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GEOGRAPHY NOTES

The Earth and the Solar System

Abstract

The Earth and the solar system is the second topic in form 1. It covers the origin of the earth, structure of the earth, heavenly bodies and how the earth revolves and rotates around the sun.

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Topic objectives:

By the end of the topic, the learner should be able to:

- a) define the solar system
- b) explain the origin of the earth
- c) explain the effects of rotation and revolution of the earth
- d) Describe the structure of the earth.

Course Outline:

1. Definition and composition of the solar system
2. Origin, shape, size and position of the earth in the solar system
3. Rotation and revolution of the earth and their effects
4. Structure of the earth
 - a) The atmosphere
 - b) The hydrosphere
 - c) The lithosphere/crust
 - d) The asthenosphere/mantle
 - e) The barysphere/centrosphere (outer and inner core)



“In future, children won't perceive the stars as mere twinkling points of light: they'll learn that each is a 'Sun', orbited by planets fully as interesting as those in our Solar system. “

~Martin Rees

Solar system is the group of heavenly bodies comprising the sun and the nine planets.

The origin of the Solar System

Theories

A theory is a set of reasoned ideas intended to explain facts or events

1. Passing Star Theory

A star with a greater gravitational pull passed near the sun, It attracted large quantities of gaseous materials from the sun, The materials split, cooled and condensed to form planets, The planets were set in orbit by the passing star

Weaknesses

- a) Doesn't explain the origin of the sun and star.
- b) Minimal chance of a star approaching another
- c) High temperature, gaseous material drawn from the sun would disperse than condense
- d) The gases should have followed the star since it had a greater gravitational pull

2. Nebula Cloud Theory

There was a slowly rotating cloud of dust and gas called Nebula, As the nebula rotated it flattened into a disc with high concentration of materials at the centre, The high concentration of material at the centre condensed to form the sun. Gases such as ammonia and methane condense to form larger planets that is Jupiter, Saturn, Uranus and Neptune. Closer to the centre of Nebula, particles of dust and gas bumping into each other formed the inner smaller planets.

Evidence

Rotation and revolution of planets in anticlockwise direction

Weakness

- a) The origin of nebular is not explained.
- b) Cause of rotation is not mentioned.
- c) All planet should rotate in the direction of the rotation of the nebula that is west to east but Venus and uranius rotates from west to east.

3. Collision Theory

Star with greater gravitational pull passed near the sun. It attracted large quantities of gaseous materials. The materials split into portions. Large portions collided with smaller ones and swept them to form planets. The weaknesses are the same as the passing star's Theory.

4. Supernova/explosion Theory

There was a violent explosion of a star. A cloud of dust (nebular) remained from the star. There was fast movement of the cloud due to the force of explosion. Rotation speed increased due to gravitational attraction. The cloud flattened into a disc. The matter began to accumulate towards the centre to form a proto-sun which later began to shine. The rest of the cloud collapsed to form planets.

Weaknesses

- a) Doesn't explain the origin of the star
- b) Doesn't explain the cause of explosion

“FIRST OF ALL, THE BIG BANG WASN'T VERY BIG. SECOND OF ALL, THERE WAS NO BANG. THIRD, BIG BANG THEORY DOESN'T TELL YOU WHAT BANGED, WHEN IT BANGED, HOW IT BANGED. IT JUST SAID IT DID BANG. SO THE BIG BANG THEORY IN SOME SENSE IS A TOTAL MISNOMER.”

~ MICHIO KAKU

Composition of the Solar System

1. The Sun

It's the centre of the universe.

Characteristics

- It's a star - A star is a heavenly possessing its own light which it transmits.
- Nebula/galaxy is a cluster of stars.
- The earth is in a galaxy called The Milky Way.
- It's made of very hot gases mainly hydrogen (70%) and helium (30%).
- Has a diameter of 1,392,000km.
- Surrounded by a layer of gas which has boiled from its surface which is called corona.
- Rotates on its own axis in anticlockwise direction.
- Has gravitational pull which holds all the planets in orbit around it.
- An orbit is a path which a planet or a satellite follows around a star or a planet.
- Temperature at its centre is $15m^{\circ}c$ and at the surface is $5500^{\circ}c$.
- Radiates solar energy which is very important for all forms of life on the earth.

