

Q.2:

(a) Briefly describe the most popular and accepted theory about the origin of the Universe.

The Universe is the sum total of all matter and energy that exists or has existed both in space and time. There are a multiple theories that explain the origin of the Universe; however, the most popular and widely accepted theory is the Big Bang Theory.

The Big Bang Theory : Origin of the Universe

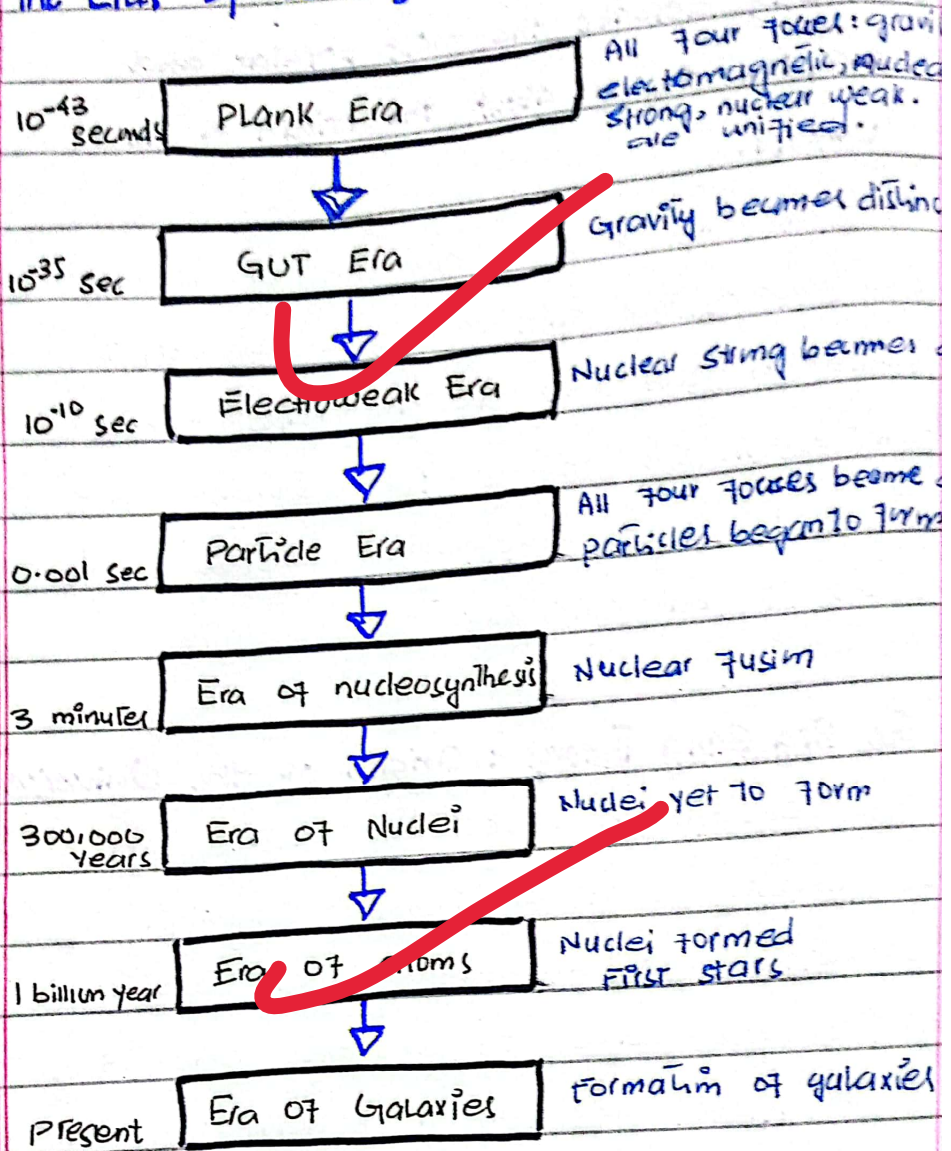
Cosmologists accept this theory as the nearest one in explaining the origin of the universe. According to this theory, the universe came into existence some 13.7 billion years ago. As it began, it went through eight different eras until the final one came which is the current one.

Relate your headings and arguments to the qs statement

The point of Singularity when the universe began

Originally, the universe was a single point, which exploded and began expanding. The expansion continues to this day.

The Eras of The Big Bang Theory



In the 10^{-43} second, all four forces are unified, the superforce. Gradually these forces become distinct. Then the formation of nuclei begins.

As the nuclei are formed the first stars begin to emerge. In the final era, galaxies are formed which continue to this day.

Evidence of the Big Bang Theory

The Big Bang Theory can be proved in two ways:

1) Red Shift

Red Light has the longest wavelength in the light spectrum. Usually, when viewed, objects from earth appear red, indicating increasing distance.

