QUESTION NO#01

mention the full qs statement or the source of the qs for proper evaluation....

BLACK HOLE

DEFINITION:

A black hole is a region in space where the gravitational pull is so strong that nothing, not even light, can escape from it.

INTRODUCTION:

Predicted by Albert Einstein in 1915 through his General Theory of Relativity.

In 1960's, astronomers observed Cygnus X-1, a strong X-ray source, now confirmed to be a black hole.

TYPES OF BLACK HOLES:

There are four types of blalk holes on the basis of mass:

Type	Mass	Desciption
1- Stellar-mass Blatk Holes	3 - 20 Solar masses	Formed from the collapse of massive stars after supernova.
2. Intermediate-mass Black Holes	100 - 1000 solar masses	Rare; possibly formed by merger of several stars or black holes.

Biggest Black Hole currently → TON 618

3- Supermassive Black Holes	Millions to Billions of solar masses.	Found at the centers of galaxies, including our own Milky Way.
4- Primordial Black Holes (Theoretical)	Sub-planetary to several solar masses.	May have formed just after the Big Bang due to high density fluctuations.

Stellar mass (3-20 solar masses)

Intermediate- mass (100-1000 solar masses)

TYPES OF BLACK HOLES

Supermassive (Millions-Billions Solar masses)

Primordial (sub-atomic scale to thousands of solar masses [Theoretical yet])

FORMATION OF BLACK HOLE:

1-STELLAR EVOLUTION BEGINS:

- A massive star (at least 20 times the mass of a Sun) forms from a nebula (cloud of gas and dust)
- It burns hydrogen in its core through nuclear fusion, producing energy and outward pressure.

2- NUCLEAR FUEL DEPLETION:

- Over millions of years, the star fuses hydrogen into helium, then into heavier elements like Carbon and iron.
- Iron cannot undergo fusion, so energy production stops
- The outward pressure drops, and gravity takes over.

3- CORE COLLAPSE:

- With no force to balance gravity, the core collapses inwards rapidly.
- The outer layers are blown away in a powerful supernova explosion.
- The core shrinks dramatically in size and becomes extremely dense.

4- FORMATION OF A SINGULARITY:

- The core collapses into 'singularity' - a point of infinite density and zero volume.
- Around it forms an 'event horizon' - a boundary from which nothing (not even light) can escape.

5- BLACK HOLE IS BORN

- If the remaining mass of the core is greater than about 3 solar masses, it becomes a 'Black hole'.
- Otherwise, it may become a Neutron star or White dwarf (if smaller)

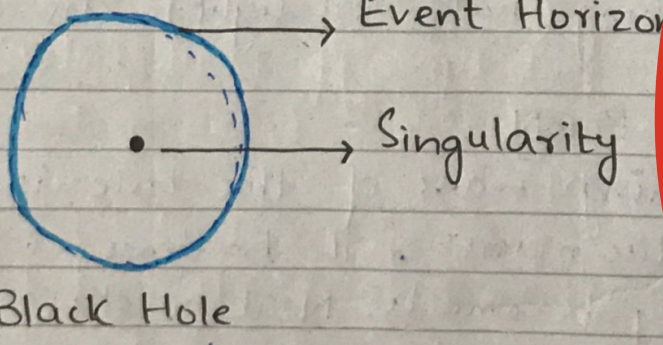
Nebula → Massive star → Fuel Exhaustion → Core collapse → Supernova → Singularity → Event Horizon → Black hole

HOW BLACK HOLES ARE DISCOVERED?

Since black holes do not emit light, they cannot be seen directly. Instead, scientists detect their presence indirectly through the effects they have on their surroundings.

eg (Cygnus X-1)

1. X-ray Emissions from Accretion Disks.
2. Stars near a black hole will orbit very fast due to gravitational pull (e.g → Sagittarius A* discovered by tracking stars orbiting it).
3. Gravitational Lensing
4. When two black holes merge, they form binary black holes and send gravitation waves - ripples in space-time. (e.g → detected by LIGO and VIRGO observatories in 2015)
5. Direct imaging (e.g → Event Horizon Telescope in 2019, captured the first ever image of black hole's shadow in galaxy M87)



(4)

QUESTION NO # 02

STAR	PLANET
DEFINITION	
. Star is a massive shining sphere of hot gas.	Planet is a round body in space that orbits a star.
LIGHT EMISSION	
. A star shines by releasing light produced by nuclear fusion.	Planets do not produce light.
ORBITAL COMPANIONS	
. Different heavenly objects revolve around star such as planet, dwarf planet, asteroid, etc.	. Objects that revolve around planets are called satellites (moon)
ORBITAL MOTION	
. Star revolve around the centre the centre of their galaxy.	. Planets revolve around star.
TEMPERATURE AND ENERGY SOURCE	
. Stars have very high temperature like sun has a surface temperature of 5500 to 6000c.	. Planets drive energy and heat from sun, therefore, the ones near to sun are hotter.
EXAMPLES	
. Sun, Proxima, Centauri, Antares and Pistol star.	Earth, Venus, Mars, Jupiter, etc.

