PHYSICAL GEOGRAPHY

THE LITHOSPHERE

Lithosphere refers to the **solid outer most shell or part of the earth**. To understand about the lithosphere, it is important to look at the internal structure of the earth.

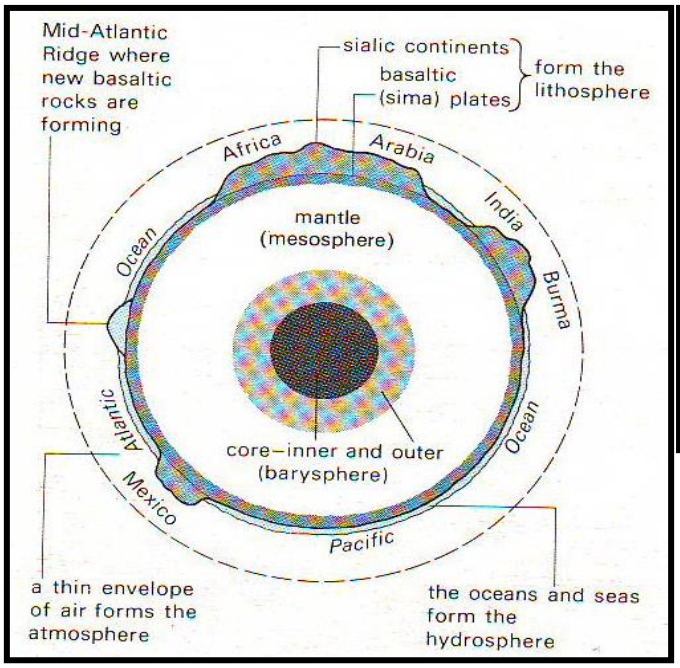
THE INTERNAL STRUCTURE OF THE EARTH

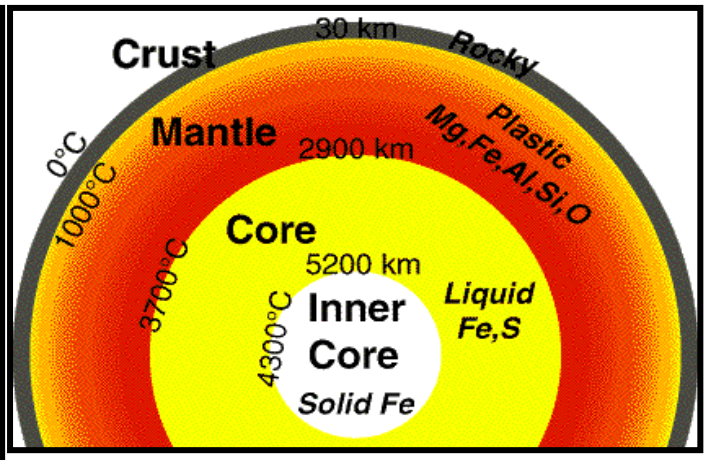
The internal structure of the earth is known by the information which is obtained from:

- Earthquake waves
- Lava emitted from volcanoes
- Deep mine operations
- Crustal borings

From the studies it has been discovered that the earth is composed of three main concentric parts or layers namely;

- The **Crust** which is also called **Lithosphere**
- The **Mantle** which is also called **Mesosphere**
- The **Core** which is also called **Barysphere**





The internal structure of the earth is then covered by the **Atmosphere** which is composed of a mixture of gases forming an envelope around the earth.

1) THE CRUST

- This is the **outer most layer** which is also called lithosphere
- It is a very **thin layer**. Its thickness varies from **6 to 8 km** beneath the oceans to an average thickness of **35 to 40 km** beneath the continents.
- It consists of minerals and rocks of varying physical and chemical properties.
- This layer is made of **two** main parts:
    a) The continental crust or **SIAL**
    b) The oceanic crust or **SIMA**

(a) THE CONTINENTAL CRUST

- ✓ This covers the **upper part** of the crust which forms continents
- ✓ It is made up of **granitic rocks** which are rich in **silica (si)** and **Aluminium (Al)** hence called **SIAL**.
- ✓ The granitic rocks are **lighter** and that they have a density of **2.7g/cm^3.**

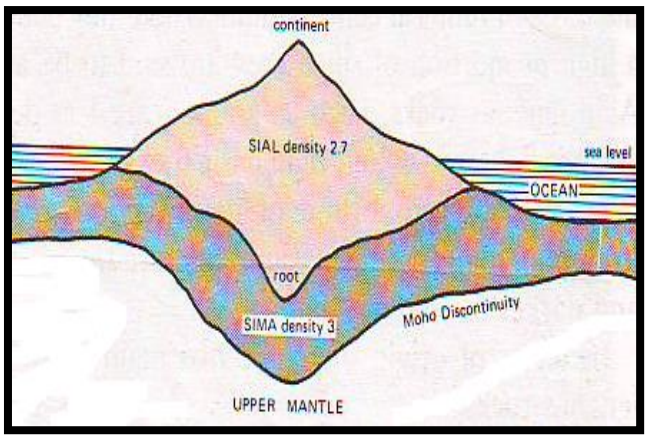
(b) THE OCEANIC CRUST

- This is the inner or **lower part of the crust**. It is mostly filled with water hence oceanic or hydrosphere.
- It is made up of **basaltic rocks** which are rich in **Silica, iron** and **magnesium**. The part has a lot of **Silica (Si)** and **Magnesium (Ma)** than Iron (Fe), therefore it is called **SIMA**.
- These basaltic rocks are heavier with a density of **3.0g/cm³**

THE FLOATING OF THE CONTINENTAL CRUST ON THE OCEANIC CRUST

Since the granitic rocks that make up the continental crust are **lighter** with an average density of **2.7g/cm³** and the rocks that make up the oceanic crust are heavier with a density of **3.0g/cm³**, the continental crust appears to be floating on the oceanic crust in a process called **ISOSTASY.**

A SECTION SHOWING HOW THE CONTINENTAL CRUST FLOATS ON THE DENSER OCEANIC CRUST.



DIFFERENCES BETWEEN THE OCEANIC CRUST (SIMA) AND CONTINENTAL CRUST (SIAL)

INTERMS OF	CONTINENTAL CRUST	OCEANIC CRUST
Thickness	34-40km on average reaching 60-70km under mountains	**6-10km** on average
Age of rocks	**Very old** mainly over 1500 million years	V**ery young** mainly under 200million years
Weight	**Lighter,** with an average density of 2.6g/cm^3	**Heavier** with average density of 3.0g/cm^3
Name of rocks	Granite rocks	Basalt rocks
Nature of the rocks	**Light in colour**, contain silica and alumina	**Darker** in colour, contain silica, magnesium and small amount of iron.

MOHOROVICIC DISCONTINUITY

This is the boundary between the crust and the underlying layer which is the mantle. The boundary is briefly known as **M- Discontinuity** or simply **Moho.**

2. THE MANTLE

- The layer can be further divided into the upper and lower mantle

CHARACTERISTICS OF THE MANTLE

- The layer between the crust and the core
- It is about **2900km** thick, the most voluminous layer.
- It has both solid and liquid characteristics with a greater part made up of **semi-molten material** called **MAGMA**
- Movements of materials are **convectional**.
- The layer is **denser than the crust** with a density ranging from **3.3g/cm^3** to **5.6g/cm^3.**
- Contains rocks which are rich in **silicate minerals** such as olivine and Pyroxene

THE GUTENBURG DISCONTINUITY

This is the boundary between the mantle and the underlying layer called the core.

(3) THE CORE

- The innermost layer and is divided into two parts: the outer core and the inner core.

CHARACTERISTICS

- It has a radius of about **3480km** with the outer core having about **2270km**
- The inner core is made up of **solid rocks with metallic properties**. This is because though temperatures are extremely high in the centre of the earth, **they may not be high enough to boil such deeply buried layers of rocks.**
- Mainly consist of rocks which are rich in **Nickel (Ni)** and **iron (Fe).**
- Since the core is mainly made up of **Nickel** (**Ni)** and **iron (Fe),** the layer is also collectively called **NIFE**
- Subjected to **high temperature** of about **1927˚ C** and **extreme pressure.**
- The outer core which is about **2270km** is largely made up of **liquid or molten material** due to **great pressure** exerted by the upper layers and **high temperature** experienced.
- It is the source of **gravitational force** due to the presence of **iron**
- Has a density of about **12.0g/cm^3**

INCREASE OF TEMPERATURE IN THE INTERNAL STRUCTURE OF THE EARTH

Temperature increases with depth in the internal structure of the earth such that the inner core has the highest temperatures because:

1. The interior parts of the earth are **cooled at a slower rate than the outside**.
2. The **radioactivity decay** through nuclear fission of certain **minerals release heat**.
3. The **weight of overlying materials exerts pressure** on the core resulting into **high temperatures.**

IMPORTANCE OF THE INTERNAL STRUCTURE OF THE EARTH

- It is the **home of valuable minerals** such as copper, gold, iron, nickel which people put them into productive uses.
- It is the home of **rocks** such as granite which have a wide range of uses.
- Helps to understand the **occurrence of some geological processes** such as volcanic eruptions, earthquakes, folding and faulting.
- Helps to understand the idea of **the drifting of continents and plate tectonics**.
- It is the source of the **gravitational** force.

SAMPLE QUESTIONS

Of what importance is mantle to the crust? (2marks)
Mention any three characteristics of the mantle (3marks)
Why is the innermost layer of the internal structure of the earth regarded as NIFE? (2marks)
Draw the internal structure of the earth and show the three main layers, Moho discontinuity and Gutenberg discontinuity (5marks)
Explain the importance of Mohorovicic discontinuity in the internal structure of the earth (2marks)

What makes the core to be the centre of gravity? (2marks)
Describe any two characteristics of the following layers (i) Crust (ii) Core (iii) Mantle (6marks)

Keywords: Convectioncurrents,mantle,iron,nickel,mohorovic,guternberg,Sial,Sima,basaltic,granitic

A THEORY: This is an **explanation** backed by results or **evidence** obtained from repeated tests or experiments **which seem to be true**.
Examples of theories in Geography
1. Continental drift theory
2. Plate tectonics theory

A HYPOTHESIS: This refers to the **data gathered over a long time** and **well supported**. A theory passes through a hypothesis.

A LAW: This is a **theory that has been accepted** by everyone and explains how something takes place. An example of a law in geography is **Ferrels Law** of deflection which states that **freely moving bodies such as water and wind are deflected to the right in the northern hemisphere and to the left in the southern hemisphere from their normal courses.**

IMPORTANCE OF THEORIES AND LAWS IN GEOGRAPHY
These help to give **geographical explanations** to some geographical information which are very **abstract** in nature.