Mathematically,

$$z = \frac{v_r}{c}$$

where, z = red shift

v_r = recessional velocity

c = light's speed.

From Hubble's law

$$v_r = Hd$$

$$\therefore z = \frac{Hd}{c}, \text{ where } d = \text{distance.}$$

Since an increase in red shift is being observed, thus it means 'd' is increasing.

Thus, the Big Bang Theory is supported.

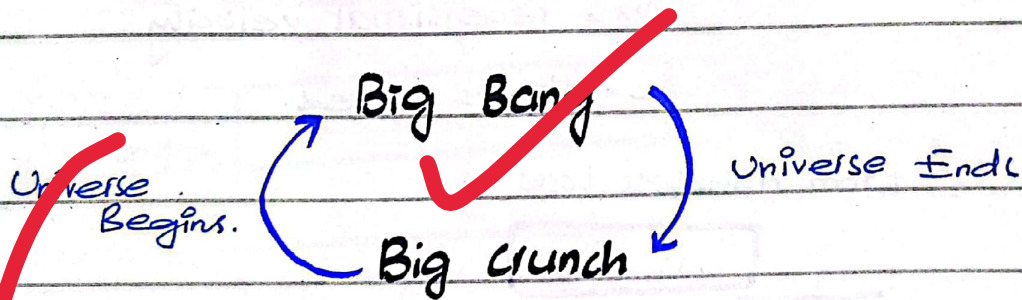
2) Cosmic Microwave Background

The electromagnetic radiation left

in the earliest cosmological epoch
support the happening of the Big
Bang.

The Ultimate Fate of the Universe

multiple models explain its end,
but the opposite of Big Bang is the
Big Crunch backed by the cyclic
Universe theory - this explains that the
universe undergoes endless cycles of
expansion and contracting, each beginning
with a "big bang" and ending in a
"big crunch".



3.5

(b) What is a Black Hole? How black holes are formed and discovered?

What a Black Hole is

A black hole is a point in space that is so dense that they create deep gravity sinks. The gravity there is so strong that beyond a certain region not even light can escape.

Anything that revolves around the black hole, be it a star, planet or spacecraft, it will be stretched and compressed like putty. This phenomenon is called spaghettification.

How are Black Holes Formed?

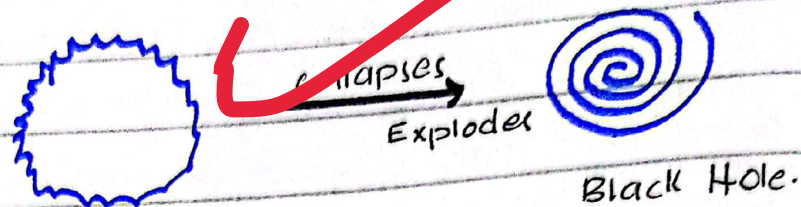
To understand the formation of black holes, NASA has divided them into different types, since their formation vary.

1) Stellar Black Holes

When a star 8 times the mass of the sun runs out of fuel it collapses, rebounds and explodes as a supernova. When the mass is 20 times than that

of the Sun, the core of the star collapses into a stellar-mass black hole.

It grows by collision with other black holes and stars.



Star - at least
20x mass of
Sun

2) primordial Black Hole

They formed in the first second after the birth of the universe.

Their formation was the result of the explosion.

However, scientists believe that as the pockets of hot materials — the primordial black holes, they ended as the universe expanded and cooled.

Discovery of Black Holes

Astronomers know that there is a black hole when the stars or gas around it are distorted.

For example:

A star is seen accelerating in an orbit around an unseen companion rather than a detectable binary companion star which normally orbit around each other.

A Novel Discovery About Black Holes in November 2024: V404 Cygni

Recently, a black hole of 9 times the mass of the sun and 7,800 light years from Earth. What is unusual about this black hole is that instead of exploding after collapse, it formed gently without any explosion. Thus astronomers have proposed another path to black hole formation called direct collapse.

The new black hole has been named V404 Cygni since it formed in Earth's constellation Cygnus.

↳ Differentiate between the occurrence of Lunar and Solar Eclipse?

Both solar and lunar eclipses are phenomena where the Sun, moon, and the Earth align such that the light of one is blocked.

Lunar Eclipse

The Earth orbits the Sun and the moon orbits the Earth. Sometimes, the Earth comes in between the Sun and the moon blocking the light of the moon from the Sun.