2. The Planets

Planets are large spherical celestial/heavenly bodies in space.

There are 9 planets in our solar system.

Characteristics

- Spherical in shape
- Don't have their own light but reflect it from the sun.

- Revolve around the sun in anticlockwise direction.
- Have their own force of gravity
- Only one is known to support life.
- The following are the planets arranged in order from the one nearest to the sun.

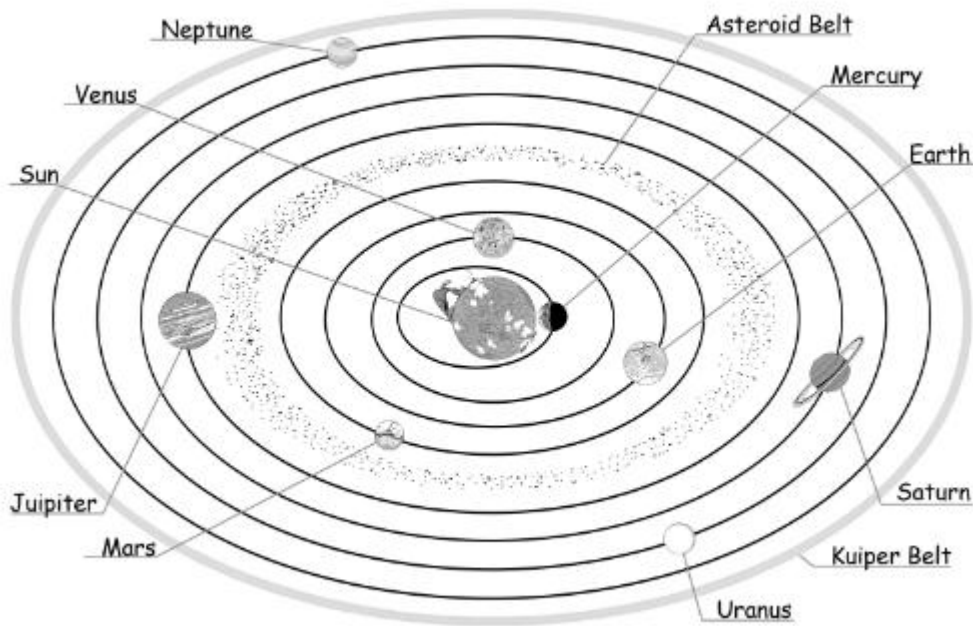


FIGURE 1: SOLAR SYSTEM

a) Mercury

- Nearest from the sun
- Its 58m km from the sun
- Has no satellites
- Takes approximately 88 earth days to revolve around the sun


b) Venus

- 2nd planet from the sun
- It's 108m km from the sun
- One of the brightest planets
- Can be seen clearly with naked eyes
- Takes approximately 225 earth days to revolve around the sun

- Slightly smaller than the earth
- Has no satellites
- Together with the earth they are called twin planets due to having many similarities

c) Earth

- The 3rd planet from the sun
- The earth and the heavenly bodies make the universe
- The only planet that supports life
- The home of man
- Approximately 149m km from the sun
- Takes 365 $\frac{1}{4}$ days to revolve around the sun
- Has one satellite, the moon



“I'D LOVE TO GO INTO SPACE AGAIN IF THERE WERE A MISSION TO MARS. I'D ALSO LOVE TO GO TO A COMPLETELY DIFFERENT PLANETARY SYSTEM, OUT OF OUR SOLAR SYSTEM.”

Mae Jemison

d) Mars

- Also called The Red Planet because when it's observed through a telescope it appears reddish.
- The 4th from the sun
- Slightly smaller than the earth
- Approximately 228m km from the sun
- Takes 687 earth days to revolve around the sun
- Between Mass and Jupiter there are small celestial bodies called planetoids.
- Has no satellite.

