problem - 05

- Why stars twinkle at night?

ANSWER

- Because all the light is coming from the single point, its path is highly susceptible to atmospheric pressure

SIMPLY

- The stars twinkle at night because of the effects of our atmosphere.

Problem-06

- State the general trends in variations of the following quantities with increasing distances of the planets from the sun.

- (i) Average temperature of the planets.
- (ii) Average densities of the planets
- (iii) Period of revolution of planets around the sun.

ANSWER

i) Average temperature of the planets decreases with increasing distance of the planets from the sun.

ii) Average densities of the planets are decreases from Mercury to Saturn.

iii) Period of revolution of planets around the sun increases with increasing distances of the planets from the sun.

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Problem - 07

a) What do you understand by the following terms

- i) Galaxy
- ii) Solar System
- iii) Constellation

- b) i) Differentiate between stars and planets
ii) Give the name of one of the star closest to the earth.
- c) i) Name the largest planet in the solar system
ii) Name two brightest planet in the solar system.

ANSWER

a)

- i) Galaxy is a giant collection of stars, gases and dust.
- ii) Solar system is the collection of the Sun, eight planets and their moons, comets, asteroids, meteoroids and dwarf planets revolving around the Sun.
- iii) Constellation is a group of stars that form a definite shape or pattern when viewed from the earth.

b) i) Refer to notes - Page - 08

- ii) Sun

c) i) Jupiter

- ii) Venus, Jupiter.

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SATELLITE

What is satellite?

- Satellite is a celestial body that revolve around the planets.

TYPES OF SATELLITE

- There are two types of satellite, namely
 - (a) Natural satellite.
 - (b) Artificial satellite.

(A) NATURAL SATELLITE

- Natural satellite is the natural celestial in which revolves around the planet.
- Example, moon.

(B) ARTIFICIAL SATELLITE

- Artificial satellite is the man made satellite and spacecraft that orbit the planet.

USES OF THE EARTH SATELLITE

- (i) Moon leads to ocean tides
- (ii) Man-Made satellite used to reflect radio waves for communication

ASTEROIDS

- Asteroid is a large rocky body in space that revolve around the Sun

OR

- Asteroid is an astronomical body smaller than planets that orbits the Sun.

(ii)

NB: Asteroids lies between mars and jupiter
and they are referred as minor planets.

METEORS

- Are asteroids which enter the earth's atmosphere and burn completely before reaching the earth's surface.
- They are also called shooting stars.

METEORITES

- Are meteors that survive the passage through the earth's and reach the ground.
OR
- A meteorite is a piece of rock or metal that has fallen to the earth's surface from outer space as a meteor.
- In Tanzania a 16 ton piece of meteorite found at Mbosi Mbeya called Mbosi Meteorite

COMETS

What is comet?

- Comet is a small icy celestial body that revolves around the sun.

Meteoroid : Is a smaller body than asteroid that moves in the solar system that would become a meteor if it entered the earth's atmosphere.

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Problem - 08

- (a) i) Explain the terms astronomy and asteroids
ii) Is Scorpion a galaxy or a constellation?
Give reason(s) for your answer.
- (b) Distinguish between a Comet and a meteor
- (c) Which planet in the Solar System is
i) Closest to the Sun ?
ii) Farthest from the Sun ?
iii) Closest to the earth ?
iv) Surrounded by rings ?
v) The second largest planet ?

ANSWER

(a) i) Astronomy is a branch of science that deals with the study of origin, evolution, composition and motion of the Universe and the celestial bodies, gas and dust with it.
An asteroid is a small rock object within the Solar System which moves in elliptical orbit primarily between the orbits of Mars and Jupiter.

ii) Scorpion is a constellation.

Reason : It is a small group of stars that form a definite shape or pattern when viewed from the Earth, whereas if it were a galaxy it would consist of billions of stars.
It is found inside the Milky Way galaxy, thus it can not be a galaxy.