MAGNITUDE OF STARS

DEFINITION:

Magnitude refers to the brightness of a star, measured in two ways:

APPARENT MAGNITUDE	ABSOLUTE MAGNITUDE
Brightness of star as seen from Earth.	Brightness of a star if it were placed at 10 Parsecs (32.6 light-years) from Earth
The Sun : −26.7 (very bright due to closeness)	The Sun : −4.8 (actual brightness at 10 parsecs)

COLOR OF STAR AND ITS RELATION WITH TEMPERATURE

Stars color is correlated with its surface temperature explained by blackbody radiation.

COLOR	TEMPERATURE	STAR TYPE
Blue	10,000 – 40,000 K	Very hot stars (Rigel)
White	~ 7500 – 10,000K	Hot stars (Vigel)
Yellow	~ 5,000 – 6,000K	Medium (Sun)
Orange	~ 3500 – 5000K	Cool stars (Arcturus)
Red	≤ 3500 K	Coolest (Betelgeuse)

- Hot stars appear Blue.
- Cooler stars appear Red.

QUESTION NO#03

UNIVERSE

The totality of everything ~~everythi~~ that exists, including all matter and energy, the planets, stars, galaxies and the contents of intergalactic space, is called Universe.

BIG BANG THEORY

There are multiple theories regarding the origin of universe but "Big Bang Theory" is widely accepted.

DISCOVERED BY:

The 'Big Bang Theory' was first proposed by 'Georges Lemaitre' in 1927. He initially refered it as the "Hypothesis of the primeval atom."

HUBBLE'S OBSERVATION:

'Edwin Hubble's' later observed in 1930s that galaxies are receding from each other provided strong evidence for an expanding universe, which supported Lemaitre's theory.

THEORY:

1. COSMIC INFLATION:

- Cosmic inflation refers to a brief period of exponential expansion that occured a fraction of a second after the Universe's birth, approximately 13.8 billion years ago.
- It is believed to have been driven by energy within the fabric of space-time.
- It explains → Uniformity of Universe, its flat geometry, tiny density fluctuations (Later evolved into galaxies and other cosmic structures)
- It set the stage for the Big Bang by stretching out space and smoothing out irregularities.

2. BIG BANG AND NUCLEOSYNTHESIS:

- After cosmic inflation, the universe entered a hot and dense state, 'Big Bang'. Within first few minutes, nucleosynthesis occured, forming light elements like hydrogen, helium and traces of lithium and beryllium. However, the universe remained too hot for atoms to fully form, so free electrons scattered light, keeping the Universe opaque.

3- RECOMBINATION:

- After 380,000 years, the universe had cooled down to capture free electrons, universe become transparent This allowed light to travel freely, resulted in cosmic microwave background.

4- THE DARK AGES:

- Universe entered a dark age for 200 million years.
- No galaxies or stars had formed, universe was filled with hydrogen and helium, with no source of light, atomic gas absorbing short wavelengths, the cosmos remained dark and opaque.
- It was interval between first atoms and first star.

5- FORMATION OF FIRST STAR:

As time passed, small fluctuations in density allowed gravity to pull gas together, region becomes hot and compact, nuclear fusion ignites, giving rise to first stars, stars grouped together to for first galaxies, illuminating the universe for first time after recombination.