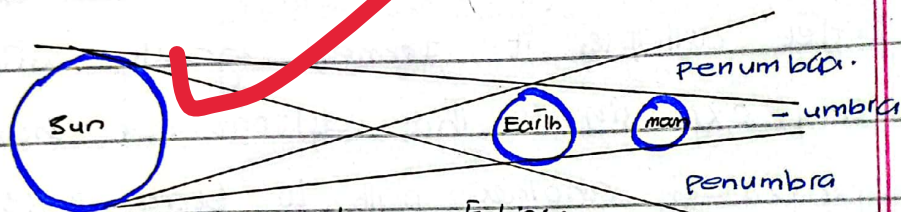


Figure: Lunar Eclipse

Lunar eclipse occurs only during full moon. It occurs twice a year at least, usually partial. It lasts for a few hours and it is safe to look at the lunar eclipse.

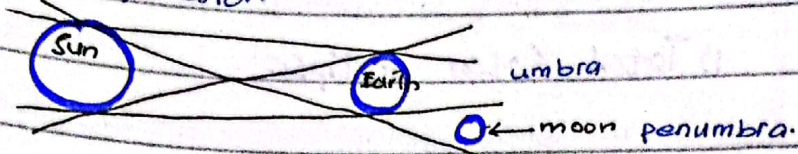
Types of Lunar Eclipse

They are of three types:

1) Penumbral Lunar Eclipse

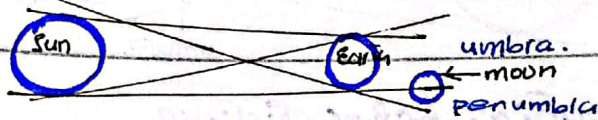
This occurs when the moon passes through the penumbral region. It is

rarely visible since there is a slight change of color.



2) partial Lunar Eclipse

A partial lunar eclipse occurs when part of the moon passes through the umbra, thus moon is partly obscured by the shadow.



3) Total Lunar Eclipse

When the entire moon passes through the umbral region of Earth's shadow and moon is completely obscured.



Solar Eclipse

A solar eclipse occurs when the moon during its orbit comes between the Earth and the Sun blocking the light to the Earth.

It usually occurs once every 18 months. It occurs during the time of new moon. Also, it is unsafe to directly look at the solar eclipse as it can damage the eyes.

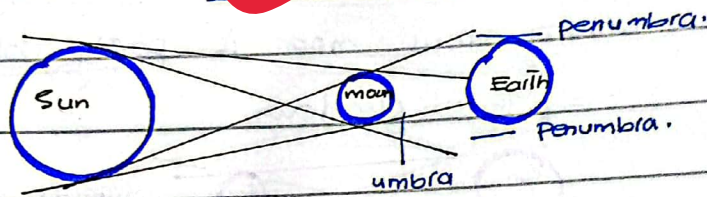
Relate your arguments and headings with the qs statement

Types of Solar Eclipse

Solar eclipses are also of three types

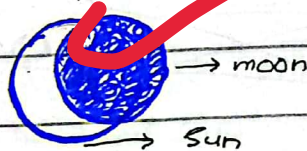
1) Total Solar Eclipse

A Total solar eclipse occurs when the moon completely covers the light from an area of the Earth. The area can be 10 - 16,100 km.



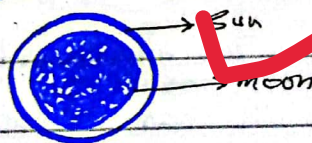
2) Partial Solar Eclipse

This happens when the moon and the Earth do not align perfectly and the moon only partially covers a disc of the Sun.



3) Annular Solar Eclipse

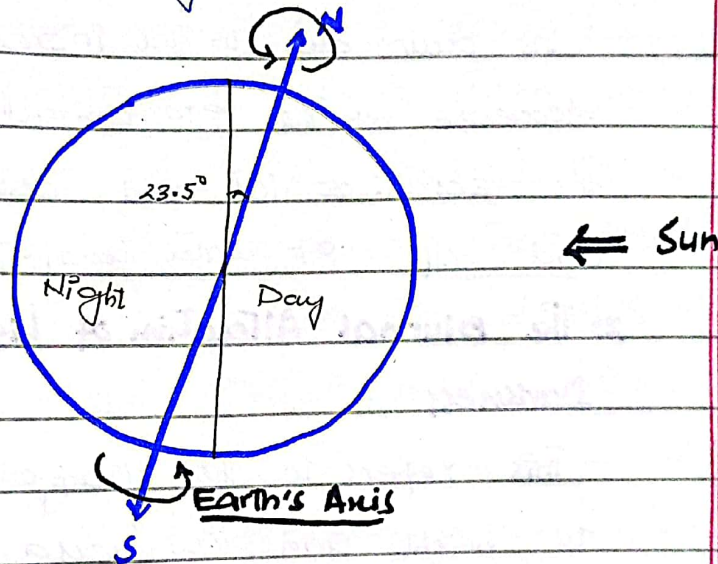
This happens when the moon appears smaller than the Sun as it passes across the solar disc forming a bright ring or annulus. It was seen in Chile in October 2024.