e) Jupiter

- 5th planet from the sun
- Approximately 778m km from the sun
- Largest in the universe
- Rotates on its own axis at very fast speed
- Has flattened poles due to its fast speed of rotation
- Has very thick layers of ice on its surface takes 12 earth years to revolve around the sun
- Has 16 satellites

f) Saturn

- 6th planet from the sun
- Second largest planet
- Approximately 1427m km from the sun
- Takes 29 ½ earth years to revolve around the sun
- Has a ring around it
- Has 18 satellites

g) Uranus

- 7th planet from the sun
- About 4 times bigger than the earth
- Approximately 2870m km from the sun
- Also rotates very fast
- Also has flattened poles due to fast speed of rotation
- It appears greenish because being surrounded by methane gas
- Has 8 satellites
- Takes 84 earth years to revolve around the sun

h) Neptune

- One of the farthest from the sun
- 8th planet from the sun
- Approximately 4497m km from the sun
- Has 8 satellites
- Takes 165 earth years to revolve around the sun
- Very similar in size, colour and character with Uranus

i) Pluto

- 9th planet from the earth
- Farthest from the sun
- The smallest
- 1/6 the size of the earth
- Approximately 5900m km from
- Takes 248 earth years to revolve
- Has one satellite
- Very little is known about it

3. Other Celestial Bodies

Natural Satellites

- Any natural heavenly body that orbits around a planet e.g. moon for earth, tritan for Saturn and Triton for Neptune.

Asteroids/Planetoids

- Also called minor planets.
- Are small fragments of rocks left going around the sun when the solar system was formed
- Found between Mars and Jupiter
- They are 1500 in number

- They sometimes collide with each other and planets due to Jupiter's gravitational pull causing them to move in erratic orbits.

Comets

- Heavenly bodies which appear to have a head and a long tail
- Made of ice, dust and frozen gas
- The head is made of many particles of dust, rock and frozen gases.
- Their tail is made of gases and points away from the sun.
- Move around the sun in extremely long and oval orbits
- Their orbits cross the earth's orbits e.g. Halley's Comet which appears after every 76 years.

Meteoroid

- Small heavenly body which strays from its orbit in the solar system and enters the earth's atmosphere at very high speed.

Meteor

- A meteoroid which is burning out due to friction after entering the earth's atmosphere.

Meteorite

- Remains of a meteoroid which have reached the earth's surface or incompletely burnt up meteoroid.
- When they fall they sink into the ground forming craters
- They are rich in iron

The Moon

- A natural satellite
- Receives its light from the sun and reflects it onto the earth.
- It revolves around the earth
- Takes 29.5 days to complete one revolution around the earth

- Its orbit is almost circular
- As it revolves around the sun it appears in various shapes ranging from crescent/new moon, half moon, gibbons moon and full moon.
- Has gravitational pull which causes the rising and falling of the ocean level
- As the moon orbits around the earth it creates an event called eclipse.

Eclipse

Phenomenon occurring when the rays of the sun are blocked from reaching the earth or the moon.

Solar/Sun Eclipse

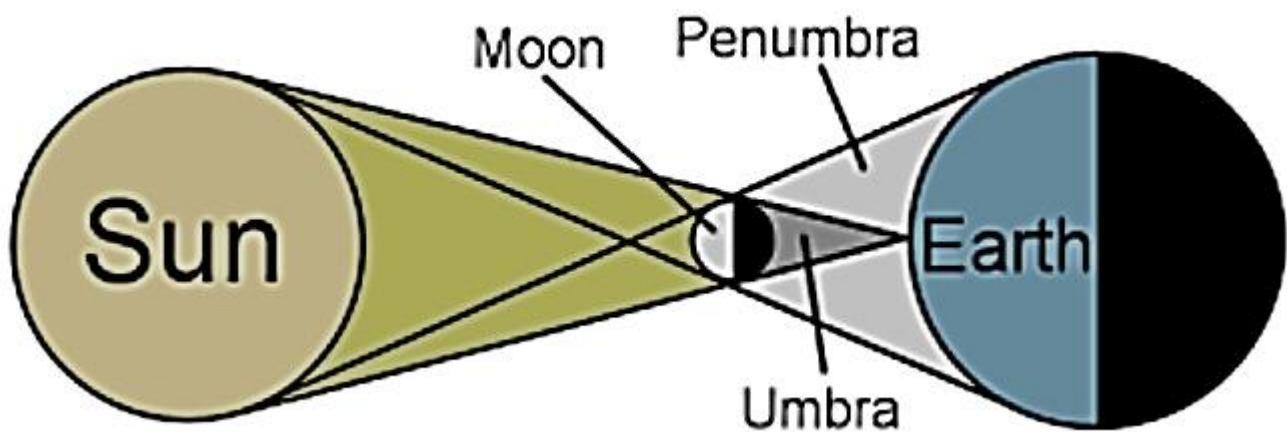


FIGURE 2: SOLAR ECLIPSE

- The moon comes between the earth and the sun
- The moon's shadow is cast on the earth
- The sun appears to be covered by darkness