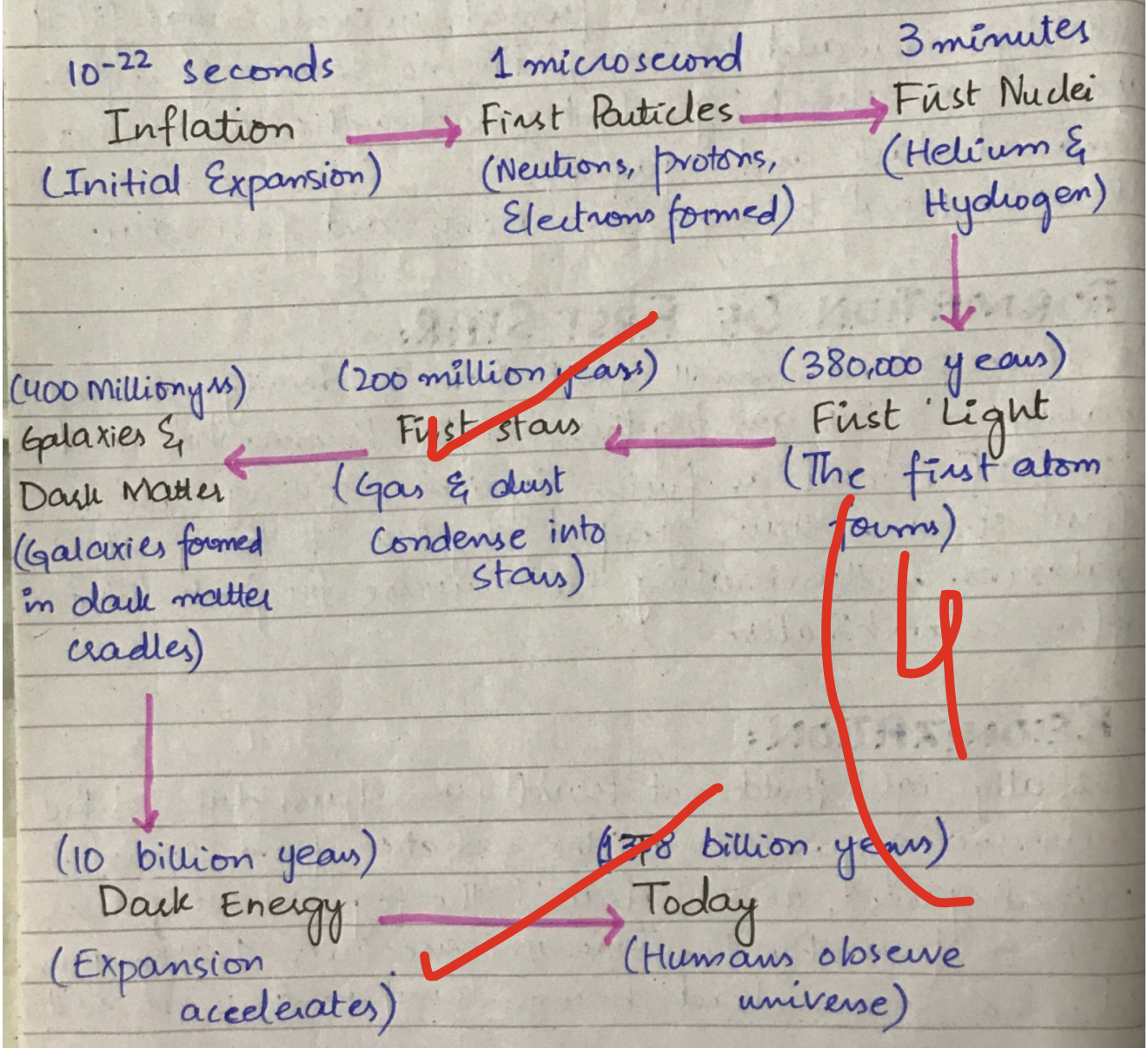
6. REIONIZATION:

- Initially, light could not travel from stars, due to the surrounding gas. Ultraviolet radiation from stars ionized gases, which cleared the fog, allowing star light to pass. By this time universe was 1 billion years old, the cosmos had become transparent as we see it today.

THE PRESENT AND THE FUTURE:

· Obsewations in 1998, of distant supernovae revealed that these stellar explosions wae fainter than expected indicating that universe is expanding. This phenomenon is attributed to the term 'Dark Energy'.

· Current theories suggest that universe will continue to expand, beroming colder and more diffuse over time.



How can Sun have such a strong gravitational field if its made of gases?

QUESTION NO# 04

GRAVITATIONAL FIELD

Every body of matter in this universe attracts other bodies of matter towards itself with a force. known as gravitational force. and a region of space surrounding a mass where gravitational force can be experienced is called gravitational field.

FACTORS AFFECTING GRAVITATIONAL FIELD:

- Man (m)
- Distance (d)

NEWTON'S LAW OF UNIVERSAL GRAVITATION:

Newton's law of Universal gravitation describes gravity as a force by stating that "every particle attracts every other particle in the universe with a force that is proportional to the product of their masses and inversely proportional to the square of the distance between their centers of mass.

$$\Rightarrow F \propto \frac{m_1 m_2}{r^2}$$

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

$\because$ G = Gravitational constant

$\because G = 6.67 \times 10^{-11} \frac{m^3}{kg \cdot s^2}$

Why sun has strong gravitational field?

Sun is a star. A star is a huge ball of gas, mostly hydrogen and helium.