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(b)

Comet	Meteor
<ul style="list-style-type: none">• Is a small icy cold spherical body that revolves around the Sun.	<ul style="list-style-type: none">• Is a small solid body (or meteoroid) that enters a planet's atmosphere from outer space and is raised to incandescence by the friction resulting from its rapid motion

(c)

- i) Mercury
- ii) Pluto
- iii) Venus
- iv) Saturn
- v) Saturn

Problem-09

- (a) Do stars emit light only during the night?
- (b) With the strong reason, explain why meteors are not visible during the day.

ANSWER

- (a) No, the stars emit light throughout the day but due to the brightness of the Sun, the light of the stars can not be seen.
- (b) The brightness of meteor is extremely small compared to that of the Sun, therefore, it is not seen during the day time.

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GRAVITATIONAL FORCE

- Gravitational force is the attractive force existing between any two objects that have masses.

NEWTON'S LAW OF UNIVERSAL GRAVITATION

- Newton's law of universal gravitation states that "Every object in the Universe attracts every other object with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres".

Mathematically

$$F \propto M_1 M_2 \propto \frac{1}{r^2}$$

$$F \propto \frac{M_1 M_2}{r^2}$$

$$F = \frac{G M_1 M_2}{r^2}$$

Where

G = Constant of proportionality (called the Universal gravitational constant).

NOTE : Gravitational force is actually very weak force. The pull is too weak to be felt between two small objects.

: It is only when at least one of the masses is very large that the gravitational force can be felt.

CONCEPT OF GRAVITY

What is gravity?

- Gravity is the gravitational force that attracts a body towards the centre of the earth.
- As we go above the surface of the earth, acceleration due to gravity goes on decreasing that is why, the astronaut in space can float without falling because the gravitational force is almost zero in the outer space.

SPACE SUIT CASES TO AN ASTRONAUT

Case 01 : If the Astronaut goes in the outer space he need a space suit due to the following reasons.

- i) Protect his body from low pressure
- ii) Supply astronaut with O₂ to breath
- iii) Supply water to drink during space walks.

- iv) Protect his body from being injured from impacts of small bits of space dust.

(v) Protect the astronaut from cold and dangerous radiations.

Case 02 : What could happen if an astronaut would not put on a space suit?

(i) Boiling blood :

→ The lower the pressure, the lower the boiling point, In space there is no air pressure. So boiling point could easily drop to his body temperature. That means his blood would start to boil.

(ii) Cell mutation:

→ He also be bombarded with dangerous radiation from the sun and other stars.

(iii) Loss of bowel control

→ He could lose control due to severe lack of oxygen.

(iv) Bloating

→ If the liquid in his blood stream started boiling, it would turn into gas that would make his skin swell.

NOTE : The astronaut use small jets of gas in his movements (maneuvers) instead of swimming like fish because there is no matter (atmosphere) to cause resistance of his movements to move forward (due to Newton's 3rd law) (17)

Problem-10

- (a) Explain why the weight of a body changes if it is taken from the equator toward one of the poles.
- (b) Rocket moves from the earth to a planet X. If its weights 10000N and 30N on the earth and on planet X respectively, determine the gravitational force on planet X.

ANSWER:

(a) The weight of the body changes as it is takes from the equator toward one of the pole simply because the weight of the body (i.e the force of gravity) it varies inversely proportional to the radius of the earth. Since the earth is spherical in shape it appears to has a greater radius at the equator and smaller radius at the both of the poles. For this reason, the weight must be large at one of the poles and less at the equator. Therefore, the weight of the body becomes large as it is takes from the equator toward one of the pole.

Mathematically

→ This is shown by the Newton's law of universal gravitation

$$F = \frac{G m_1 m_2}{r^2}$$

(18)

Where

F = Universal gravitation

M_1 = Is the mass of first point mass.

M_2 = Is the mass of second point mass.

r = Is the distance between two point mass.