THE CONTINENTAL DRIFT THEORY

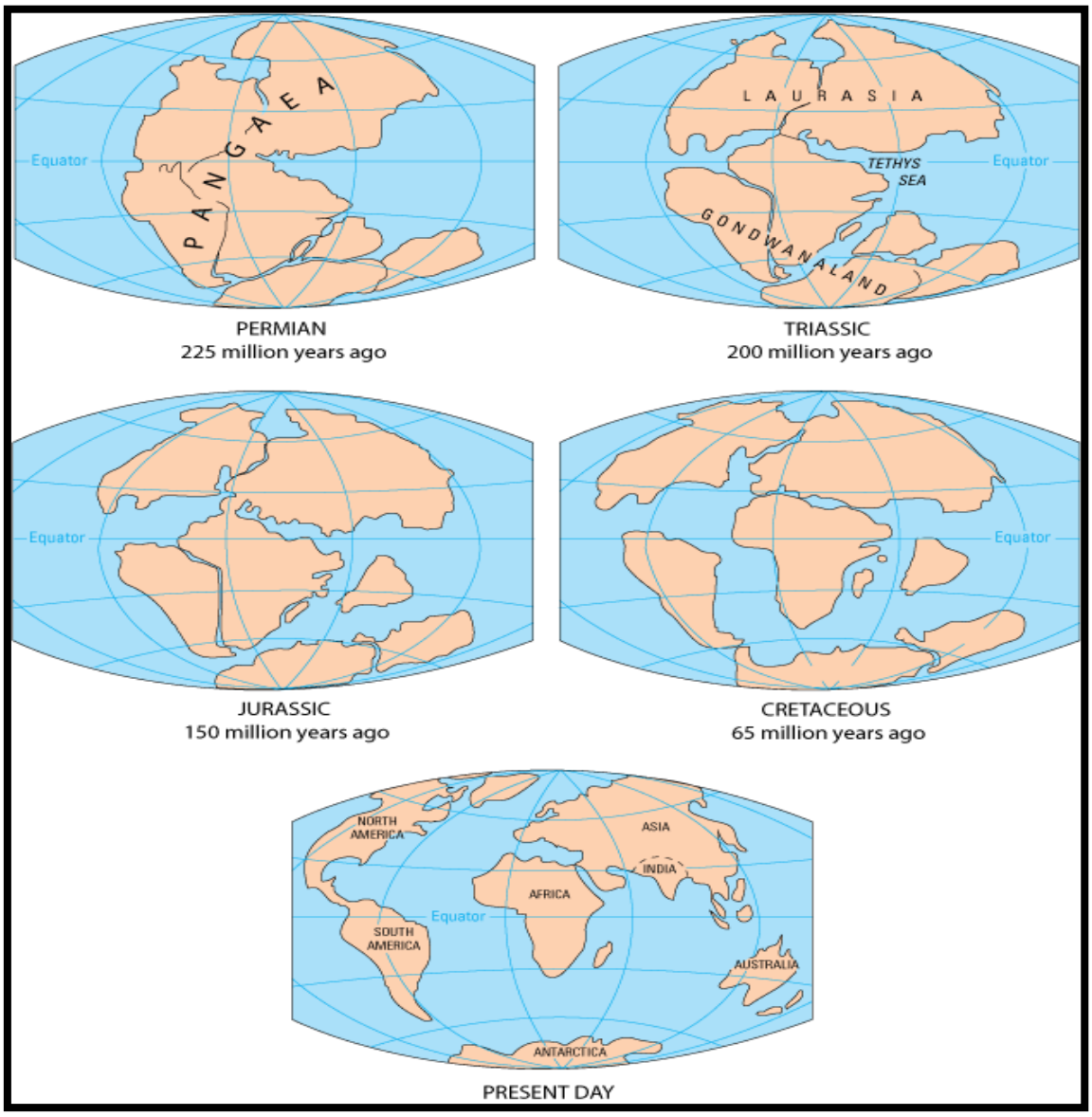
The theory of **continental drift states that the continents move or drift across the surface of the earth gradually,** changing their positions from the **super continent called pangea.** Over **200 million** years ago, all the continents were together into a single super- continent called **PANGEA *meaning all lands,*** which was surrounded by a big ocean, called **PANTHALASSA** with a small sea called **TETHYS SEA**. Later on the Pangea had to split into two large land masses called **LAURASIA** and **GONDWANALAND**.
LAURASIA: This was the **northern land mass** after the split of Pangaea which included the continents of **Europe**, **Asia, Arctic** and **North America.**

GONDWANALAND: This was the **southern land mass** after the split of Pangea which included the continents of **South America**, **Africa**, **India**, **Arabia**, **Australia** and **Antarctica.**

Then the Laurasia and Gondwanaland continued splitting and drifting apart. This further split made **South America** to be joined to **North America**, **India** to be joined to **Laurasia** with **Australia** becoming an island. Continents then reached their present positions. The continents still drift apart at the rate of 10 to 15cm per year.

Therefore, the theory of **continental drift** is about the **movement of the continents** from the super continent called **Pangaea** into **Gondwanaland** and **Laurasia** which splits further making them to be in present positions which are still drifting slowly.

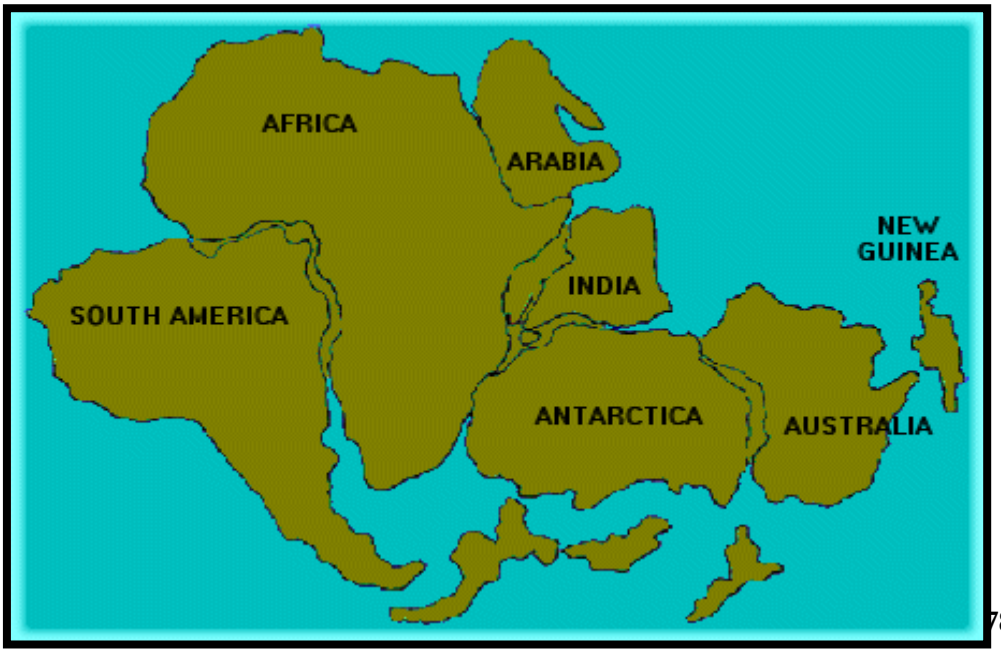
The man who put forward the theory of the continental drift was a German climatologist and geophysicist called **ALFRED WEGNER.**



EVIDENCES SUPPORTING THE THEORY

1) THE FIT OF THE CONTINENTS

The **present shapes of the continents suggest that their coastlines on the opposite** sides can be joined together. For example, the shape of the Eastern coast of **South America** and that of the **Western coast of Africa** if brought together seem to **fit like pieces** of a **jigsaw puzzle.**



2) ROCK TYPE AND STRUCTURAL SIMILARITIES

Global distribution of rock types, structures and characteristics is evidence. Rocks found in a particular region on **one continent are closely matching in age and type with those found in adjacent position on the matching continent.** For example, rocks in **West Africa** match in **age** and **structure** with those in **Brazil** but in between there is a great mass of water.

3) FOSSIL OR PALAEONTOLOGICAL EVIDENCE

Fossils of plants and animals have been discovered in most parts of continents such as Africa, America and Asia. **Such fossils of animals like Mesosaurus and fern plants like Glossopteris are similar in age.** This really indicates that the super continent really existed because **such animals and plants cannot cross big oceans that exist today on their own.**

4) PALEOCLIMATIC EVIDENCE

The ancient climatic data gives a lot of evidence through the following:

- **Glacial grooves which have been preserved in areas such as South America, India, Australia and Antarctica** shows that the continents have been drifted apart from a super continent as the grooves **point in one direction**. The presence of **glacial grooves** in The **Democratic Republic of Congo** proves because the area is **in the tropics** with **hot conditions** not allowing **the formation of glaciers,** so it might have been joined to the Polar Regions and drifted.
- **Great forests** which existed within the continents were later turned into coal fields which extend from **North America** across **Africa** and **Eurasia**. Moreover, these **coal fields** in America and Europe indicate that the **tree ferns** which produced the coal deposits came from **the tropics** and were brought there due to the drifting of the continents from the super continent.
- **Mountain belts** appear to move in a line **from one continent to another**, Rockies, Atlas, Alps and the Himalayas. Such mountains were formed during the same period which supports that there existed the super continent. Moreover, the **mountain ranges** in South America are similar in **age** and **structure** to the **Cape Ranges** in South Africa.

5) MAGNETISM OF ROCKS

Magnetism of ancient rocks especially igneous rocks shows that the continents were once a single entity. Rocks were **magnetised in the direction of magnetic north** when solidifying. All ancient rocks on all the continents **show similar magnetic pattern** showing that all the continents were joined together.