Lunar/moon Eclipse

- The earth comes between the moon and the sun
- The earth's shadow is cast on the moon
- The moon appears to be covered by darkness

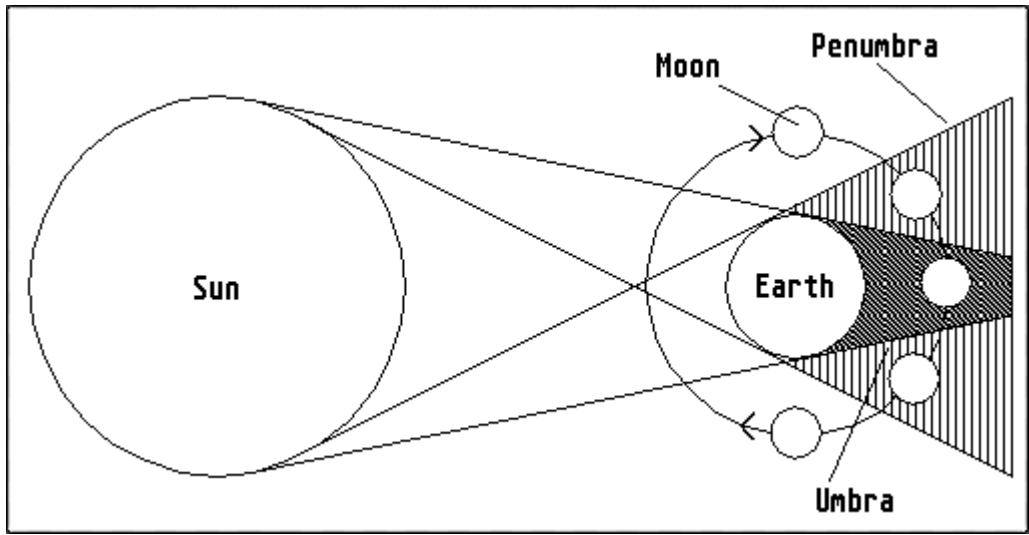


FIGURE 3: LUNAR ECLIPSE

The Origin of the earth

- A star with a greater gravitational pull passed near the sun
- It attracted large quantities of gaseous materials from the sun
- The materials split, cooled and condensed
- Heavier materials collected at the centre to form the core
- Less dense materials collected around the core to form the mantle
- The lightest materials formed the crust

The shape of the earth

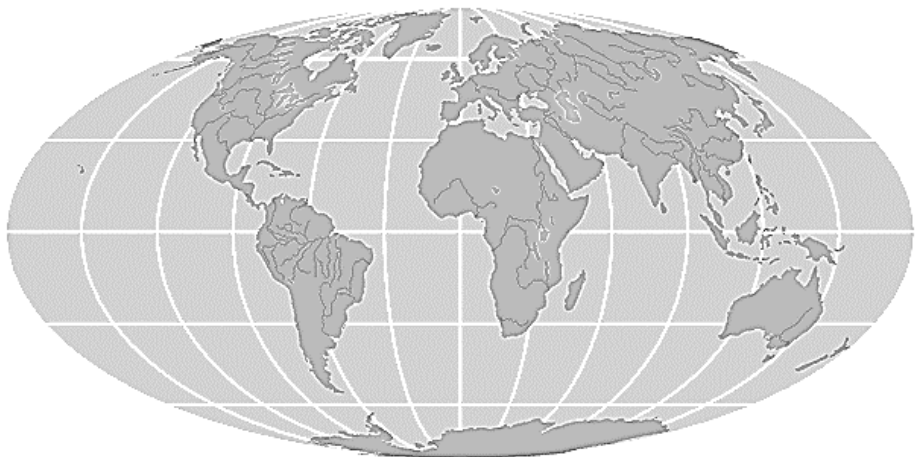


FIGURE 4: SHAPE OF THE EARTH

The shape of the earth is called geoid/ovoid/oblate spheroid due to being an imperfect sphere by being wide at the equator and flat at the poles.