(c) Briefly explain what effects are produced due to Rotation and Revolution of Earth.

The Rotation of Earth on its Axis

The Earth rotates West To East or counterclockwise on its axis. The Sun, Stars and moon appear to rise from east because the Earth spins steadily eastwards, creating the illusion.



The Earth is tilted at about 23.5° from the true North. Although the speed of rotation varies by latitude, the velocity is constant at a given point on Earth. Thus, no motion is felt at any point of the Earth.

Effects of Rotation of The Earth

The rotation of the Earth has certain consequences.

1) Coriolis Effect

It refers to the deflection of winds and ocean currents. The deflection is to the right in the northern hemisphere and to the left in the southern hemisphere.

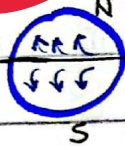


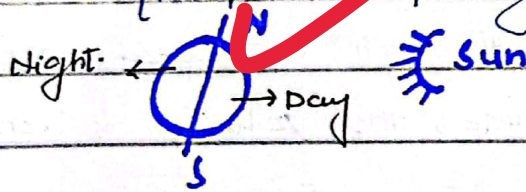
Figure: Coriolis effect on winds.

2) Tides

They occur due to the increase and decrease of the gravitational pull as the Earth rotates and cause rise and fall of water level.

3) The Diurnal Alteration of Light and Darkness

This refers to the change of day to night and vice versa due to the shift of side facing the Sun.



4) Bulge at the Equator

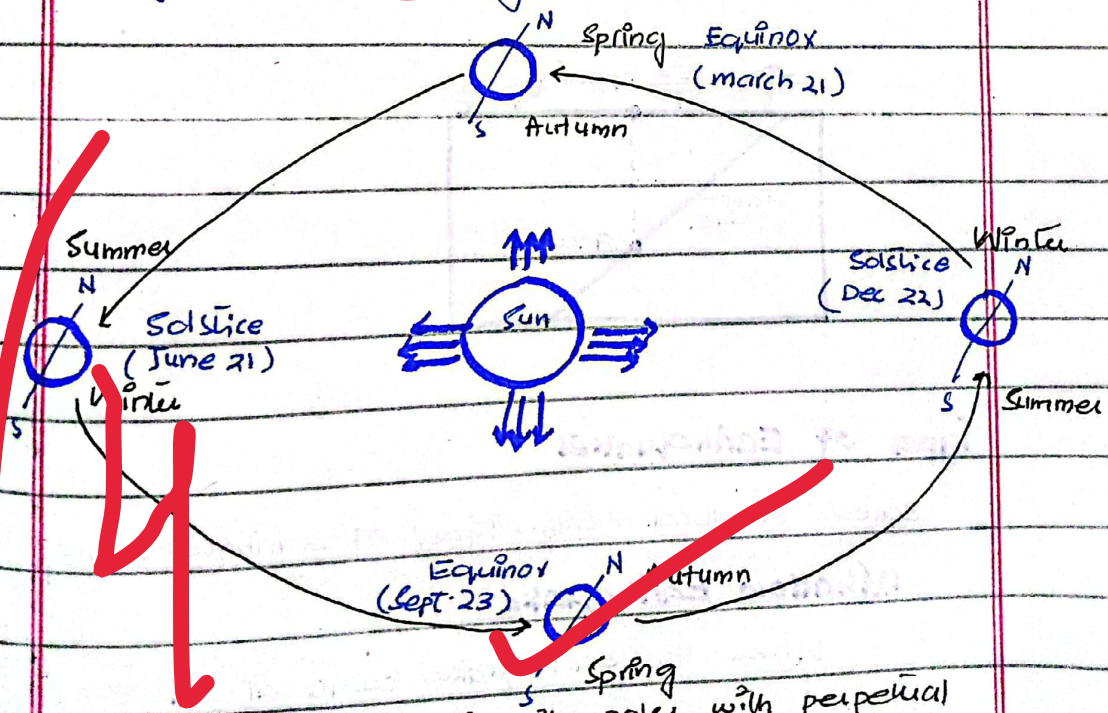
The constant rotation of the Earth has caused a bulge at the equator and thus explains the elliptical shape of the Earth.

The Revolution of The Earth Around The Sun

The Earth revolves around the Sun and completes 1 revolution in 365 days, 5 hours, 48 minutes and 46 seconds, which is about $\frac{365}{365}$ days. Thus, the distance between the Earth and Sun ranges from 147 mn km to 153 mn km.

Effects of Earth's Revolution around The Sun

The biggest impact of the Earth's revolution combined with rotation, inclination and polarity is the changes of seasons. It also cause equinox and solstice, where in former the days and nights are equal and in latter has longest day & night.