WEAKNESSES OF THE CONTINENTAL DRIFT THEORY

1. It fails to come up with the **convincing mechanism or forces** that could have been powerful enough so as **to separate the Pangea**. Wegner suggested the tidal influence of the moon and a cut in the earth's crust which were weak arguments.
2. The evidence of the **similar in the coastlines** has been challenged by **water erosion processes** at the coastlines which **shape the coastlines** in the positions that they have.
3. Fossil evidence has been challenged in the way that plants could be grafted and **move in water** by **currents** with **some animals attached** to them and **cross such mass of water** only to **regrow** to the other side of the continent. This makes the **fossils** to be similar **in age** and **structure.**
4. **Not all continents fit when joined** and some parts **need to be removed** for the continents to join.
5. The theory focussed very much on **continental crust** and did not state what happens to **oceanic crust.**

Key words

Pangea, Gondwanaland, Laurasia, continental drift, jigsaw puzzle, fossils, racial grooves, coastlines, Alfred Wegner

SAMPLE QUESTIONS

Define the following terms (i) Pangaea (2marks) (ii) Gondwanaland(2marks) (iii) Laurasia(2marks) (iv) Panthalassa (2mars)

Explain the continental drift theory(3marks)

How can the following stand as evidence for the continental drift theory (i) the coasts of western Africa and eastern south America(3marks) (ii)paleoclimates(3marks) (ii)paleontological(3marks) (iii) glacial glooves in Congo(3marks) (iv)Mid oceanic ridges (3marks)

Explain any two major weaknesses of the continental drift theory (4marks)

"The earth was once one big landmass." Explain any two proofs to support this (4marks)

THE PLATE TECTONIC THEORY

The theory of plate tectonics **states that the outer shell of the earth called lithosphere is made up of rigid structures called plates**. These plates **move over** the underlying **soft layer** of the mantle called the **ASTHENOSPHERE.** As the plates move they **therefore carry the earth or continents and the ocean floors with them.**

PLATES. These are **rigid or slab like structures** that make up the **lithosphere** and are in constant **motion** on the soft layer **of the mantle called asthenosphere.**

TECTONICS. This refers to the **movements** in the crust which bring **new features**.

PLATE TECTONICS. Is the idea that the Lithosphere is made up of **slab like structures** which are in constant motion.

TECTONIC ACTIVITY

This refers to the general processes involving **faulting**, **folding** and **warping** making the crust to be **deformed.** This is also called **DIASTROPHISM**

CHARACTERISTICS OF TECTONIC PLATES

1. A plate is a block of **continental** as well as the **ocean** crust.
2. Oceanic **plates are higher** in **density** than continental plates. This is because **oceanic plates** are made up of **basaltic rocks** which have a **high density** while **continenta**l **plates** are made up of **granitic rocks** which are **less dense**
3. Plate's movements are compelled by **compression** and **tensional forces**.
4. Plates though perceived as **rigid,** are capable of **bending and breaking**
5. Plates are separated by mobile belts or **boundaries** characterised by **earthquakes, volcanic activity, Fold Mountains and ridges.**

CAUSES OF TECTONIC ACTIVITY OR PLATE MOTION

- The **heat produced in the upper mantle** by radio activity causes slow-moving **convection currents** to **operate laterally and diverge** at the base of the overlying lithosphere causing a weak tension on the solid plate above it therefore weakening the floating of the solid plate therefore pushing the **plates apart.**
- **Gravitational force**. The cold oceanic slab has a greater density than the asthenosphere supporting it from below. This being the case makes the gravitational force to pull down such slabs on the edge more strongly in **a slab-pull manner**.
- The **injection of lava or hot plumes** originates near the mantle- core boundary. Upon reaching the lithosphere these **hot plumes spread laterally and carry the plates** away from the zone of upwelling. These hot plumes reveal themselves as volcanic structures.

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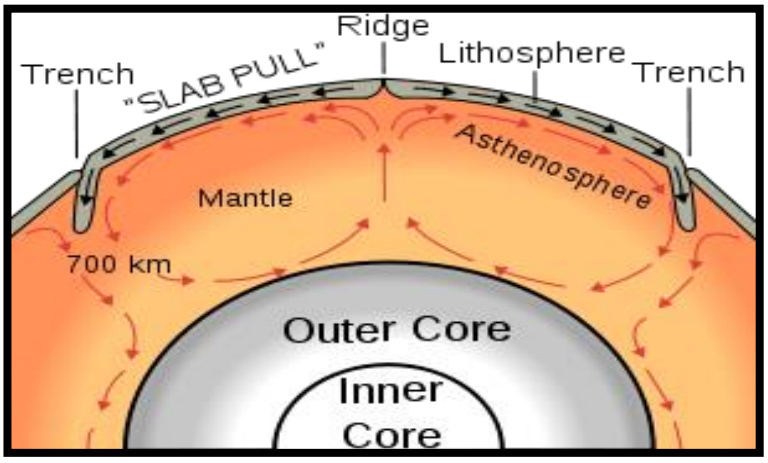


TYPES OF PLATES

There are **two** types of plates

1. Continental plates
2. Oceanic plates

1. **OCEANIC PLATES**

- These form **oceanic crust**
- Are denser than continental plates
- Made up of young **dark basaltic** rocks
- Are **thinner** than continental plates

EXAMPLES OF OCEANIC PLATES

- Pacific plate
- Cocos plate
- Scotia plate
- Juan de fuca plate
- Nazca plate
- Antarctica plate

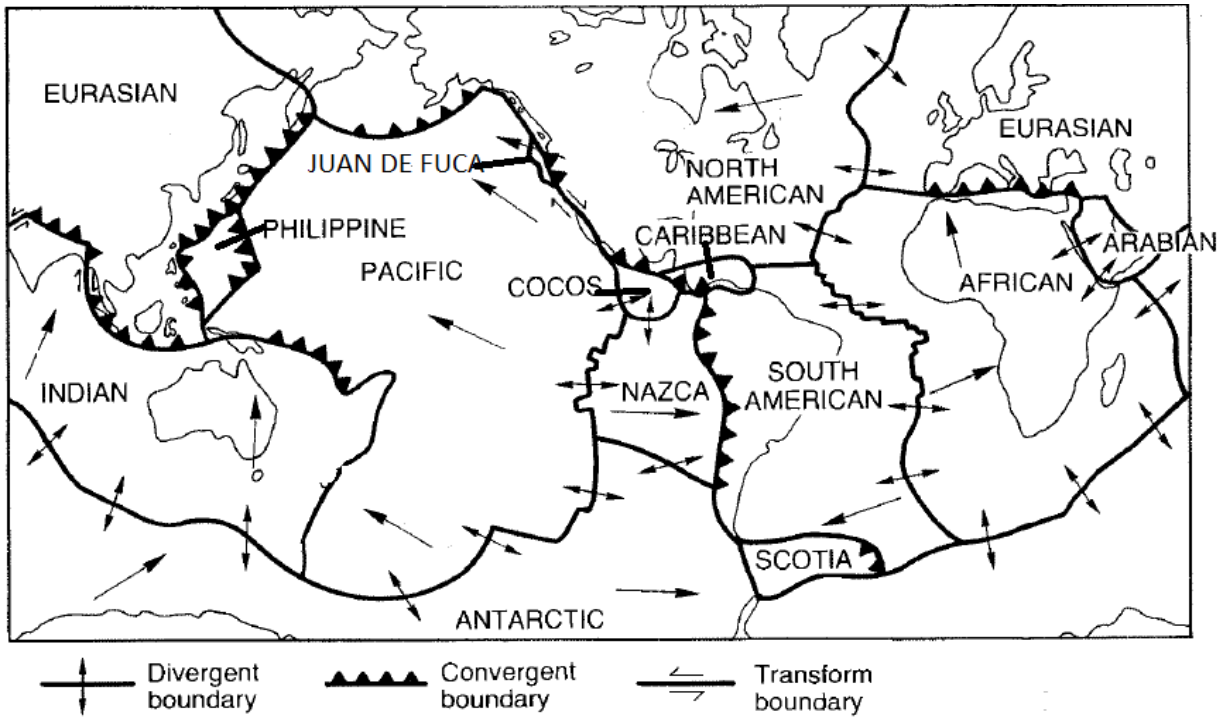
CONTINENTAL PLATES

- Form part of the **continental crust**
- Are **less dense** compared to oceanic because **granitic rocks** that make up continental plates are **lighter** than the **basaltic rocks** that make up oceanic plates.
- Made up of light **coloured** granitic rocks
- Are **thicker** than oceanic plates

EXAMPLES OF CONTINENTAL PLATES

- Iranian plate
- Indo-Australian plate
- Arabian plate
- Philippine plate
- Eurasian plate
- North American plate
- South American plate
- African plate

NAMES AND LOCATION OF PLATES



TYPES OF PLATE BOUNDARIES (MARGINS)

As the tectonic plates move about on the asthenosphere, they interact with one another at their boundaries. There are **three** types of plate boundaries or margins.

1. Divergent
2. Convergent
3. Transform, tear or shear

1. DIVERGENT BOUNDARY

It is created where **plates are moving apart because of tensional forces operating laterally.** As plates move a part, **a gap is** left, or **faulting** takes place making materials from the mantle **to upwell, forming new features.**

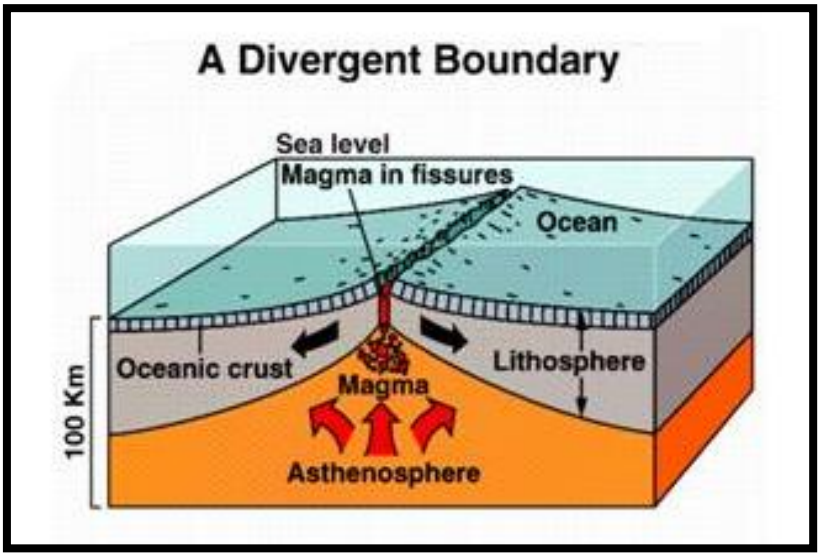
The boundary is also called **CONSTRUCTIVE** because the boundary **results into the upwelling of magma forming new oceanic features such as mid oceanic ridges and volcanic islands**.