1) Massive in nature:

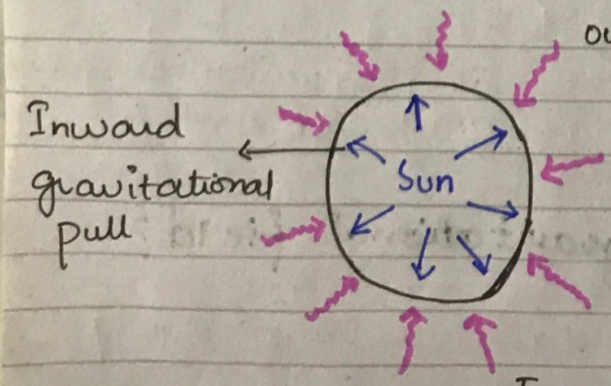
- Despite of being gaseous in composition, sun's gravitational field is strong, it is primarily due to it's enormous mass, not its gaseous composition, containing over 99% of the mass of the entire solar system.
- The sun's mass is about 330,000 times that of Earth, which means it has substantial gravitational pull.
- Newton's Gravitational Law:

→ As we discussed earlier, a/c to Newton's Univ. gravitational law, the strength of gravitational force is dependent on masses and distance.

→ Since, the Sun is massive, it exerts significant gravitational force on objects in its vicinity such as planets and other celestial bodies.

2) Compression of gases:

- Compression of gases within the sun is also a crucial factor. Immense gravitational force compresses the core of Sun. leading to high density and pressure. This inward generated ~~this~~ pressure is balanced by outward thermal pressure caused by high temperature in core. Hence, this balance maintains sun's stability and prevent it from collapsing under its own gravity.



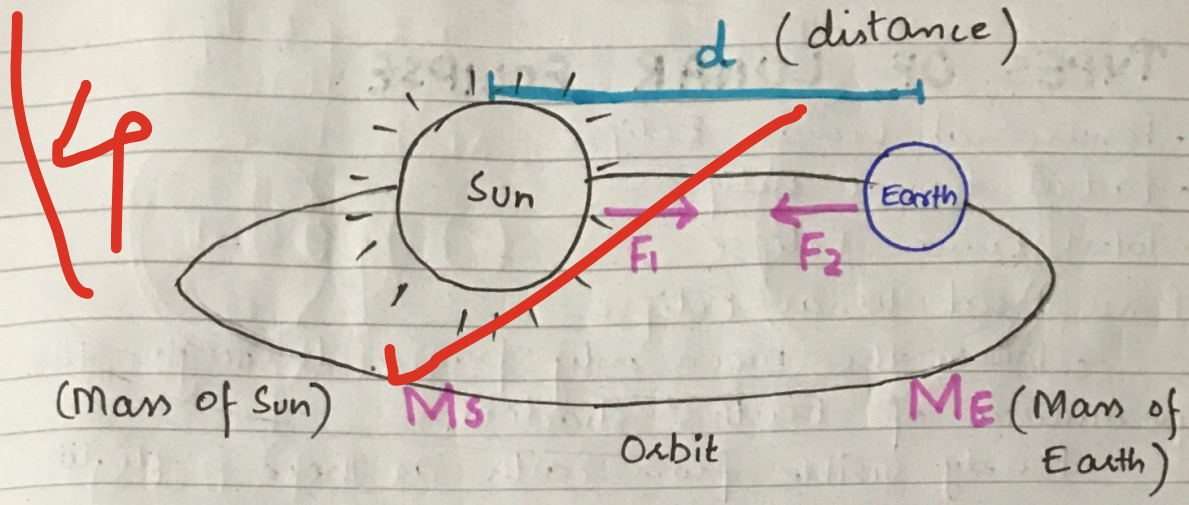
$\Rightarrow F \propto m_1 m_2$

$\Rightarrow F \propto \frac{1}{d^2}$

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

good answers!!

length, presentation and arguments are good.....



QUESTION NO.05

attempt and upload a single qs at a time for evaluation.....

ECLIPSE

An eclipse takes place when one heavenly body such as moon or planet moves into the shadow of another heavenly body, blocking light either partially or completely.

TYPES OF ECLIPSE

- Eclipse of the moon (Lunar Eclipse)
- Eclipse of the Sun (Solar Eclipse)

LUNAR ECLIPSE

The moon moves in an orbit around Earth, and at the same time, Earth orbits the Sun. Sometimes Earth moves between the sun and the moon. When this happens, Earth blocks the Sun light that normally reflected by the moon. Instead of light hitting the moon's surface, the Earth's shadow falls on it. This is called Lunar Eclipse.

When does it occur? Can occur only when the moon is full.

TYPES OF LUNAR ECLIPSE

- Penumbral Lunar Eclipse
- Partial Lunar Eclipse
- Total Lunar Eclipse

1) Penumbral Lunar Eclipse:
   - When the moon only passes through the penumbra of Earth's shadow.
   - Rarely visible from Earth as there is slight change of colour of the moon.

2) Partial Lunar Eclipse:
   - When part of the moon passes through the umbra of Earth's shadow.
   - Whole area is not obscured by the shadow.