The seasons vary in the poles with perpetual days and night.

Q.3:

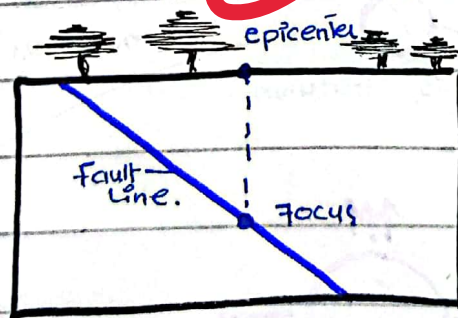
(a) What is an earthquake? What are the types of Earthquakes? Explain its cause and measurement.

"An earthquake is what happens when two blocks of the Earth suddenly slip past one another."

- US Geological Survey

Thus, an earthquake occurs when the blocks of earth called the tectonic plates interact causing the earth to shake.

The line along which the earth's plates slip is called fault line. The location below the surface where earthquake begins is called focus and the point directly above focus is called epicenter.



Types of Earthquakes

Based on focal depth, types of earthquakes are:

1) Shallow Earthquake

When the earthquake occurs at a

focal depth of less than 60 km.

2) Intermediate Earthquake

This type of earthquake is the one when the focal depth ranges from 60 to 300 km.

3) Deep Earthquake

An earthquake is called deep when the focal depth exceeds 300 km.

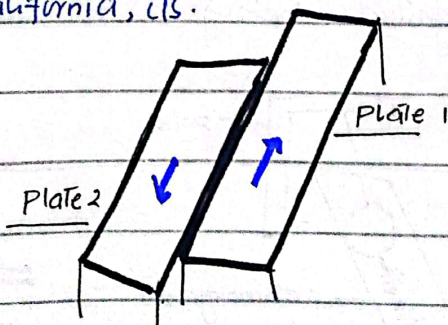
What causes an Earthquake

The lithosphere is divided into blocks called tectonic plates. These plates have boundaries and based on these boundaries, different earthquakes occur.

1) Earthquake in Transform Boundary

When two plates slide past one another, an earthquake occurs. Mostly the earthquakes are shallow focus.

Example: San Andreas fault in California, US.



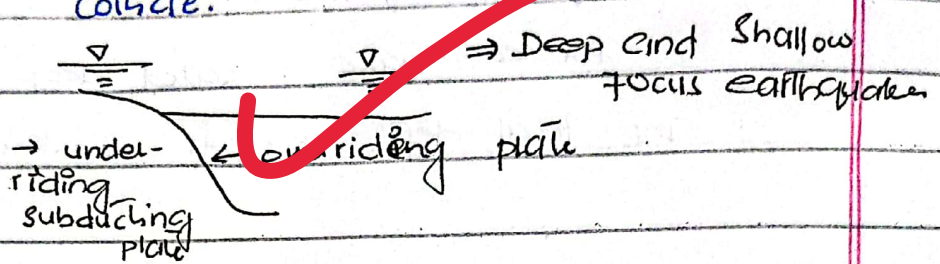
2) Convergent Boundary

This has three types but in two cases earthquakes occur

a) Oceanic - Oceanic Convergence

Two oceanic tectonic plates

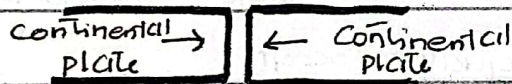
collide.



Example: Japan arc systems.

b) continental - continental Convergence

Two continental plates collide



Localism: Alps of Himalayas.

Measurement of Earthquakes

Earthquakes are measured using a seismograph. The recording may be using a richters scale or moment magnitude, with moment magnitude being more accurate.