Proofs/Evidence That the Earth Is Spherical

- i. If one moves towards the east in a straight line he will end up where he started.
- ii. Satellite photographs taken from space show that the earth is like a sphere.
- iii. Places in the east see the sun earlier than those in the west.
- iv. When a ship is approaching the smoke is seen first, then the mast and finally the whole ship.
- v. All the planets are spherical so the earth being one of them is also spherical.
- vi. During the moon eclipse the earth casts a spherical shadow on the moon.
- vii. The earth's horizon appears curved when observed from a very high point like a tower.

The size of the earth

- Equatorial diameter-12756km
- Equatorial circumference-40085km
- Polar diameter-39995km
- Surface area of the earth- 510×10^6 km²
- Water surface-73%.

The Movement of the Earth

There are 2 movements of the earth namely:

- i. Rotation of the earth on its axis
- ii. Revolution of the earth around the sun

Rotation of the Earth

- Movement of the earth on its own axis (imaginary line through the centre from N pole to S pole).
- Rotates through 360° .
- Takes 24 hours (day) to complete 1 rotation.
- Rotates in an anticlockwise direction (west to east).

Effects of Rotation of the Earth

1. Creates day and night because at any one time one side of the earth faces the sun (day) and the other remains in darkness (night).
2. Causes deflection of winds and ocean currents in the N hemisphere to the left and in the S hemisphere to the right.
3. It causes rising and falling of ocean tides.
4. Causes time difference between longitudes.
 - Takes one hour to go through 15° .
 - 4 min to go through 1° .

Calculation of Local Time

The time recorded in places within the same longitude. A longitude is an imaginary line running from N to S which shows how far E or W a place is from the prime meridian. Greenwich Meridian (0°) longitude is the point of reference when calculating time. Time is gained towards the E and lost towards the W.

Examples

1. Suppose the time at GWM is 12 noon what is the local time at Watamu 40°E ?

$$\text{Time gained} = 40 \times 4 = 160\text{min} = 2 \text{ hours } 40\text{min}$$

$$\text{Local time at Watamu is } 12.00 + 2.40 = 14.40 - 1200 = 2.40\text{pm.}$$

2. At Dar-el-Salaam 40°E time is 12pm what is the time at Ecuador 40°E ?

$$40^{\circ} + 20^{\circ} = 60^{\circ}$$

$$60 \times 4 = 240\text{min} = 4 \text{ hours}$$

$$\text{Ecuador is behind in time} = 12.00 - 4 = 8 \text{ am.}$$

If the places are on the same side subtract the degrees to get the difference and add or subtract from the reference time depending on which side the place is.

Calculation of Longitude

What is the longitude of place x whose local time is 8 am when local time at GWM is noon?

$$\text{Time difference} = 12.00 - 8 = 4 \text{ hours}$$

$$\text{Degrees} = 4 \times 15 = 60^{\circ}$$

Since x is behind in time its then 60°W .

Standard Time and Zones

Standard time is time recorded by countries within the same time zone.

Standard time was come up with due to confusion resulting from time changing at every longitude.

The world has 24 time zones.

The International Date Line

It's the 180° longitude.

Effects of Crossing It

- One gains time when he crosses it from W to E and has to adjust the clock ahead by 24 hours.

- One loses time when he crosses it from E to W and has to adjust the clock backwards by 24 hours.

Revolution of the Earth

- Movement of the earth in its orbit around the sun.
- It's in anticlockwise direction.
- The orbit of the earth's revolution is elliptical.
- Takes $365 \frac{1}{4}$ days in a year or 366 days in a leap year (every 4 years).
- The sun moves from the tropic of cancer to the equator and then towards tropic of Capricorn and back to the tropic of cancer.
- 21st march and 23rd September are called **equinoxes** because the length of day and night is equal. The sun is vertically overhead at noon at the equator.
- 21st June is called **summer solstice** because its summer in the N hemisphere. The sun is vertically overhead at noon at the tropic of cancer.
- 22nd December is called winter solstice because its winter in the S. hemisphere. The sun is vertically overhead at noon at noon at the tropic of Capricorn.
- Solstice is the period of maximum tilting of the earth towards the sun.