3) Total Lunar Eclipse:
   - When the entire moon passes through the umbral region of Earth's shadow.
   - Moon is totally obscured. (In America)

Recent Lunar Eclipse: Was seen on Nov 8, 2022 and the next is expected on sep 7-8 2025 (according to Al-Jazeera and space report) across Asia, Africa, Australia and parts of Europe).

SOLAR ECLIPSE:

Sometimes when the moon orbits Earth, it moves between the Sun and Earth, blocking the light of the Sun from reaching Earth. This is called 'Solar Eclipse'.

When does it occur? Every 18 months at the time of new moon.

TYPES OF SOLAR ECLIPSE:

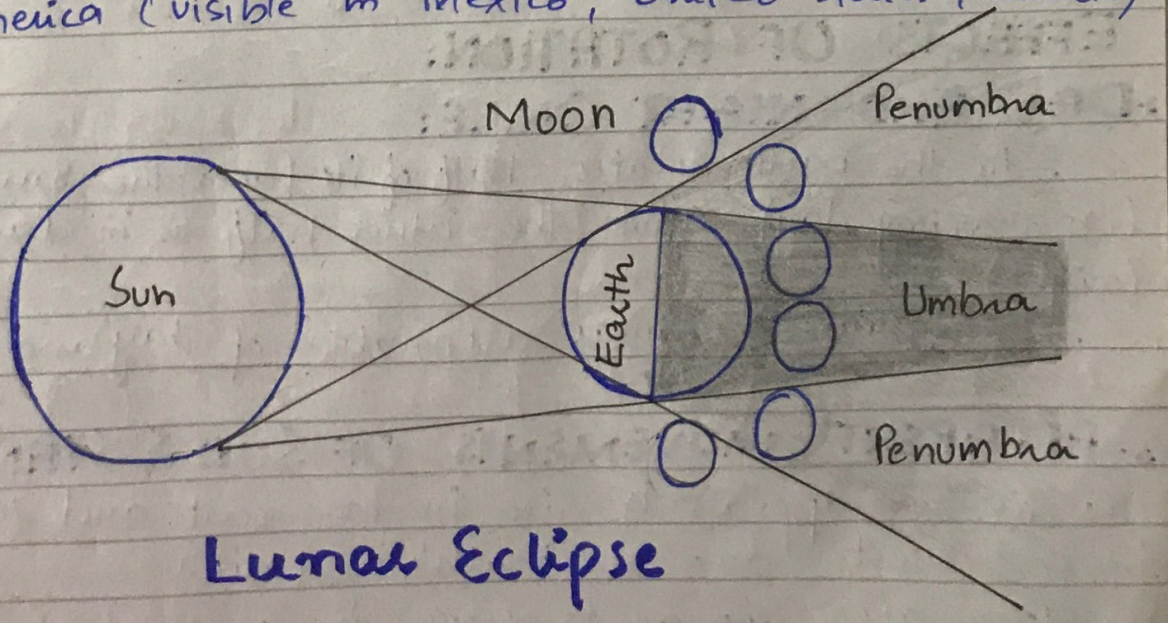
- Total Solar Eclipse
- Partial Solar Eclipse
- Annular Solar Eclipse

1) Total Solar Eclipse:
   - When the moon completely covers the sun, as seen from Earth.
   - Totality during such an eclipse can only be seen from a very small area on Earth. (area about 100 miles (60km) wide and 10,000 miles (16,100km) long.

2) Partial Solar Eclipse:
   Can be observed when the Earth, Sun and the moon do not align in a perfectly straight line and moon only partially covers the disc of the Sun.

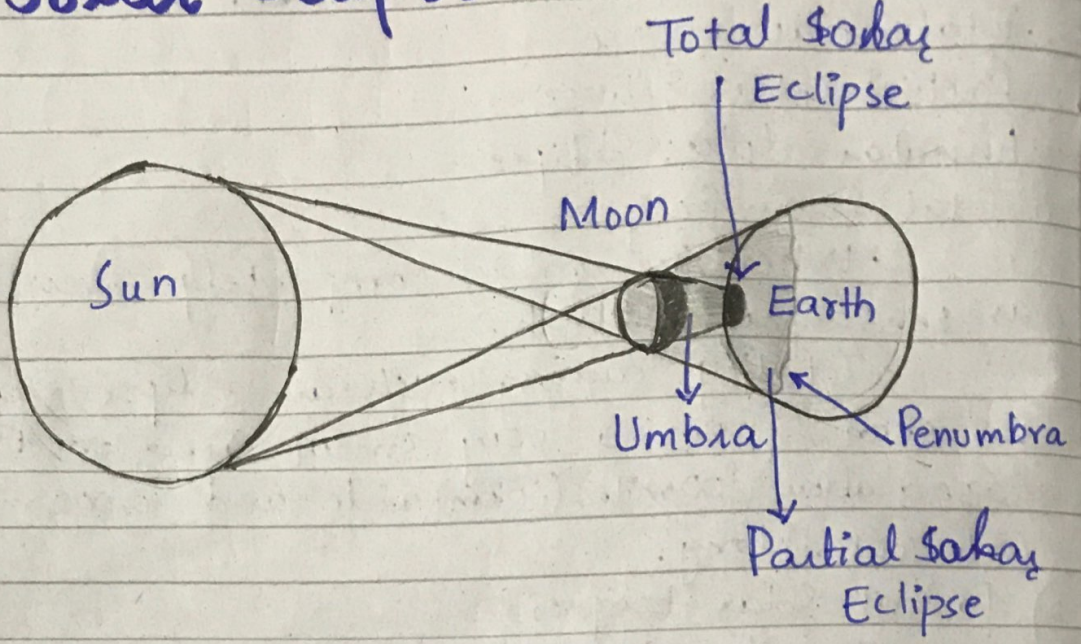
3) An annular Solar Eclipse:
   When the moon appears smaller than the Sun as it passes centrally across the Solar disc and a bright ring, or annulus, of sun remains visible during the eclipse.