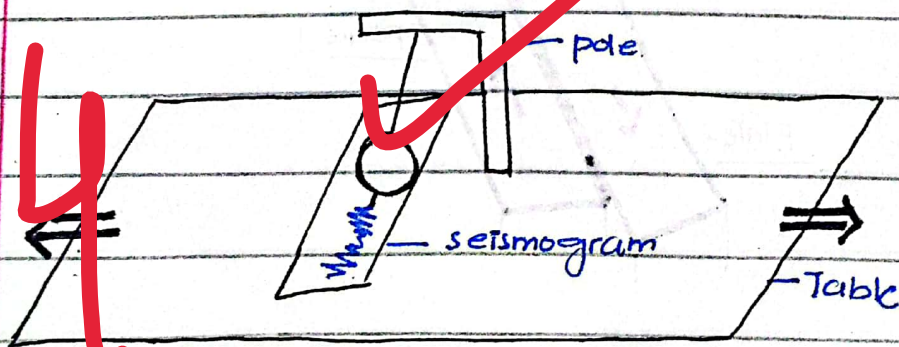


Figure: Seismograph

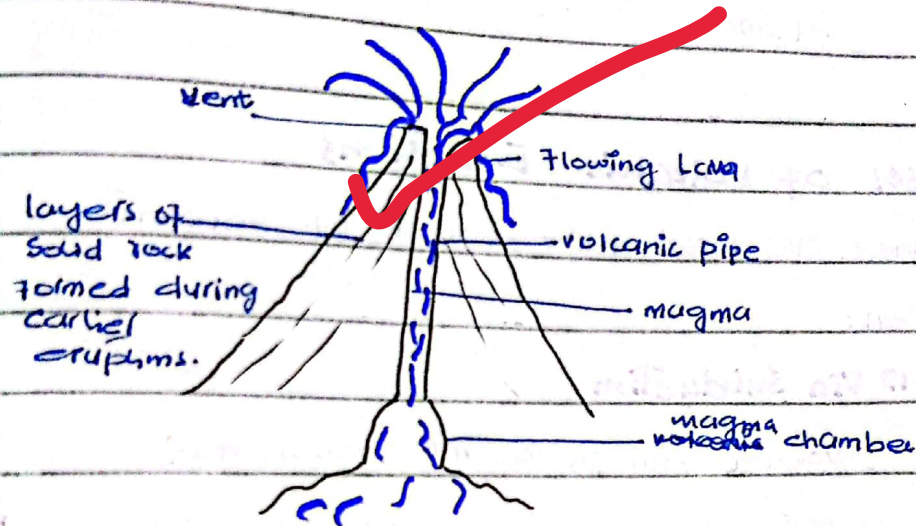
The 1935 Quetta earthquake was Mw 7.7.

Q) What do you know about volcanoes?

Discuss the causes and effects of

The United States Geological Survey define volcanoes as,

"openings or vents where lava, tephra (small rocks), and steam erupt onto the Earth's surface."



Types of Volcanoes

Based on the viscosity of magma, the British Geological Survey has divided volcanoes into two types:

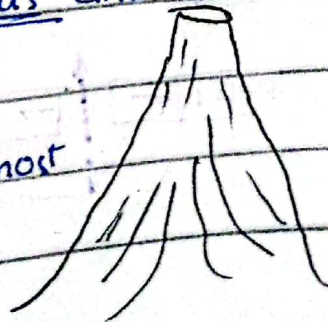
1) Stratovolcano

These are the types of volcanoes which are steep-sided, coned-shaped.

The magma is viscous and flows slowly

Example

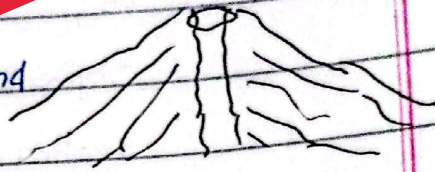
Andesite is the most common type of stratovolcano.



2) Shield Volcanoes

The lava of such volcanoes is less viscous, runny. Thus, the slope formed is gentle.

Example: Mauna Kea and Mauna Loa in Hawaii,



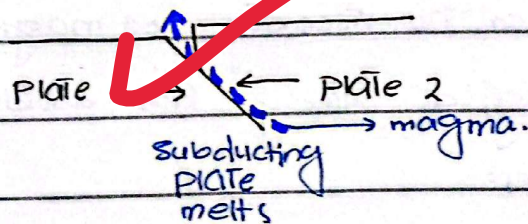
They are also world's largest active volcanoes.

Causes of Volcanic Eruptions

There are three major causes of volcanic eruptions:

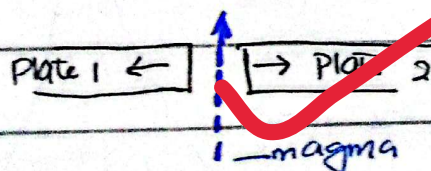
1) Via Subduction

Volcanic eruption occurs when two tectonic plates converge and one of the subducts.



2) via Rifting

It happens when two tectonic plates diverge.



3) At Hotspots

It is usually rare, but such volcanic eruption can occur in the middle of a plate where magma pressure bursts open the crust.

Effects of Volcanic Eruptions

A volcanic eruption can have the following impacts on the Earth:

- 1) **Earthquakes** The eruption is explosive causing the earth to shake.
- 2) **Tsunamis if in the sea** The earthquakes within the sea results in tsunamis.
- 3) **Toxic Gases** Gases such as aerosol, sulphides cause difficulty in breathing.
- 4) **Damages by molten Lava** places in Pompeii, Italy have directly been destroyed.
- 5) **modification of Landscapes** New mountains and rocks are formed.
- 6) **Increasing in surrounding temperature** The direct temperature reach up to 1200°C .
- 7) **migration of surrounding people** The surrounding people have to move away. Such sights are common in Iceland and Indonesia where eruptions are common.