The process of the separation of plates and the upwelling of magma forming new oceanic crust is called **SEA-FLOOR SPREADING.**

FEATURES FORMED IN THE DIVERGENT BOUNDARY

- Volcanic islands
- Mid oceanic ridges
- Volcanoes
- The boundary is also associated with **faulting** which give rise to shallow **earthquakes**

A DIAGRAM OF A DIVERGENT BOUNDARY



EXAMPLES OF PLATES WITH A DIVERGENT BOUNDARY

- The **African plate** which is moving away from the **South American** plate resulting into the **mid – Atlantic Ocean ridge**.
- The **Indo- Australian plate** which is moving away from the **African plate** resulting into the **mid-Indian Ocean ridge.**

2. CONVERGENT BOUNDARY

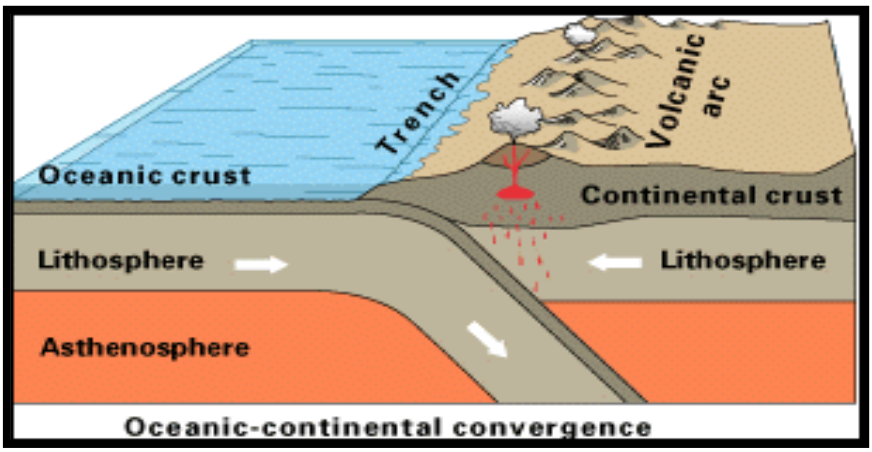
This is a boundary formed **when plates are moving towards each other because of compression forces and collide.**

When such two plates collide one plate **dives under the other**. The area where one plate is forced downwards is called **SUBDUCTION ZONE**.

If the collision is between the **oceanic plate** and the **continental plate**, the oceanic plate is forced **downwards since it is denser than the continental plate.** Features found in the subduction zone include **oceanic trenches, volcanoes**, **earthquakes, Fold Mountains** and **oceanic islands.**

The convergent boundary is also called a **DESTRUCTIVE** because **it destroys the crust during plate collision and when one plate dives under the other after colliding.**

A DIAGRAM OF A CONVERGENT BOUNDARY



EXAMPLES OF PLATES WITH A CONVERGENT BOUNDARY

- The Indian plate and the Eurasian plate
- The Nazca plate and the south American plate
- Juan de Fuca and the pacific plates with the North American plate

The Convergent boundary takes place between Continental and Continental plates and Oceanic and Oceanic plates

OCEANIC TO OCEANIC CONVERGENCE

In this the **subduction** zone also takes place as one plate which is longer is forced to dive after collision. This collision is associated with earthquakes, trenches, volcanoes and volcanic islands.

CONTINENTAL TO CONTINENTAL CONVERGENCE

This takes place between continental plate and another continental plate. In this collision, **no subduction takes place** as both plates are **forced to rise** due to their low densities. Instead both **plates rise and crumble to form huge fold mountains**. Examples of plates forming this collision include Indian plate and Eurasian plate forming Himalayas Fold Mountains. Volcanoes and earthquakes also take place.

3. THE TRANSFORM, SHEAR OR TEAR BOUNDARY

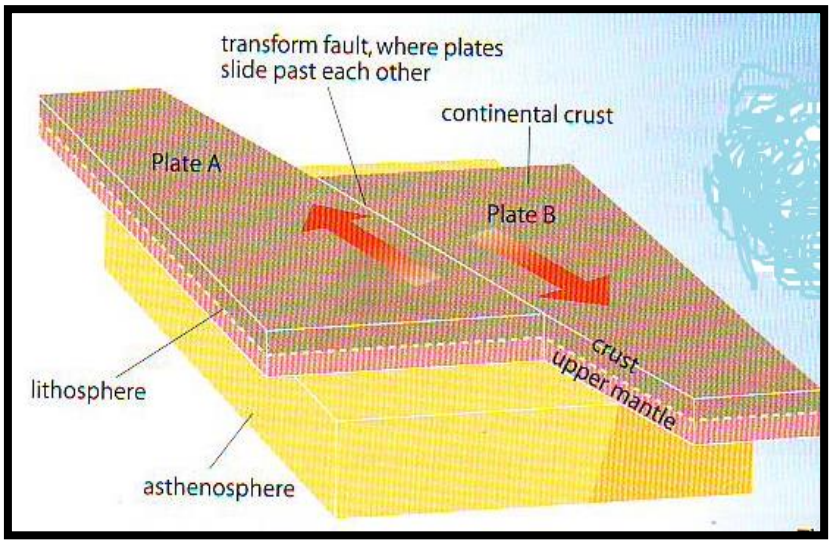
This is a boundary formed when **plates slide passing each other in a parallel manner in opposite direction.**

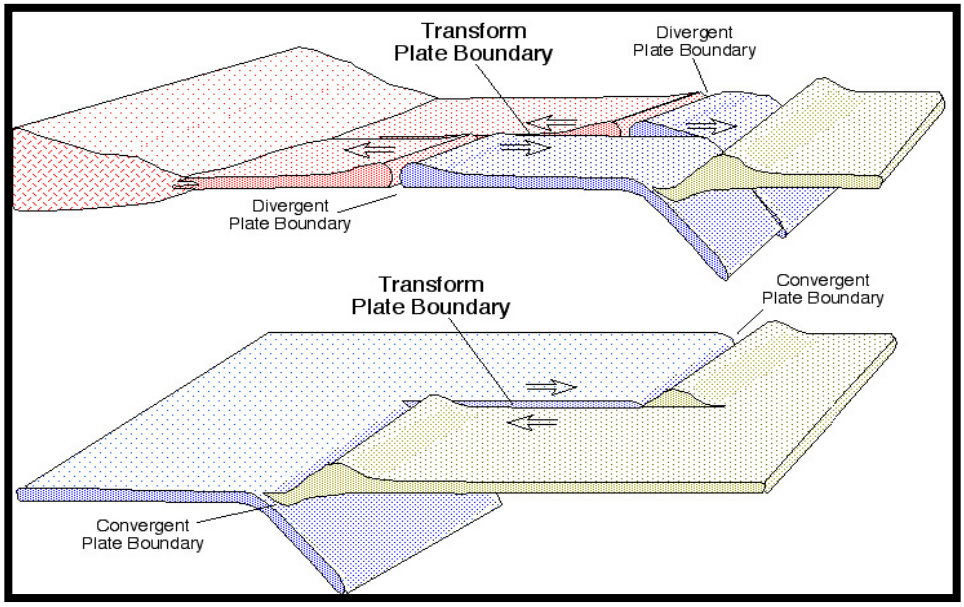
This is a **CONSERVATIVE** boundary because **the crust is neither created nor destroyed.**

It results into the formation of faults such as the **San Andreas Fault around California** in America.

Such faults are associated with **earthquakes** and the change of the river courses.

DIAGRAMS OF THE TRANSFORM BOUNDARY





EXAMPLES OF PLATES WITH A TRANSFORM BOUNDARY

The **pacific plate** which moves passing the **North American** plate giving rise to the San Andreas Fault.

RESULTS OF THE TECTONIC ACTIVITIES

These are **geological features** which have a great impact on the environment. They are called **geological** features because they are **formed and come from the internal structure of the earth**.

The movement of plates results into the creation of several features such as oceanic ridges, oceanic islands, oceanic trenches, fold mountains, volcanoes, and earthquakes.

(a) OCEANIC RIDGES

- Formed in the **divergent boundaries**
- Plates **move away** from each other leaving a **gap.** Magma with rocks **up well** from the mantle and form a ridge.
- Such mid oceanic ridges **do not rise** to the surface but remain **below the ocean**
- Geologic activities that take place along such mid oceanic ridges include the **seafloor spreading, volcanic eruptions, earthquakes.**
- Examples of such mid oceanic ridges include the **mid Indian Ocean ridge** and the mid **Atlantic Ocean ridges**. The mid Atlantic Ocean ridge formed between the plates of America and Africa is a gigantic submerged mountain range standing **2500-3000 metres** above the adjacent deep-ocean basin.

(b) OCEANIC ISLANDS

Formed in the **diverging boundary.** The oceanic islands **rise directly from the ocean floor beyond the top level of water**. These are wholly surrounded by water.

Examples of such islands include the Canary, Iceland and Falkland.

(c) OCEANIC TRENCHES

- These are oceanic **deeps making the deepest part of the oceans** formed when the oceanic plate dives under the continental plate in the **subduction zone.**
- Trenches sometimes form when **plates move apart.** Such trenches are later filled with the molten rock or magma from the mantle'
- Examples of trenches include **Aleutian, the Marianas,** the **Tonga,** the **Java** and the **Peru**.

(d)FOLD MOUNTAINS

- ✓ Fold Mountains are formed in the **convergent boundary** where one plate **collides** over the other. This is especially true when there is a collision between a continental and another continental plate. Under such circumstances the sediments in between are **crushed, squeezed and folded into anticlines and synclines giving rise to mountains.**

- ✓ Examples of such mountains are the **Rockies** formed when the Juan de Fuca and the pacific plates collided with the North American plate, the **Andes** formed when the Nazca plate collided with the South American plate, the **Himalayans** formed when the Indian plate rammed into the Eurasian plate.

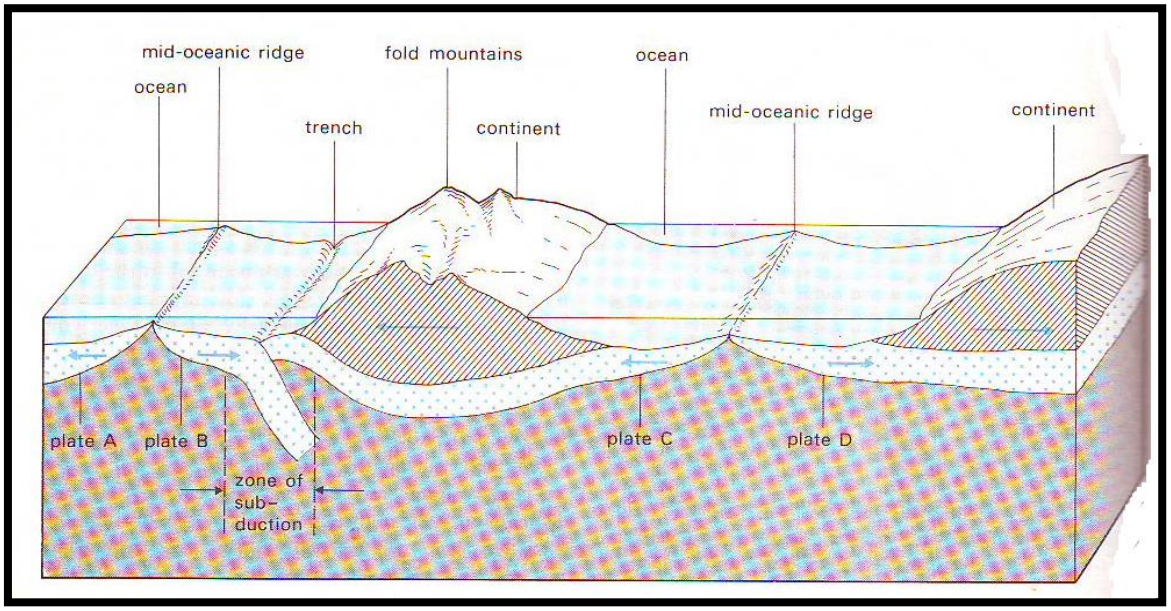
(e) VOLCANOES

- ❖ These are formed in the **convergent boundary** when one plate dives under the other. The plate that dives under the other is subjected **to high temperatures in the mantle and starts to melt. This produce magma which using the faults formed during collision rises to form volcanoes.** The plate that dives also **disturbs magma** which then uses the **faults** created to rise. This again contributes to volcanoes.
- ❖ Volcanoes also exist in the **divergent boundaries**. In this the **gap or faults** created due to the separation of plates make **magma** to rise from the **mantle and form volcanoes**. Some of such volcanoes exist under the oceans.