Recent Solar Eclipse: On April 8, 2024 across North America (visible in Mexico, United States, Canada)



Lunar Eclipse

Solar Eclipse



QUESTION NO:06

EARTH'S ROTATION

The rotation of Earth refers to the spinning of Earth on its axis from west to east. It completes one rotation approximately every 24hours.

EFFECTS OF ROTATION:

1-DAY AND NIGHT CYCLE:

. As the Earth rotates, half of it faces the Sun (experiencing day), while the other half is in darkness (night)

. This causes regular alternation of day and night.

2- APPARENT MOVEMENTS OF SUN & STARS

. The Sun appears to rise in the east and sets in the west due to Earth's rotation.

. Stars also appear to move in a circular path in the night sky.

3- TIME ZONES:

- The Earth is divided into 24 time zones, each covering 15° of longitude.
- Rotation provides a basis for the standard time system globally.

4- CORIOLIS EFFECT:

- Due to rotation, moving objects (winds, ocean currents) are deflected.
- To the right in the Northern Hemisphere.
- To the left in the Southern Hemisphere.
- This effect influences weather patterns such as the formation of cyclones and trade winds.

5- TIDAL EFFECT: (in conjuction with the Moon)

1) While tides are primarily caused by the Moon's gravity, Earth's rotation plays a crucial role in how tides are experienced on Earth.
- The moon's gravity pulls ocean water towards it, creating a tidal bulge (high tide) on the side of Earth facing the Moon.

2) At the same time, the centrifugal force caused by the Earth-Moon system's rotation creates another bulge on the side opposite the Moon.
- So at anytime, there are two tidal bulges on Earth.
- As Earth rotates once every ~24 hours, different places move through these bulges.
- A coastal region rotates into the bulge (high tide) and out of the bulge (low tide)
- This gives 2 high tides and 2 low tides every 24 hours and 50 minutes.

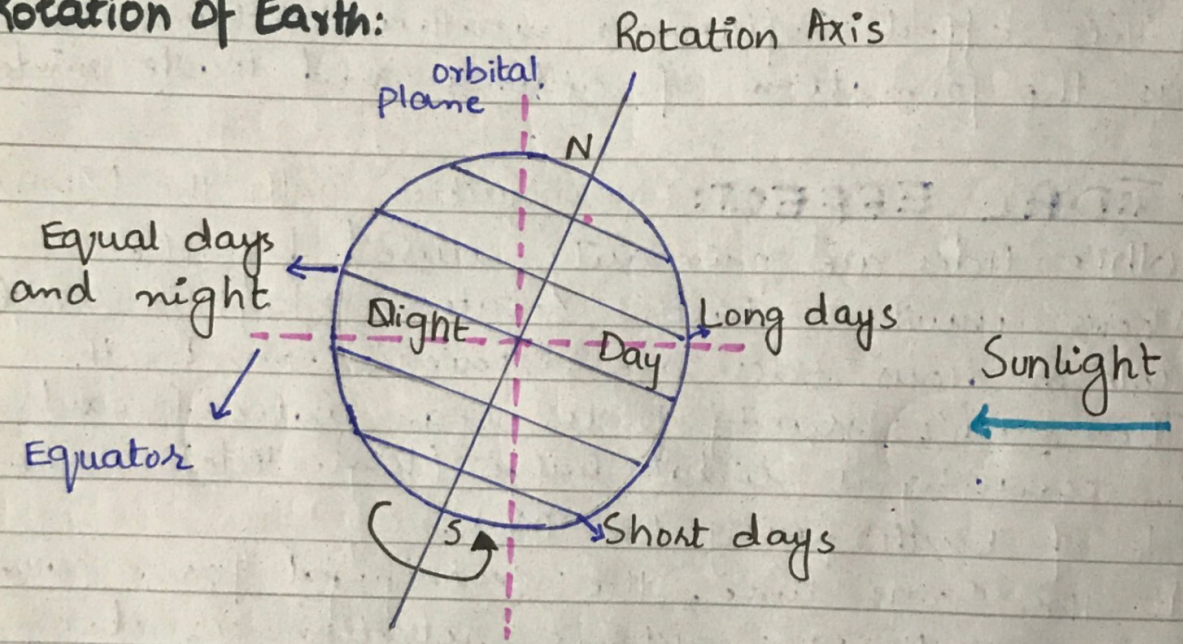
6. BULGING AT THE EQUATOR:

- Due to the centrifugal force caused by rotation, Earth is not a perfect sphere but an oblate spheroid.
- The equatorial center is larger than the polar diameter.

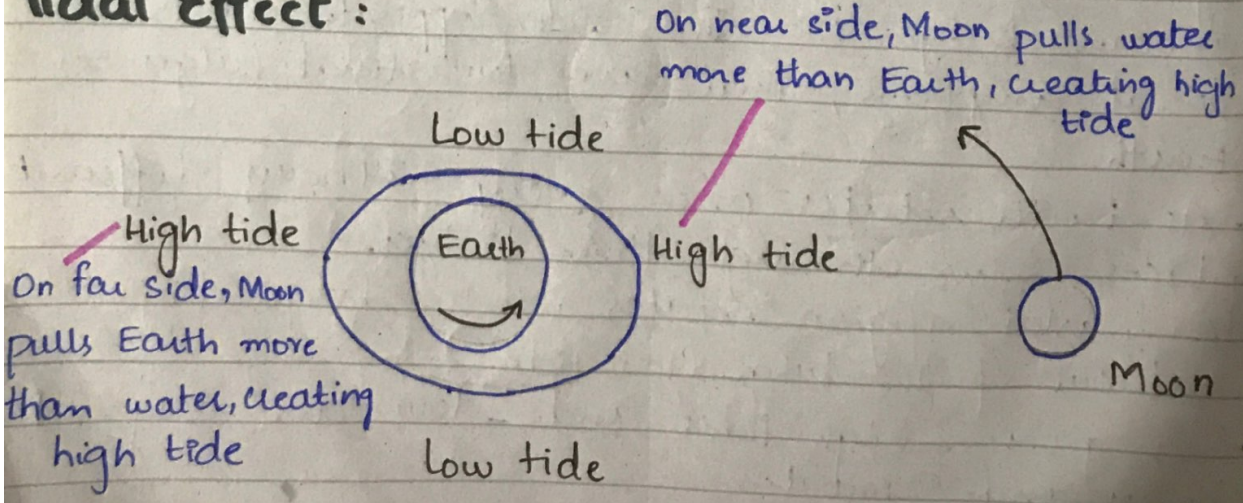
7. DIFFERENCE IN CIRCADIAN RHYTHMS

- Biological clocks in organisms, including humans, are influenced by the 24-hour light-dark cycle resulting from rotation.

Rotation of Earth:



Tidal Effect:



EARTH'S REVOLUTION

The revolution of Earth, is its orbiting around the Sun in an elliptical path. It takes about 365.25 days to complete one revolution.

EFFECTS OF REVOLUTION:

1- FORMATION OF SEASONS:

- Earth's axial tilt (23.5°) and revolution result in varying sunlight across the year:
  - Summer: When a hemisphere is tilted toward sun
  - Winter: When a hemisphere is tilted away.
  - Spring and Autumn: Intermediate phases.

2- VARIATION IN DAY LENGTH:

- Longer days in summer and shorter in winter, especially at higher latitudes.
- Equator has almost equal day and night throughout the year.

3- CHANGING ALTITUDE OF THE MIDDAY SUN:

- In summer, the Sun appears higher in the sky at noon.
- In winter, it is lower - this affects temperature and solar intensity.

4- DIFFERENT CONSTELLATIONS IN DIFFERENT SEASONS:

- Due to Earth's position in space, night sky constellations vary ~~the~~ with the seasons.