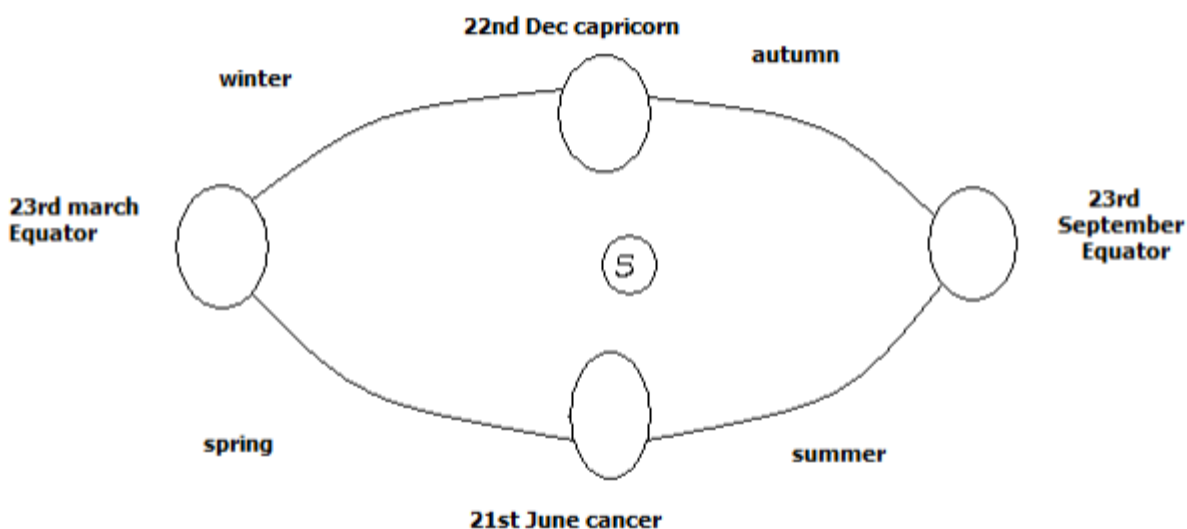


FIGURE 5: REVOLUTION OF THE EARTH

Effects of the Revolution of the earth

1. Causes the four seasons summer, autumn, winter and spring due to the movement of overhead sun causing changes in the heat belt.
2. Causes variation of day and night's lengths due to the earth's axis being inclined to the path of revolution at an angle of 60° .
 - a) Equinoxes have equal lengths of day and night.
 - b) Summers have longer days and shorter nights.
 - c) Winters have longer nights and shorter days.

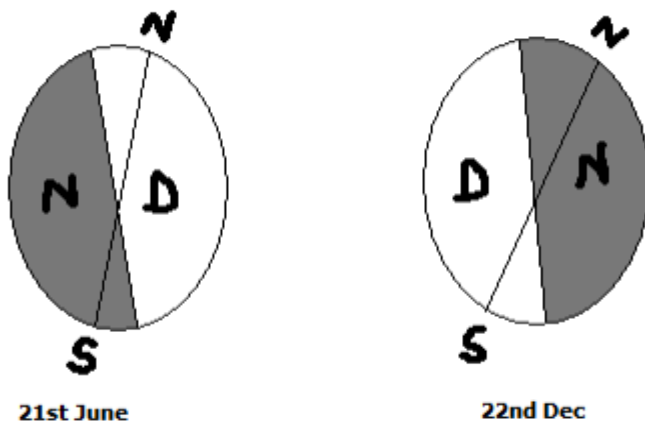


FIGURE 6: EFFECTS OF EARTH REVOLUTION

3. Causes changes in the altitude of the midday sun due to the earth's orbit being elliptical.
 - a) Highest altitude during equinox
 - b) Lowest altitude during solstices
4. Causes lunar eclipse due to revolution bringing the earth in line with the sun and the moon