Q) What is a tsunami? How are the tsunamis generated and what are their characteristics?

Definition of Tsunami

"A tsunami is a series of waves caused by earthquakes or undersea volcanic eruptions."

— National Oceanic and Atmospheric Administration.

A tsunami can thus be defined as a heighted wave of the sea that causes destructions mostly and occurs in coastal areas.

Tsunami is derived from a Japanese word which means 'harbor wave'.

Characteristics of Tsunami

A tsunami can be distinctly recognized from the following features:

1) A heighted wave at the shore and short wave offshore

The wave begins offshore at 0.5 - 1 m and increases towards the shore. This increment is called shoaling and can reach up to 30 m.

2) Long Wavelengths

The waves of tsunami have a wavelength of 100-300 Km.

3) Becomes dangerous only at the Land

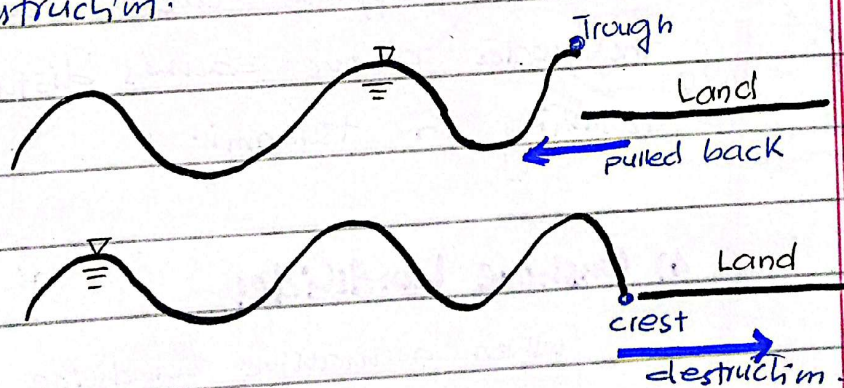
A tsunami is harmless within the sea. That is why fishermen fail to predict it when in the sea.

4) What magnitude of Earthquake causes tsunami

Normally an earthquake of 7.0 or greater on Richter scale causes tsunami.

5) What part of wave causes destruction

If the trough of the tsunami approaches the land first, then the water will be pulled back. Otherwise, it causes destruction.



What causes a Tsunami

A tsunami is generated due to multiple reasons.

1) Earthquake

When an earthquake occurs near or under the ocean, waves begin to surge and get higher and higher as they reach the shore.

2) Volcanic Eruption

When a volcanic eruption takes place within the sea, the process causes the earth to tremble resulting in a tsunami.

3) Submarine Landslides

Oceans have hilly landscapes under them. When a massive landslide happens under sea, the water above causes disturbance resulting in tsunami.

4) Onshore Landslides

When a massive landslide onshore results in a large volume of debris falling in water, the volume replaces the water causing a huge wave accumulating into a tsunami.

(d) What is a cyclone? How is it formed?

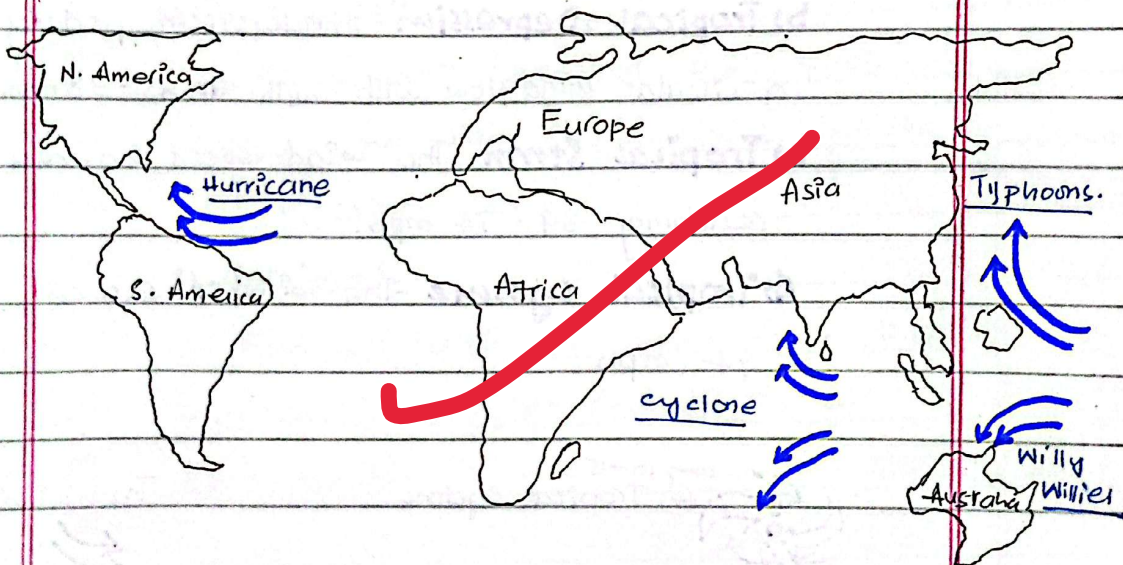
Explain its anatomy and effects.