5- LEAP YEAR:

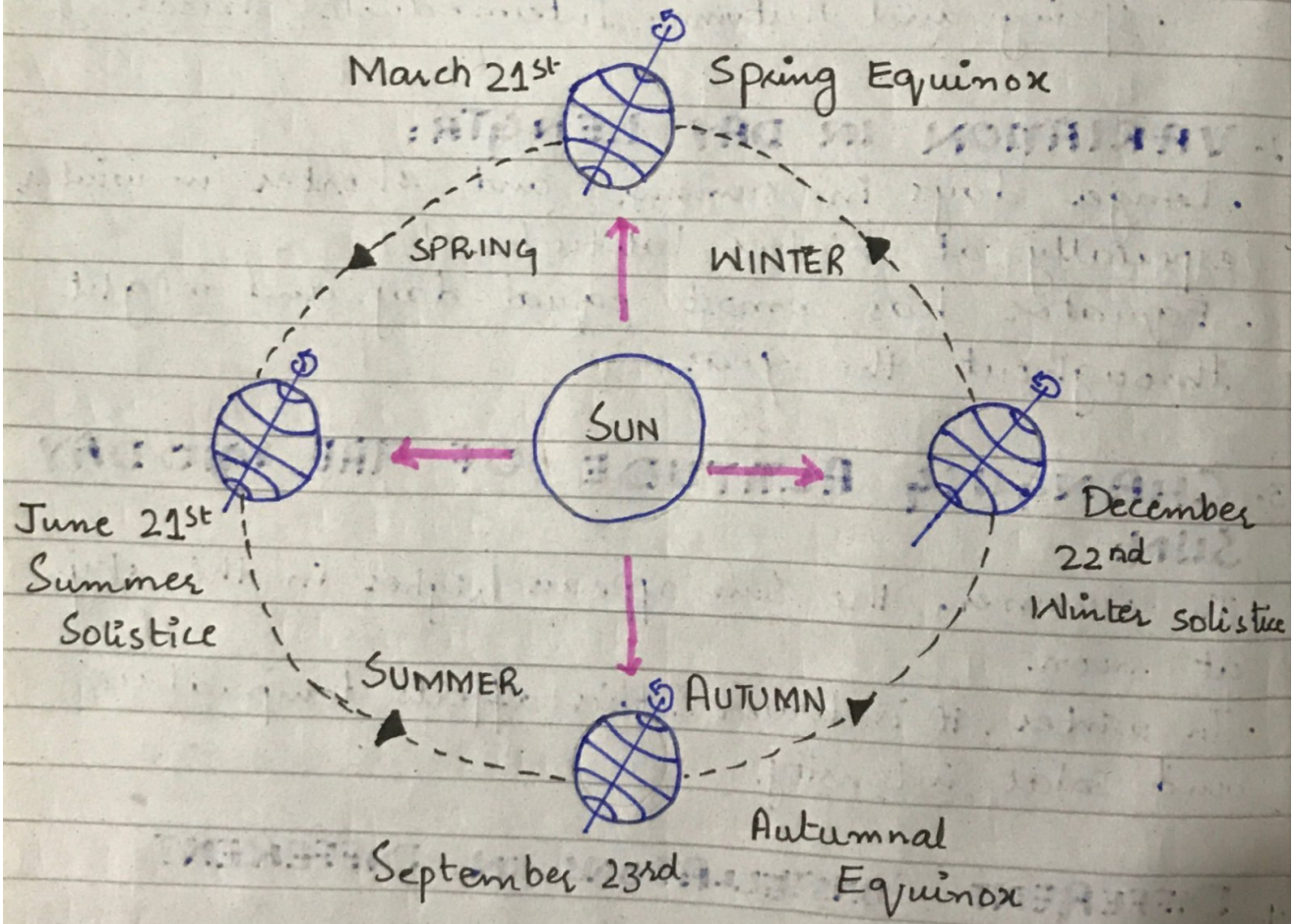
- Revolution takes 365.25 days, so every four years,

day.

an extra ↑ is added (Feb 29) to synchronize the calender - this is a leap year.

6- EQUINOXES AND SOLISTICES:

- Equinoxes : March 21 and september 23 - day and night are equal.
- Solistices: June 21 (Summer Solictice): Longest day in Northern Hemisphere.
  : December 21 (Winter solictice): Shortest day in Northern Hemisphere.



Revolution of Earth

ROTATION	REVOLUTION
DEFINITION	
. Rotation of earth is the spinning at its own axis	Revolution of earth is the movement of earth around sun.
TIME TAKEN	
. Earth completes one rotation on in one day. (23hrs 56min)	Earth completes one revolution in one year. (365.25 days)
EFFECTS	
. Due to rotation days and nights are formed.	Due to revolution seasons are formed.
DIRECTION	
• Earth rotates from west to east.	Earth revolves counter clock-wise.
SPEED	
. Rotation speed at equator is almost 1000mph	Revolution speed is incredible 66,000 mph.
~~CAUSE OF~~ **TIDAL IMPACT**	
• Rotation is the cause of tides, currents and winds	Revolution is the cause of equinox and solistice
IMPACT ON GRAVITY ~~CAUSE OF~~	
. Rotation causes bulge at the equator of earth.	. Revolution balances centrifugal and centripetal forces of earth.
AXIS TILT	
. Rotates at 23.5° tilt	Tilt at the same angle throughout orbit