(f) EARTH QUAKES

These are produced along the edges of the plate boundaries especially where two plates meet in the **convergent boundary**. The force that is generated during **the collision** makes the ground to shake or vibrate. They are also produced in the **transform boundary** which results into faults. Such faults like the San Andreas give rise to earthquakes. They also take place in the **divergent boundary**. When plates separate the motion of them make the ground to shake. In addition, when plates separate, **magma** comes out. This magma comes with a lot of **force** that make the ground to shake.

DIAGRAM SHOWING SOME OF THE FEATURES PRODUCED BY TECTONIC ACTIVITIES



A SUMMARY OF PLATE BOUNDARIES WITH FEATURES FORMED

TYPE OF PLATE BOUNDARY	EXAMPLES OF PLATES	NAMES OF FEATURES FORMED	TYPE OF MOVEMENT	EXAMPLES OF FEATURES FORMED
Destructive with Oceanic plate and a Continental plate	Nazca and South American plates	Andes	Compressional	Earthquakes, Fold mountains, Volcanoes,Oceanic trenches
Destructive with two Oceanic Plates	Pacific to Pacific	Japan,Phillipines	Compressional	Earthquakes, Island arcs,Volcanoes,Oceanic trenches
Destructive with two continental plates colliding	Eurasian plate and Indo-Australian plate	Himalaya	Compressional	Earthquakes,volcanoes,Fold mountains
Constructive	American plates away from African plate	Mid Atlantic Ridge	Tensional	Earthquakes,Mid oceanic ridges, Volcanoes
Conservative	Pacific plate and North American plate around California	San Andreas Fault	Shearing	Earthquakes

EFFECTS OF GEOLOGICAL ACTIVITIES ON ENVIRONMENT AND HUMAN ACTIVITIES

Geological activities have both **positive** and **negative** effects to the environment and which in turn affects human activities.

POSITIVE OR CONSTRUCTIVE EFFECT	NEGATIVE OR DESTRUCTIVE EFFECTS
1.Good **scenic features** that attracts **tourists** which bring money to the nations where such features exist.eg volcanoes, fold mountains	**1.** Destroy **peoples' lives** e.g. volcanoes and earthquakes.
2. Sources of **minerals** which are mined and put into industrial use e.g. tin in fold mountains.	**2.**Geologic activities such as volcanoes and earth quakes **destroy buildings** and infrastructure such as bridges, roads thereby affecting the economy of the country
3.Bring volcanic **weathered fertile** soils for the cultivation of crops e.g. volcanic ash	**3.** Contribute to **air pollution** inform of smoke and poisonous gases. This does not only disturb **air transport** but also accumulation of greenhouse gases contributing to global warming.
4. Volcanic eruptions results into the formation of **crater** or **caldera lakes** for domestic purposes.	**4**.Geologic processes form block mountains and fold mountains which are **barriers to transport and communication** as it is difficult and expensive to construct roads and railways through such features
5.Geologic feature like mountains **act as sources of rivers** which supply water for domestic, irrigation and transportation	**5**. Some geologic features such as mountains and plateaus **create rain shadow to some areas** making them to receive very little or no rainfall. This affects the cultivation of crops.

6.Some geologic processes **act as windows** to the ground thereby knowing more about the internal structure of the earth e.g. earthquakes	
7. Formation of **rocks and precious stones** which people use them in construction works.	

DIFFERENCES BETWEEN CONTINENTAL DRIFT AND PLATE TECTONICS THEORIES

1. The continental drift theory deals with the **movement of the continents** from the super continent while as the plate tectonics is about the **movement of the plates in the crust**.

2. The plate tectonics concern the **plate boundaries** such as convergent boundary, divergent in which **some features are formed**. This is not the same as continental drift which talks **about the movement of continents and not formation of features.**

3. The continental drift deals with **the movement of the whole continents** while as plate tectonics is **about the movement of the crust**

SIMILARITY BETWEEN THE TWO THEORIES.

Both concern some movements of some parts of the earth.

HOW DOES THE PLATE TECTONICS THEORY SOLVE THE PROBLEM LEFT BY THE CONTINENTAL DRIFT THEORY?

The plate tectonics explain about the **causes of plate motion on the asthenosphere** such as convection currents operating in the mantle. The movement of plates **make continents and oceanic floors to move too hence the movement of continents** which Alfred Wegner failed to explain.

From the plate tectonics there is an idea of **sea floor spreading** which contributes to the formation **of mid oceanic ridges.** This can stand as evidence for the continental drift too as these make **continents to move away** from each other as **the new crust** is formed. For example, the mid Atlantic ridge makes Africa to move away from South American plates. In such mid oceanic ridges, **new rocks** are found **on the middle** part while **old rocks away** from the ridge an indication of some movements. Moreover, mid oceanic ridges grow bigger or higher under the ocean due to sea floor spreading, pushing the continents away from each other.

Key words

Plates,tectonics,tectonicactivity,convergent,divergent,transform,destructive,constructive,conservative,subduction,hot plumes, sea floor spreading, trenches,volcanoes,diastrophism

SAMPLE QUESTIONS

Describe the plate tectonics theory(3marks)

What do you understand by tectonic activity? (2marks)

Explain three results of plate motion (6marks)

Why convergent plate boundary is described as *destructive(2marks)*

Describe how the following features are formed (i) fold mountains (3marks) (ii) mid oceanic ridges(3marks) (ii) oceanic trenches (3marks)

Explain the reasons why some plate tectonic boundaries are referred to as (i) Constructive (3marks) (ii) Conservative(3marks)

Explain what happens when (i) an oceanic plate collides with a continental plate (3marks) (ii) two continental plates collide (3marks)

What do you understand by the following terms (i) subduction zone (2marks) (ii) tectonics(2marks) (iii) constructive boundary (2marks) (iv) plates (2marks)

Mention two examples of features formed in convergent plate boundary (2marks)

Why is transform boundary regarded as a conservative boundary (2marks)

MOUNTAIN BUILDING PROCESS: FOLDING AND FAULTING

Mountains and upland areas were formed through some of the following ways:

1. **Folding** i.e. fold mountains
2. **Faulting** i.e. block mountains
3. **Volcanic eruption** e.g. volcanic mountains
4. **Denudation processes** e.g. Residual Mountains

RELATIONSHIPS BETWEEN MOUNTAIN BUILDING PROCESSES AND PLATE TECTONICS OR PLATE MOTION

1. Plate motion results into **folding processes** that build up **Fold Mountains**.

2. Plate motion creates tear in the crust producing faults making some **blocks** to stand as **Block Mountains.**

3. Plate motion results into **eruption of volcanoes** which builds up **volcanic mountains** on the earth's crust.

Process	**Type of mountain**	**Example**
Folding	Fold mountains	Rockies, Andes
Faulting	Block mountain	Ruwenzori
Volcanism	Volcanic mountain	Kilimanjaro
Denudation	Residual	Mulanje

OROGENESIS is the term given to **all processes involved in the building up of mountains**.

FOLDING: This is the **bending of the rock strata as a result of compressional forces**. These are forces that move towards each other from either direction when sedimentary rocks are subjected to compression, they bend or fold. These compressional forces originate beneath the crust in the upper mantle pushing the tectonic plates.

A FOLD: this is **a bend of the sedimentary** rocks due to **compressional** forces.

COMPONENTS OF A FOLD

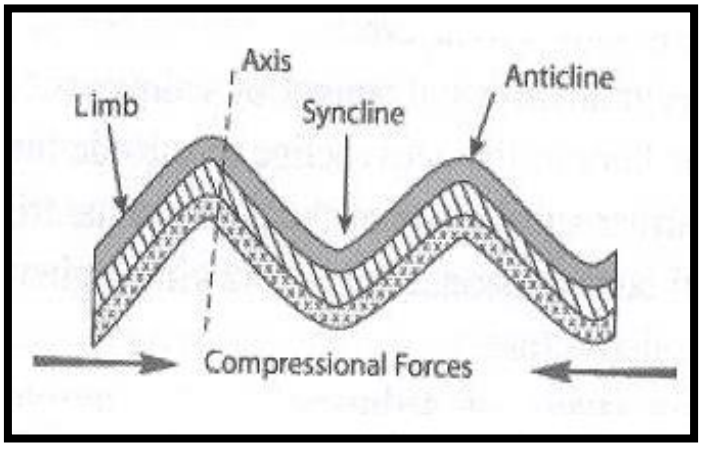
A fold has three major parts:

i. **ANTICLINE**
   It is a feature that is formed when rock layers **bend up into an arch-like form**, it is also known as an **up fold**.

ii. **SYNCLINE**
   Ii is a feature which is formed when rock layers **bend downwards** into a trough like form. It is also known as a **down fold**.

iii. **LIMB**
   It is the **side** of the fold. The two sides of folds are called **limbs.**

DIAGRAM OF A FOLD SHOWING ITS MAIN COMPONENTS



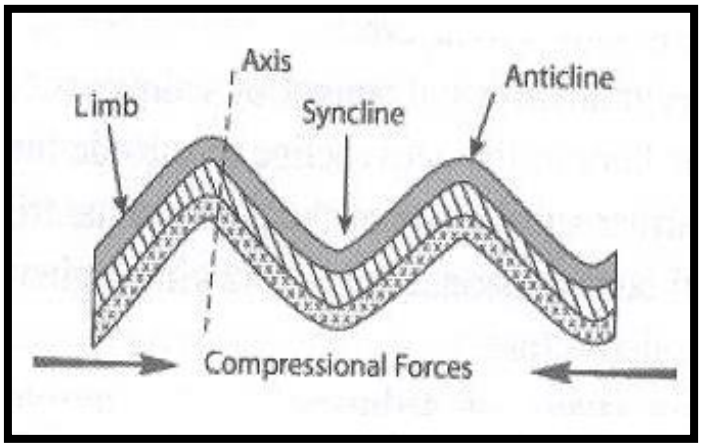
MAIN TYPES OF FOLDS

There are **four main** types of folds:

1. Simple or symmetrical
2. Asymmetrical
3. over fold
4. over thrust fold

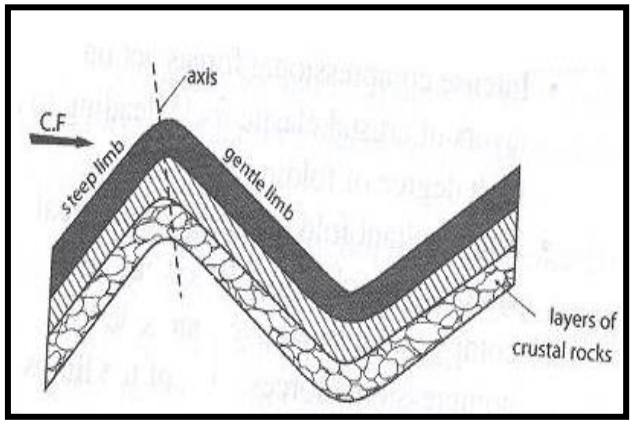
1. SIMPLE OR SYMMETRICAL

This consists of **an anticline and a syncline whose limbs dip at the same angle**. The fold forms when compressional **forces are equally applied** on both sides of the rock strata. The diagram of a simple fold can be like that which shows components of a fold.



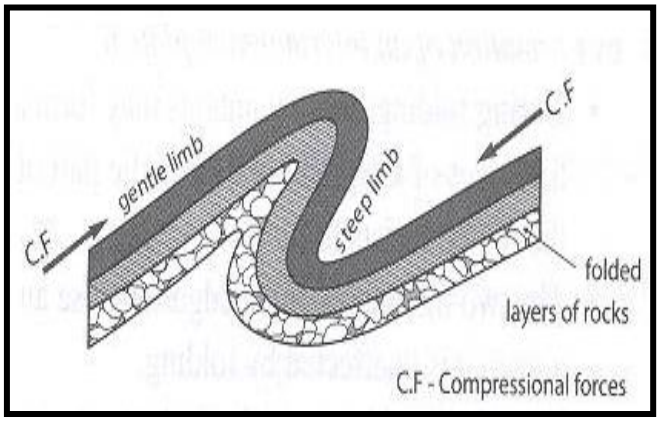
2. ASYMMETRICAL FOLD

This is the fold in which one **limb is steeper than the other.** This fold develops where pressure is **greater in one direction** than the other.



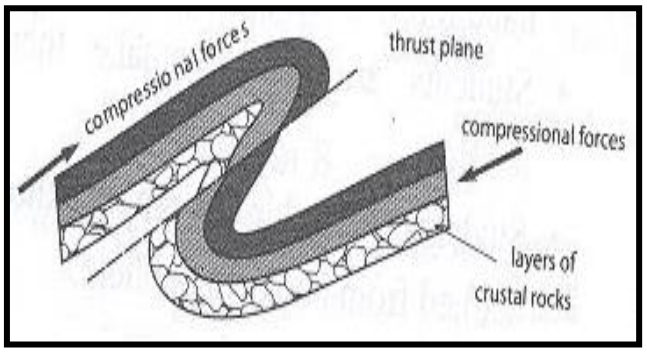
3. OVERFOLD

In this one limb is **pushed over the other** and when one limb rests on the other the fold is called **RECUMBENT**.



4. OVER THRUST FOLD OR NAPPE

This occurs when a **fracture** develops in the **fold due to intense pressure** as one limb is pushed over the other. The **rock layers are displaced** from their normal positions.



RESULTS OF FOLDING PROCESSES

The processes results into the formation of **Fold Mountains**

FOLD MOUNTAINS

Fold Mountains are mountains which develop when rocks after being subjected to plate motion, were **folded** and **elevated.** Such motions consist of long belts of folded rocks with thickness.

FORMATION OF FOLD MOUNTAINS

In the formation of Fold Mountains, the folded rocks are mainly those of sedimentary type. There are several procedures which take place during the formation of Fold Mountains. These processes are:

1. FORMATION OF GEOSYNCLINES

Geosyncline is elongated down **warping** of the crust which forms a **deep trough**. These geosynclines are formed **when two plates collide in the subduction zone**. The geosynclines are important because they **create a temporary sea in which sediments collect**.

2. COLLECTION OF SEDIMENTS

Erosion taking place on the opposite sides wear down the slopes and the sediments are deposited in the geosynclines. These sediments later on will **form sedimentary rocks.**

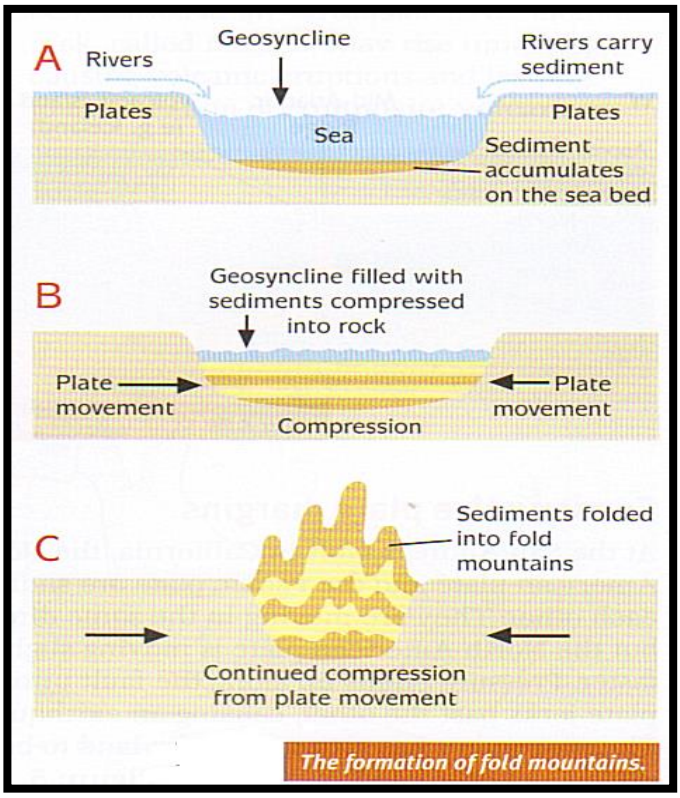
3. SUBSIDENCE

This is the **sinking of the land.** The weight of the sediments collected in the troughs cause the sinking of the land in the trough.

4. FOLDING

The width of the rock strata in the trough is folded by the plates moving towards each other causing compression. This shortens the rock zone **but increases thickness** there by leading to fold mountains

DIAGRAM SHOWING HOW FOLD MOUNTAINS FORM

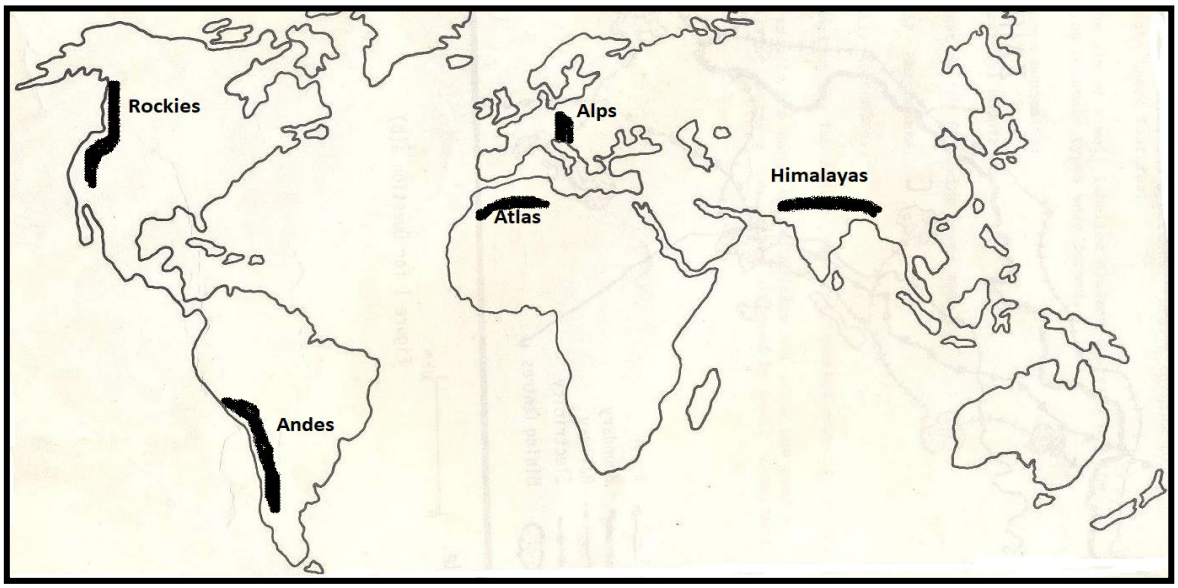


YOUNG FOLD MOUNTAINS (Alpine)

These are the **highest mountains** today. Examples**: Atlas, Alps, Himalayas, Andes and the Rockies** These have formed **recently about 25 million years ago**.

They are known as the **Alpine** fold mountain system after the Alps Mountains which were formed at the same time.

POSITIONS OF YOUNG FOLD MOUNTAINS



CHARACTERISTICS OF FOLD MOUNTAINS

- They are **long** and **high.** These are long due to **following the convergent boundary.** They are high due to the **bending of the rock strata into anticlines**.
- Are associated with volcanoes and volcanic intrusions. **During collision, faults are formed which act as passages for magma.**
- Contain **rich minerals** such as tin, copper and gold.

- ❖ Generally found **on the western continental margins** with their interior badly folded. Found on the western sides of the continents **because that is where convergent boundaries exist.**

INFLUENCE OF MOUNTAIN BUILDING PROCESSES.

This can be regarded as the effects or importance of young fold mountains. The influence can be divided into **positive** and **negative.** But it is important to know that the negative influence is also taken as important as it makes people to solve such negative areas.

POSIVE INFLUENCE OF FOLD MOUNTAINS

a. Some fold mountains **contain valuable minerals** such as copper, gold and tin. Such minerals are mined and put into productive use.
b. Receives heavy rains, or snow which **gives rise to big rivers.** These rivers are used to **generate electricity**, **irrigation and transport**. Examples include: Ganges and Indus of India for irrigation, Mississippi for generating electricity.
c. Contains **valuable timber** which can be exploited e.g. western Rockies have coniferous soft woods, the Himalayas have teak.
d. **Tourist attraction** some mountains are snow covered which act as a source of money.