G = Is the Universal gravitational Constant.

(b) Data given

Weight of a body on planet X (w_x) = 30 N

Weight of a body on the earth (w_e) = 10000 N

Gravitational force on the earth (g_e) = 9.8 N/kg

Gravitational force on planet X (g_x) = Unknown

Solution

→ Consider the weight of the body does not change with the location, then

Mass of a body = Mass of a body on
on the earth (m_e) = Mass of a body on
planet X (m_x)

$$m_e = m_x = 1020.408 \text{ kg}$$

therefore

$$w_x = m_x g_x$$

$$g_x = \frac{w_x}{m_x}$$

$$g_x = \frac{30 \text{ N}}{1020.408 \text{ kg}}$$

$$= 0.0294 \text{ N/kg}$$

∴ Gravitational force on planet X is 0.0294 N/kg

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Problem - 11

- With the aid of formula state the Newton's law of Universal gravitation
- Distinguish between Heliocentric and geocentric theories

ANSWER

- Newton's law of Universal gravitation

$$F = G \frac{m_1 m_2}{r^2}$$

Where

G = Universal gravitational Constant

F = Universal gravitation

m_1 = Is the mass of first point mass

m_2 = Is the mass of second point mass

r = distance between two point masses

- The Newton's law of Universal gravitation states that "Any two bodies in the Universe attract each other with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between them"

(b) Heliocentric theory

- Heliocentric theory was based on the position of the sun relative to the earth in which the sun and not the earth was stationary at the center. This theory states that "All other heavenly bodies including the earth moved around the sun in circular orbit." (20)

"while rotating about their own axes"

WHILE

Geocentric theory : Was the theory based on religious beliefs, observation and common-sense. This theory states that ;

"There was no direct evidence to suggest that the earth is in motion . The other bodies, like the Sun, were observed to be in motion across the sky".

CONSTELLATIONS

What is Constellation ?

- Constellation is a group of stars that form a definite shape or pattern when viewed from the earth .

OR

- Constellations are small groups of bright stars that form patterns in the sky which resemble familiar with animals and objects on the earth .

NOTE : There are about 88 known constellations and some of them (known) are LEO, GEMINI, IRON, URSA MAJOR, CORPUS, PIRATES, CANIS MAJOR and the SOUTHER CROSS.

U.B.N ACADEMIC CENTRE
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TYPES OF CONSTELLATIONS

— There are three types of Constellations namely

- (a) Circumpolar Constellations.
- (b) Seasonal Constellations.
- (c) Zodiac Constellations.

(A) CIRCUMPOLAR CONSTELLATIONS

- Are Seen all of the year round in the night sky for observers in high northern or high southern latitudes because of the rotation of the earth.

(B) SEASONAL CONSTELLATIONS

- Seasonal Constellation are the Constellation that appear at some time of the year and are not seen at other time of the year.
- In Tanzania and in Central Africa are closest to the equator so we do not see any Circumpolar stars or Circumpolar Constellations. Hence in Tanzania night sky we see only Seasonal Constellations.

(C) ZODIAC CONSTELLATIONS

- Is a set of Constellations situated along the ecliptic in the sky, through which the sun, moon and planets move.

Asterism: Is any prominent star pattern that is not a whole Constellation.

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NOTE: Asterism is any prominent star pattern that is not a whole constellation.

- Celestial Coordinate is a grid system for locating things in the sky.
- Black hole is a concentration of mass so dense that nothing - not even light - can escape its gravitational pull once swallowed up.

IMPORTANCE OF CONSTELLATIONS

(i) Religion

- Early religions believed that constellations were God's way of communicating to people on the earth.

(ii) Agriculture

- Early farmers used constellations to determine to determine the different seasons for growing crops.

(iii) Navigation

- Can help travelers to determine the direction of their destinations by locating neighboring constellations.

(iv) Nomads

- Nomads used constellations in travelling with their herds from one place to another, searching for pasture.