The Structure of the Earth

Internal Structure of the Earth

The evidence used to study the earth's interior are

- a) mining

- b) drilling
- c) quarrying/excavation

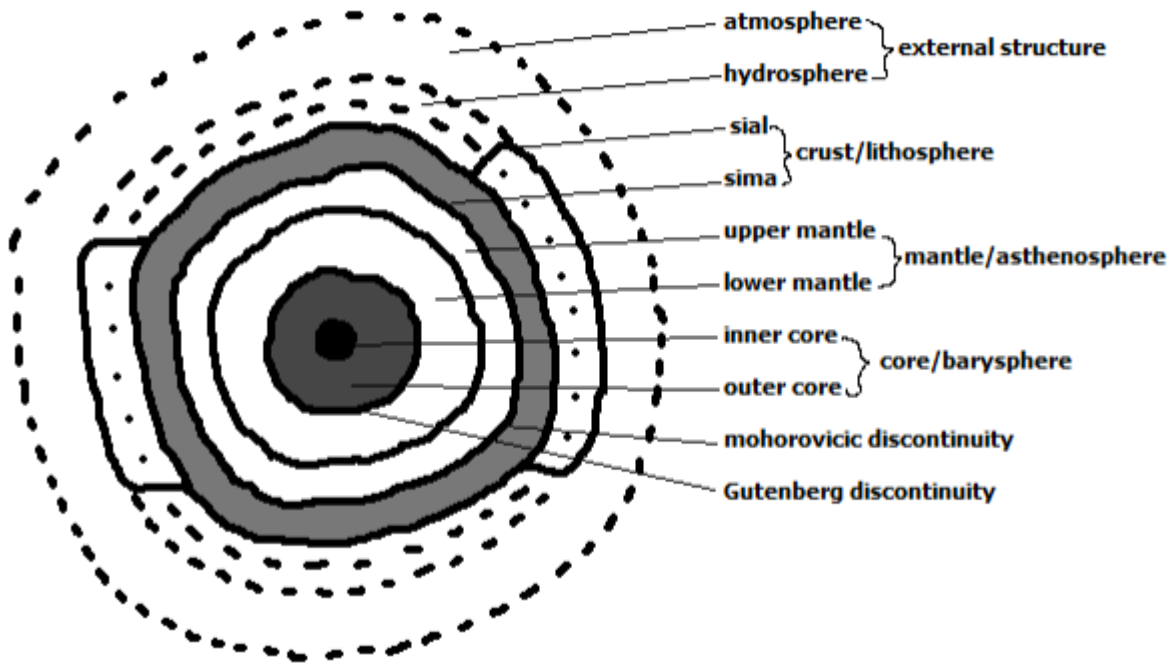


FIGURE 7: THE STRUCTURE OF THE EARTH

A. Crust/Lithosphere

- Outermost layer of the earth
- Made of soils and other loose deposits of sand
- The dominant rocks are granites.
- Extends 0-50km
- Has 2 layers

Sial

- Also called continental crust
- Made of light coloured rocks
- Called sial because it's made up of silica and aluminium.

Sima

- Also called oceanic crust

- Mainly made of basaltic rocks which are brittle.
- Called sima because it is made of silica magnesium and iron.

Mohorovicic Discontinuity (Moho)

- A definite zone of discontinuity between the crust and the mantle.
- Was discovered by Dr. Andrija Mohorovicic in 1909.

B. The Mantle/Asthenosphere

- Layer lying between the crust and the core
- Made of iron and magnesium
- Has two layers

Upper mantle

- Rocks are more elastic than those of sima.
- Temperature is about 1000⁰c.

Lower mantle

- Rocks are like very viscous liquid.
- Temperature ranges between 1000⁰c to 3000⁰c.

Why the Interior of Earth Is Very Hot

- a) Due radio-active decay causing most of the heating.
- b) Due to great pressure as a result of overlying crustal materials.
- c) The original heat resulting from slow cooling of the materials which were pulled off the sun

Gutenberg Discontinuity

- A definite zone of discontinuity between mantle and core.

C. Core/barysphere/Centrosphere

- The innermost/central layer of the earth.
- Has 2 layers

Outer Core

- Composed of very dense rocks
- Made up of nickel and iron
- Temperatures are up to 3700⁰c.

Inner Core

- A solid mass of mainly iron
- Temperatures are estimated to be 4500⁰c to 5000⁰c

External Structure of the Earth

a) The Atmosphere

- Layer of gases surrounding the earth.
- The earth revolves with it because it's held onto it by gravity
- It's about 330km thick.