NEGATIVE INFLUENCE OF FOLD MOUNTAINS

1. **Act as climatic barriers.** Areas on one side of a fold mountain may have a different climate from those on the other side. For example, British Columbia has mild winters, warm summers and rain throughout the year. The prairies on the other side have very **cold winters**, **hot summers** and **rains in summer** only. This happens because of **the Rockies in between**.
2. Act as **communication barriers**. The construction of roads, railways and telephone lines is **difficult and expensive**.
3. Associated with **earth quakes and volcanoes**. These destroy life and property.

SAMPLE QUESTIONS

Describe the following mountain building processes (i) folding (2marks) (ii) faulting (2marks)
Why it is that Fold Mountains exist on the western sides of the continents (3marks)
Explain any two negative effects of mountain building processes (4marks)
Why are Fold Mountains associated with volcanoes? (3marks)
What influence do Fold Mountains have on the following (i) climate (3marks) (ii) transportation(3marks) (iii) economy of a country? (3marks)
With the aid of a diagram, explain how an over thrust fold is formed (5marks)
With the help of a diagram, explain the terms anticline and syncline in a simple fold. (5marks)
Explain any two differences between an overthrust fold and overfold (4marks)
Define Orogenesis (2marks)

FAULTING PROCESSES

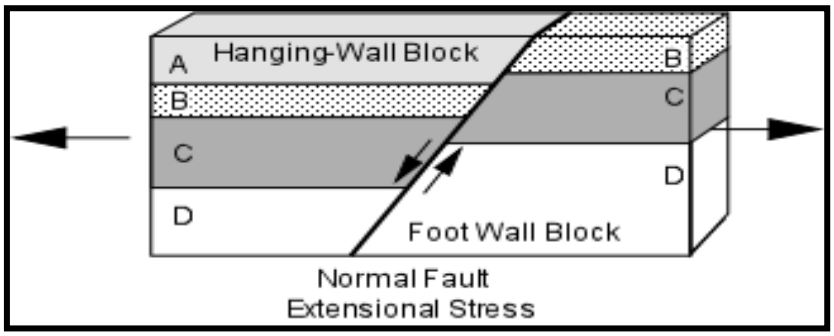
A FAULT: is a **crack produced in the earth's crust because of earth movements**.
FAULTING: is the process through which a crack is made in the earth's crust. Faulting is caused by both **tensional and compressional forces.**
Tensional forces stretch or pull apart rocks till the mid weak zone crack or tears.
Compressional forces squeeze the rock strata resulting into cracks.

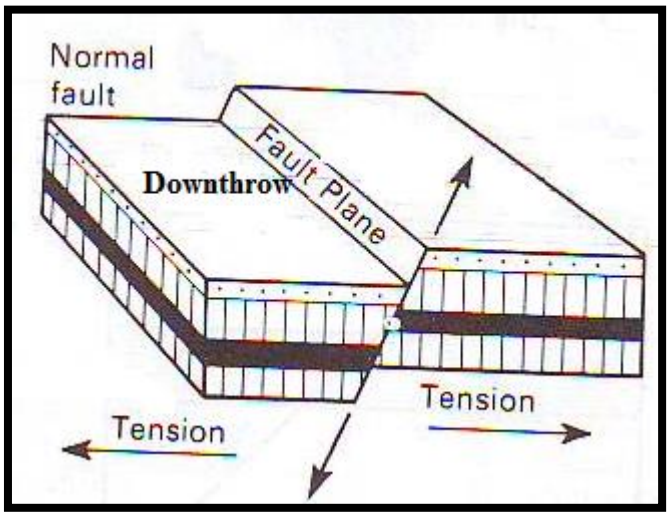
TYPES OF FAULTS

1. Normal fault
2. Reverse
3. Tear (shear or transform) fault

1. NORMAL FAULT

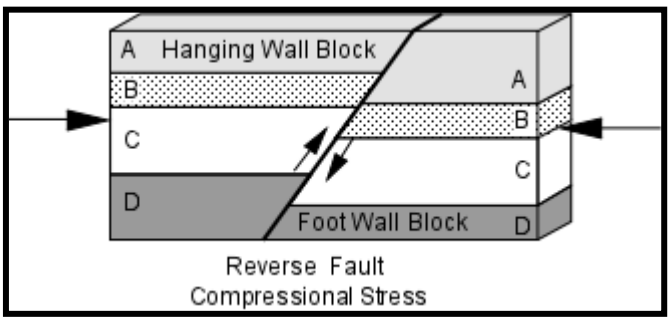
This is caused by **tensional forces** in which one block of **rock strata slides downwards** relative to another. The block that slides downwards is called a **down throw**.

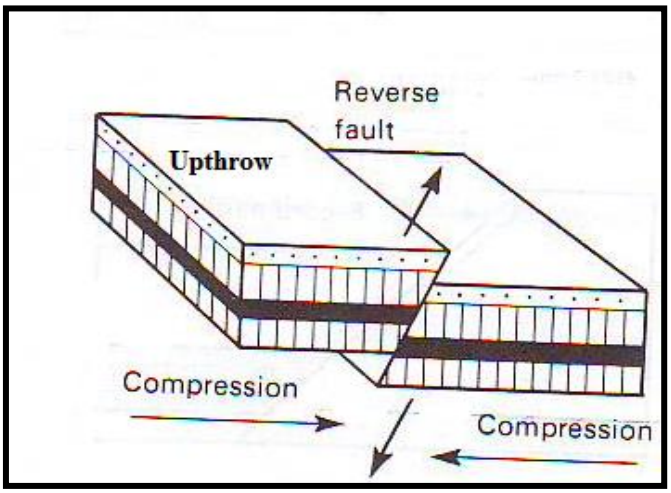




2. REVERSE FAULT (THRUST FAULT)

This is caused by **compressional forces** in which one block of strata **overrides or is pushed** on top of the other due to compression forces. The block that is pushed upwards is called an **upthrow**

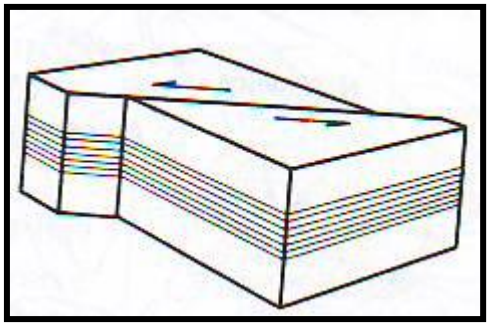




3. TEAR (SHEAR OR TRANSFORM FAULT)

Occurs where blocks of rock **slide along one** another horizontally.

It is also known as tear, shear or transform.



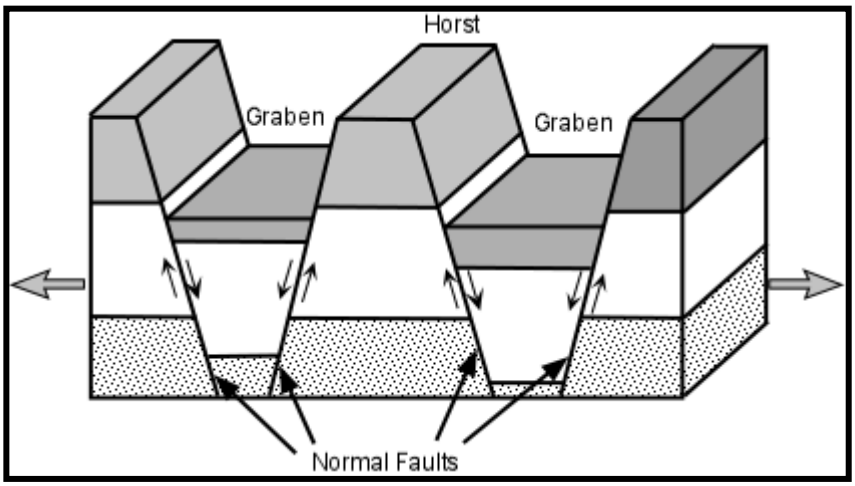
RESULTS (EFFECTS) OF FAULTING

Faulting results into the formation of distinct landforms such as: **rift valleys block mountains, fault scarp and a fault line escarpment.**

FORMATION OF RIFT VALLEYS AND BLOCK MOUNTAINS

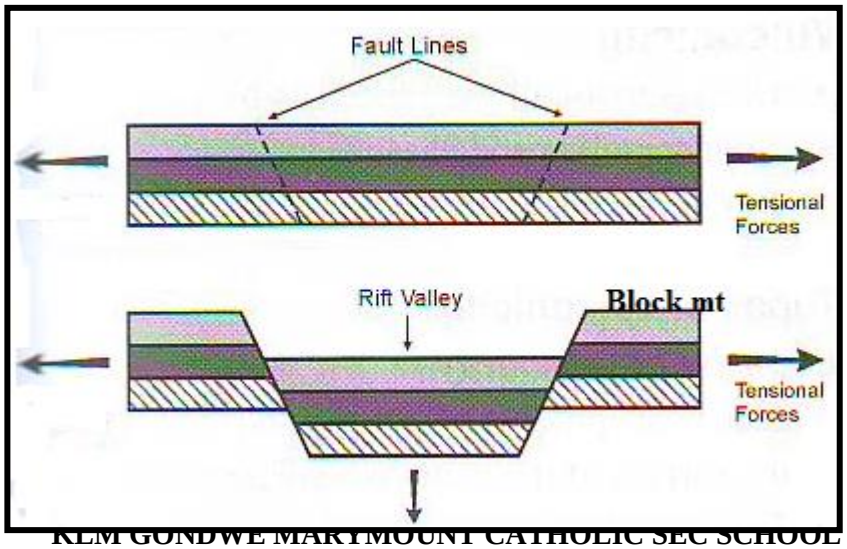
A rift valley is a **long, narrow section of the earth's crust let down between two parallel series of faults**, appearing as a long, flat-floored valley with steep slopes.