(v) Curiosity of studying nature

- Constellations as other celestial objects trigger humankind to explore more about the Universe.

THE EARTH AND ITS MOON

Moon : Is a natural satellite that moves in a circular orbit around the earth.

CHARACTERISTICS OF EARTH'S MOON

- The moon's gravitational field is one sixth of the earth's field ($g_{\text{moon}} = 1.6 \text{ N/kg}$)
- It takes 27.3 days to revolve around the earth. This period called sidereal month.
- Moon surface temperature are on the range of 107°C during the day and -153°C during night.
- It has no molten iron core so its haven't magnetism.
- Iron Core is surrounded by a rocky mantle and crust.
- It revolves in an anticlockwise direction around the earth.
- Moon has no atmosphere.

You SHOULD NOTE THAT

- Perigee : Is the moon's position when it is nearest to the earth.

2. Apogee : Is the moon's position when it is furthest from the earth.

3. Perigee : Is the moon's position when it is usually close to the earth.

SURFACE OF THE MOON

- There are two primary types of terrain of the moon, namely
 - (a) Lunar highlands
 - (b) Maria

(A) LUNAR HIGHLANDS

- Lunar highlands are bright zones on the surface of the moon.

(B) MARIA

- Maria is the dark region on the surface of the moon.
- Maria is an Italian word means Sea.

CAUSES

- Maria is caused by huge impact craters that were later flooded with molten lava.

NOTE : Most of Maria is covered with regolith, a mixture of fine dust and rocky debris produced by meteor impact.

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OCEAN TIDES

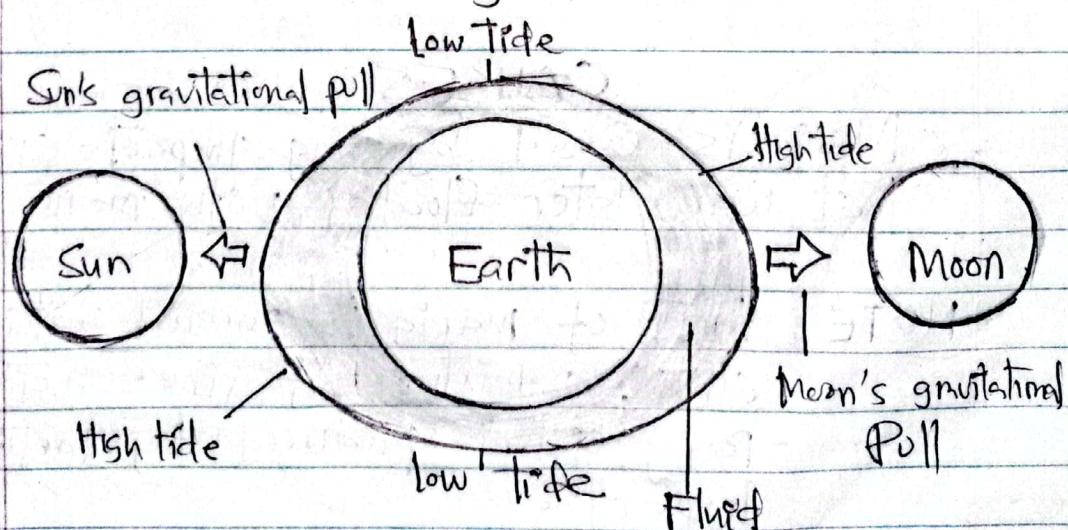
- Ocean tides are periodic rises and falls of large bodies of water.

CAUSES OF OCEAN TIDES

- Ocean tides are caused by the gravitational pull (force) between the earth and the moon.

HOW OCEAN TIDES OCCURS

- Due to difference in gravitational force the earth pulls the moon to keep it in orbit. also the moon pulls the earth and the sun pulls the earth to keep it in orbit. also the earth pulls the sun. This gravitational interaction tends to pull earth's fluid resulting in rising and falling of the ocean level. As the earth rotates on its axis two tides occur each day.