The World Meteorological Organization defines a cyclone as:

"A rapidly rotating storm that begins over tropical oceans, and they can vary in size and intensity."

Such rapidly rotating storms develop after passing through multiple stages, develop in oceans and die upon landfall.

They have different names in different regions.



Formation of Cyclones

1) Conditions needed for a cyclone to form

A cyclone needs the following to form:

a) High sea temperature at least 27°C

b) Converge winds near the surface

of the ocean.

- a) A low wind shear - the velocity of wind does not vary significantly with height.
- b) Sufficient distance from equator for Coriolis effect to take place
- 5 - 30° latitude
- c) Moisture

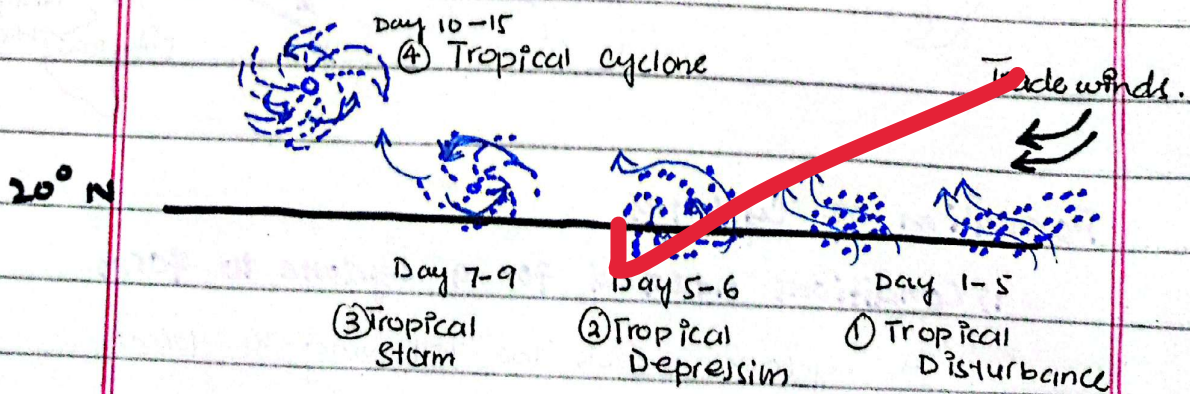
2) Stages of Development of a cyclone

a) Tropical Disturbance - water evaporates and forms clouds forming a cluster of thunderstorm.

b) Tropical Depression - Thunderstorm produces a circular wind flow with at 25-38 mph

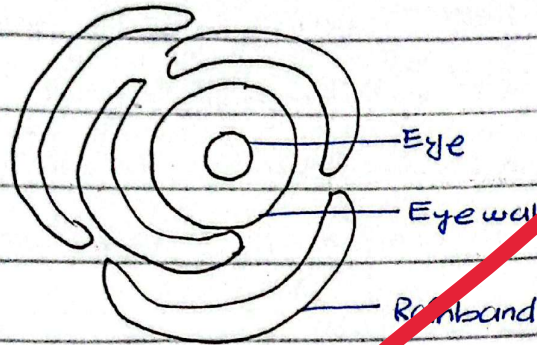
c) Tropical Storm - The wind speed increases reaching 39-74 mph.

d) Tropical cyclone - The winds exceed 74 mph



Anatomy of a cyclone

A typical cyclone looks as follows:



1) The Eye

As the centre of the cyclone, the pressure is the lowest, and it's warmer with no clouds.

2) The Eyewall

It is the most dangerous part of the cyclone. The winds are strongest followed by heaviest rainfalls.

3) Rainbands

They are bands of thunderstorms that trail away from the eyewall in a spiral fashion.

In the gaps between the spiral bands, there is no rain or strong wind.

Effects of cyclones

1) Storm Surge

powerful winds carry water and lash it ashore causing flood and destruction. The Fengal cyclone in India and Sri Lanka and Milton in United States this year caused major destruction.

2) Floods

Rain continues even after the cyclone causing floods.

3) Heavy Winds

Strong winds near the coastal area as a result of cyclone causes heavy destruction.

4) Tomadoes

Sometimes, the cyclone that reaches the land initiate a Tomado. Such a phenomenon is rare but it does occur.

5) Socio-economic Effects

cyclone causes fatalities, property destruction severely affecting communities.

Good answers!!!