Composition of the Atmosphere

- a) Gases-exist as a mixture
- b) Smoke particles
- c) Dust particles
- d) Water vapour

The structure of the Atmosphere

It's divided into 4 layers/zones namely:

1. Troposphere

- Lowest layer of the atmosphere
- Contains 90% of water vapour
- Rainfall is got from it

- Temperature decreases with increase in altitude (lapse rate)
- Air is turbulent due to mixing of air
- Contains dust particles
- There is a zone of transition between troposphere and stratosphere called tropopause.

2. Stratosphere/ozonosphere

- Layer lying next to troposphere
- Has layers
- Lower isothermal layer in which temperature is constant
- Upper layer of temperature inversion in which temperature increases with increasing altitude
- Has ozone layer which absorbs harmful ultraviolet radiation.
- Air is calm so it's used by passenger jets
- Limited amounts of water vapour
- There is a zone of transition between stratosphere and mesosphere called stratopause.

3. Mesosphere

- Middle layer of the atmosphere.
- Temperature decreases with increasing altitude.
- There is a zone of transition between mesosphere and thermosphere called mesopause which is an inversion layer.

4. Thermosphere/ionosphere

- High radiation is present.
- The pressure is very low.
- Gases and molecules in this layer exist as ions due to high radiation.
- Has no definite top but merges gradually into the outermost part of the atmosphere called exosphere.
- Exosphere consists of rare gases like hydrogen and helium.
- Beyond the atmosphere there is the outer space.
- Outer space is the universe beyond the atmosphere in which other planets and stars exist.

- a) Animals and plants breathe in from it oxygen for respiration.
- b) Plants use carbon dioxide from it for photosynthesis.
- c) Water vapour in the atmosphere condenses to form clouds which give us rain.
- d) Ozone layer in the stratosphere shields us from ultraviolet radiation which may cause cancers.
- e) Carbon dioxide and methane in the atmosphere cause global warming through the green house effect.

5. The Hydrosphere

- Part of the earth's surface covered by water masses e.g. oceans, seas, lakes, rivers and even underground water.
- It comprises 73% of the earth's surface area.
- The atmosphere and hydrosphere are related in that atmospheric gases penetrate to the ocean depth in solution form.
- The lower atmosphere, hydrosphere and the upper part of the earth's crust are called biosphere meaning the sphere of the earth in which organic life exists.

“It bears mentioning that the Milky Way is only one of 150 billion galaxies visible to our telescopes - and each of these will have its own complement of planets. “~Seth Shostak

The Earth and the Solar System Questions



1. State the three weaknesses of the Nebula cloud theory.
2. Identify the shape of the earth.
3. Describe the forces responsible for the shape of the Earth.
4. Explain five proofs that have been brought forward that the earth is spherical.
5. Distinguish between rotation and revolution of the Earth.
6. Explain four effects of rotation of the Earth
7. Name the exact dates when the following occurs.
 - a. Equinox
 - b. Summer Solstice
 - c. Winter Solstice
8.
 - a. The local time at Nairobi on longitude 0° is 8:00 AM. What will be the time at Moyale on longitude 40°W
 - b. If the local time in Kampala on longitude 37°E is 10:00PM, what will be the time at Buchanan Liberia on Longitude 10°W
 - c. The time at town A which is at longitude 15°E is 10.00am what time is at town B 0°
 - d. When the local time in New York 74°W is 8.00 a.m. what is the local time at Kitale 35°E .
9. What is the effect of International Date Line on time?
10. Define the Solar system, eclipse, star and orbit.
11. Mention the components of the solar system
12.
 - a. What are celestial bodies
 - b. Name **five** celestial bodies
13. Name the parts of a cross section of the earth's structure.
14. Give two dates in the year when the number of hours of darkness is equal in both the north and south poles.

15.

- a. Draw a well labelled diagram to show the external structure of the earth.
- b. Draw a simple labeled diagram to show the internal structure of the earth.

16. Differentiate between meteors and meteorites.

17. Identify the minerals that make up the:-

- a. Mantle.
- b. Barysphere.

18. Why is the interior of the earth very hot?

19. Name the known planets which belong to the solar system.

20. Discuss the passing star theory.

21. With the aid of a well labeled diagram, describe the formation of:

- a. Solar eclipse
- b. Lunar eclipse