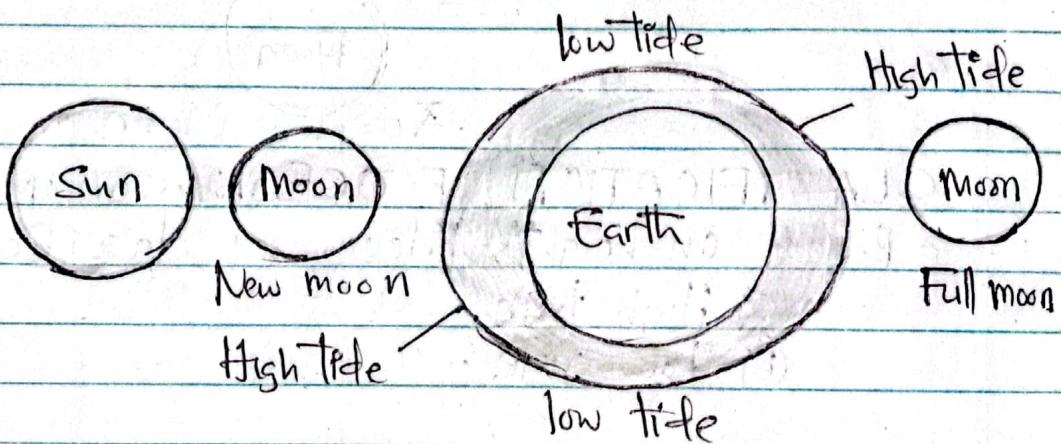
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TYPES OF OCEAN TIDES

- There are two types of ocean tides, namely
 - (a) Spring tides
 - (b) Neap tides
- } Based on lunar phase

(A) SPRING TIDES

- Spring tides occur when the Sun, moon and earth line up in a straight line
- They typically occur around a full or new moon and they are strong tides.

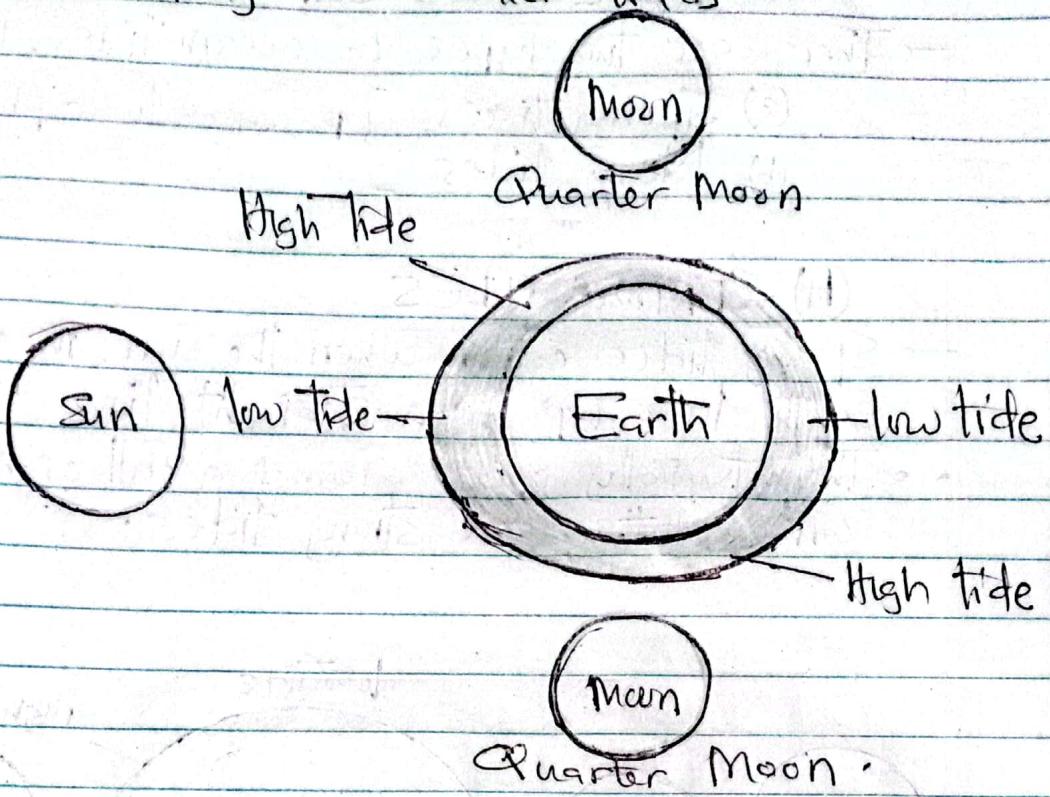


- The spring tides are called proxigean spring ocean tides.

(B) NEAP TIDES

- Neap tides occur when the gravitational forces of the Moon and the Sun are perpendicular to one another (with respect to the Earth).
- Neap tides occur during quarter moons. At this time, the Sun and the Moon are lying at right angles to each other giving their gravitational forces to cancel each other.

other. They are weaker tides.



CLASSIFICATION OF TIDES, BASED ON HEIGHT

- o Based on height, tides are classified as
 - (a) High tide.
 - (b) Low tide.

ADVANTAGES OF TIDES

- (i) High tides clear the sea shore from garbage.
- (ii) High tides are used for generating electricity.
- (iii) High tides enable bigger ships to move into harbor and unload.

Problem - 12

- (a) Briefly explain the causes of ocean tides.
- (b) Mention two types of tides.
- (c) With the aid of diagram, describe how ocean tides are formed.

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ANSWER

(a) Tides are caused by gravitational pull of the moon on the ocean of the earth.

(b) Types of ocean tides

i) Spring tides

ii) Neap tides

(c) How tides are formed (Diagram - Page # 26)

The moon's gravitational pull tries to pull everything around it including the earth; but since the earth is heavy the moon only pulls the water of the earth which bulges outwards towards it to a point where the moon's pull balances the earth's pull on the water, when this happens, water on that side bulges towards the moon, since the earth rotates on its axis two tides occur each day.

Problem - 13

(a) What is Zodiac light?

(b) Mention two uses of earth's satellite

(c) How are the bodies in the Solar System kept in their position?

ANSWER

(a) Zodiac light is the faint diffuse and roughly triangular white glow visible in the night sky extending from near the Sun. (Q)

(b) Uses of earth's satellite

- i) The moon leads to ocean tides.
- ii) Man made satellites help to reflect radio waves used for communication and so facilitate communication between different parts of the earth

(c) Bodies in the solar system are kept in their position by a combination of gravitational force and their velocity.

Problem-14

- (a) Which planet is often called "Morning star"?
- (b) Briefly explain how astronomy gave rise to the 12 months of the years.
- (c) Specify the difference that exists between galaxy and planet.

ANSWER

(a) Morning star is the name given to planet VENUS when it appears in the east before Sun rise.

(b) The 12 months of the year
→ Through astronomy man was able to determine the beginning and end of a month by observing the phases of the moon. It also determined the year from the changing position of sun &.

(c) Galaxy is a great collection of billions of stars and bodies which revolve around them. WHILE

Planet is a large object which revolves around star and which has cleared its neighbourhood by its gravitational force.

Problem - 15

- Olympus Mons is a large Volcanic mountain on which planet?
- Why does the moon change its shape daily?
- Briefly explain Why we see the same side of the moon?

ANSWER

(a) Mars

(b) Since moon doesn't emit its own light, then the "Moon light" 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.

(c) We always see the same side of the moon because the period of the moon on its axis is equal to the period of its revolution around the earth, so we only see the side that faces us and this side faces at us all the time.

X-END-X-OF-X-TOPIC-XX (31)