It should be known that these two are formed **together through the same processes**. When a Rift valley is formed, a block mountain is also formed. **Rift valleys** and block **mountains** were formed through **tensional forces** and **compressional forces.**



FORMATION OF RIFT VALLEYS AND BLOCK MOUNTAINS THROUGH TENSIONAL FORCES

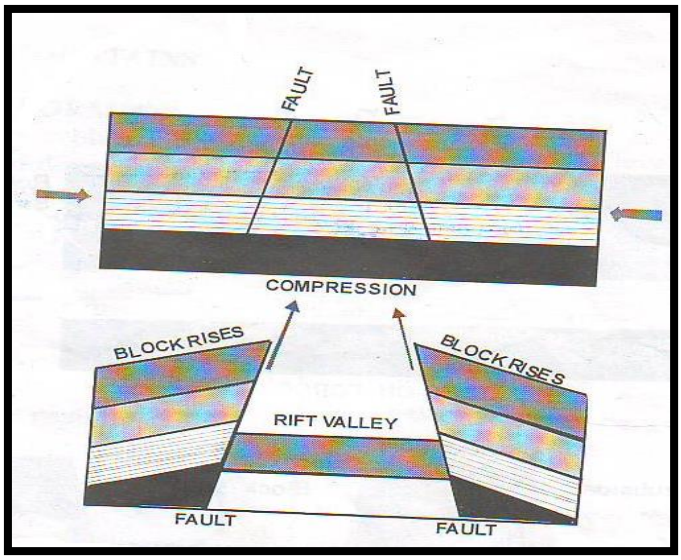
1. **Tensional** forces act on a piece of land.
2. Two **parallel faults** are formed because of tension.
3. The land between the faults or the **middle part** goes **downwards**.
4. **A gap** is left in the middle which forms **a rift valley or a graben**
5. The side **blocks that are left behind** form block mountains or Horsts.



FORMATION OF RIFT VALLEYS AND BLOCK MOUNTAINS THROUGH COMPRESSINAL FORCES

1. **Compressional** forces act on a piece of land.
2. Two **parallel faults** are formed because of tension.
3. The blocks **outside the faults** are pushed upwards.
4. **A gap** is left in the middle which forms **a rift valley or a graben**
5. The side **blocks that are pushed upwards** form **Block Mountains** or **Horsts.**

NOTE. In both ways when the question is about a **Rift valley,** there no need to include Block Mountain, and when the question is about **Block Mountain**, the part which concerns **Rift valley** can be skipped



EXAMPLES OF BLOCK MOUNTAINS

1. Ruwenzori (mountain of the moon) in East Africa
2. Sierra Nevada in Europe.
3. Vosges in Europe
4. Black Forest in Europe

EXAMPLES OF RIFT VALLEYS

1. The Great African Rift valley
2. The Great Glen Rift Valley in Scotland
3. The Eden Valley in England
4. The Rhine Valley in Germany

GENERAL CHARACTERISTICS OF RIFT VALLEYS

1. Borderd by very **steep sides** or fault lines.
2. Are **long** and **narrow** as they follow parallel faults.
3. They have **flat floors** due to the going down of part of the land.
4. Are associated with **volcanoes** and **earthquakes** due to the faulting that takes place.

DIFFERENCES IN THE FORMATION OF RIFT VALLEY AND BLOCK MOUNTAINS THROUGH TENSIONAL AND COMPRESSIONAL

1. In tensional forces, the **middle block** goes downwards while in compressional the **blocks outside** the faults move upwards.

2. Tensional is caused by **normal faulting** while as in compressional is by **reverse faulting**.

SIMILARITIES BETWEEN FORMATION THROUGH TENSIONAL AND COMPRESSIONAL

1. Both **faults** are formed whether normal or reverse.

2. Both involve some parts of the **earth moving**.

THE GREAT AFRICAN RIFT VALLEY

This is the most **impressive rift valley** system in the world.

It starts from **Beira** in Mozambique and ends in the **Jordan valley** around **Syria**. It extends for about **7200km** of which about **5600km** is in Africa. At Lake Malawi the valley system is divided into two sections- the eastern and the western.

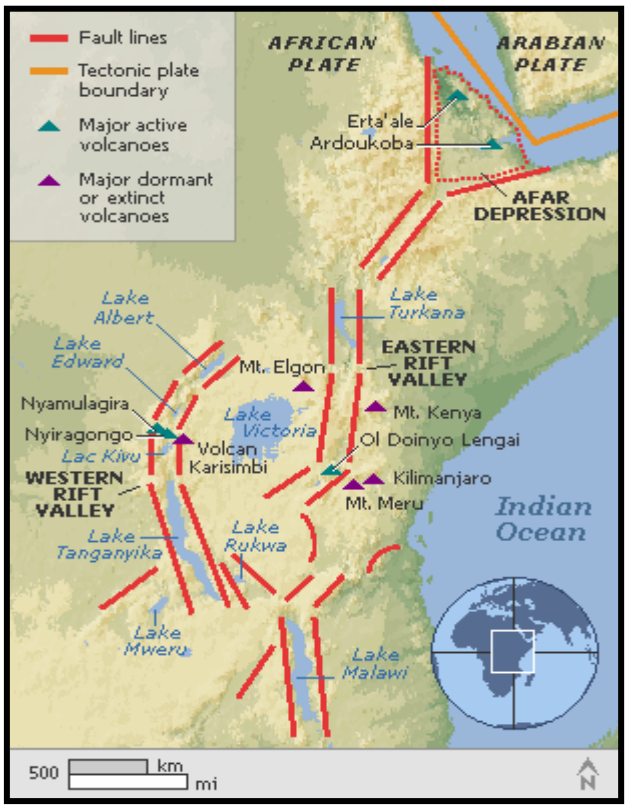
THE EASTERN SECTION

It passes through Tanzania where it contains Lake Turkana after which it enters Ethiopia, finally into Gulf of Aden, Red sea and the Dead Sea.

THE WESTERN SECTION

Passes through lakes Tanganyika, Kivu, Edward and Albert after which it gradually fades away.

The width of the valley varies from 30km to 100km and its sides are sometimes both steep and high scarps.



THE RIFT VALLEY SYSTEM AND ASSOCIATED FEATURES

1.LAKES: lakes that are associated with rift valleys are referred to as **rift valley lakes**. Such lakes were formed due to **faulting** processes in which two **parallel faults** were formed. The **gap** formed due to movement of **part of the ground** made **water to collect** in it forming a lake. These lakes occur within the rift valley. Examples include Lake Malawi, Lake Tanganyika and Lake Magadi.

2. **VOLCANOES: These** are found in association with the Rift valley in the sense that the rift valley **is associated with faults or cracks** as the crust is being pulled apart. **Magma uses the same cracks** to move to **the surface and form cone shaped** structures called **volcanoes.** This is the reason for the existence of volcanic mountains such as **Kilimanjaro**, **Kenya** and **Elgon** along the Great east African Rift valley

3. **EXISTENCE OF EARTHQUAKES**: The forces and cracks **contribute to rebound displacement** of the crust making the crust to **vibrate**. Such vibrations are called earthquakes. Thus, the existence of **earthquakes and earth tremors** in such parts of Malawi such as Salima and Karonga is **since the country is in the African Rift valley**, in where the formation of **faults** bring some displacement of rocks under the ground.

4. **STEEP SIDES OR SCARPS**: These are the **steep sides formed when part of the crust has moved downwards** forming steep escarpments such as
Karonga, Livingstonia, Chilumba, Usiska, Zomba-Changalume, Chikhwawa-Thyolo, Dedza-Golomoti in Malawi.

5. **BLOCK MOUNTAINS**: The block that remains upwards after part of the land moves downwards form Block Mountains

POSITIVE INFLUENCE OF THE RIFT VALLEY

1. Flat floors of the **rift valley are good for settlement** as construction of houses is easier.
2. The erosion taking place on the sides of some highlands provide **good soils** for the growth of crops.
3. **Contain lakes** such as Malawi, Tanganyika, which are used for various purposes such as domestic, irrigation and fishing.
4. Most of the area contains **great scenic beauty** for tourist attraction.

NEGATIVE INFLUENCE OF RIFT VALLEY

1. It is associated with **steep sides** which are **barriers to transport and communication** as it is difficult and expensive to construct roads in such areas.
2. Associated with **volcanoes and earthquakes** which destroy life and property. For example, the earth quakes that happen in some areas in Malawi is since the country in the Rift valley.
3. The steep **sides and some upland areas** in the rift valley create **rain shadow areas** making farming a problem.

GENERAL POSITIVE EFFECTS OF FAULTING PROCESSES

1. Formation of **unique features** such as the tilting of the blocks creating **beautiful scenes** which attract tourists, bringing money to areas where such features are found.
2. Cracks created act as passages for the **hot water** to move from the ground to the surface inform of **hot springs** and **geysers**. These are utilised for **heating** and **geothermal** purposes.
3. Faulting results into the creation of **long and narrow** depressions called **rift valleys** on the earth's surface which **form lakes** such as Lake Malawi which provide water, transport, tourism and fishing among some other uses.
4. Result into the formation of **block mountains** which are utilised for **tourism**, influence **rainfall** on the wind ward side, contain **forests** for lumbering and act as **sources of rivers**.
5. The creation of faults gives a chance for the formation of **ore-bearing minerals** and their movement through the cracks to the upper parts of the crust.

GENERAL NEGATIVE EFFECTS OF FAULTING PROCESSES

1.Faulting creates **steep sided landforms** called **escarpments** which gives problems in **transport** and **communication** as it becomes **expensive to construct roads** and **railways** in such areas. When roads are constructed they are very dangerous.
2. Faulting makes the possibility of some **rivers disappearing** into the ground through the cracks or **change the course** whereby negatively affecting people in terms of the supply of water.
3. Faulting makes **mining difficult** and **expensive**. Through the cracks created in the crust, land subsidence takes place leading to **loss of lives**.
4. Faulting creates the chances of **earthquakes** and **volcanic eruptions** which destroy life and property.
5.Faulting creates **steep sided landforms** which tend to limit **rainfall** on the other side as the steep sides block the direction of rain bearing winds making some areas to be in a **rain shadow** receiving very **low or no rainfall** at all making **farming difficult**.

SAMPLE QUESTIONS

Describe the formation of Rift valley through tensional forces (4marks)
Explain how Mount Ruwenzori was formed through compressional forces (4marks)

Explain any two problems faced by Malawi because of being in the Rift valley (4marks)
Explain any two negative effects of faulting to the physical environment (4marks)
Mention two ways in which Rift valleys benefit the people in the surrounding areas (4marks)
Apart from the Great African Rift Valley, mention other two examples of Rift valleys in the World (2marks)
Explain the negative effects of faulting on (i) mining (2marks) (ii) transport and communication(2marks) (iii) Rainfall (2marks)
Mention any three characteristics of Rift valleys (3marks)
Explain the positive effects of faulting processes on the following (i) Power generation (3marks) (ii) Tourism (3marks) (iii) Crop growing (3marks)
Explain the main reason for the existence of Mount Kilimanjaro and Mount Kenya along the rift Valley System of Africa (3marks)
Explain the main reason for the occurrence of earthquakes and earth tremors in some parts of Malawi such as Karonga and Salima (3marks)

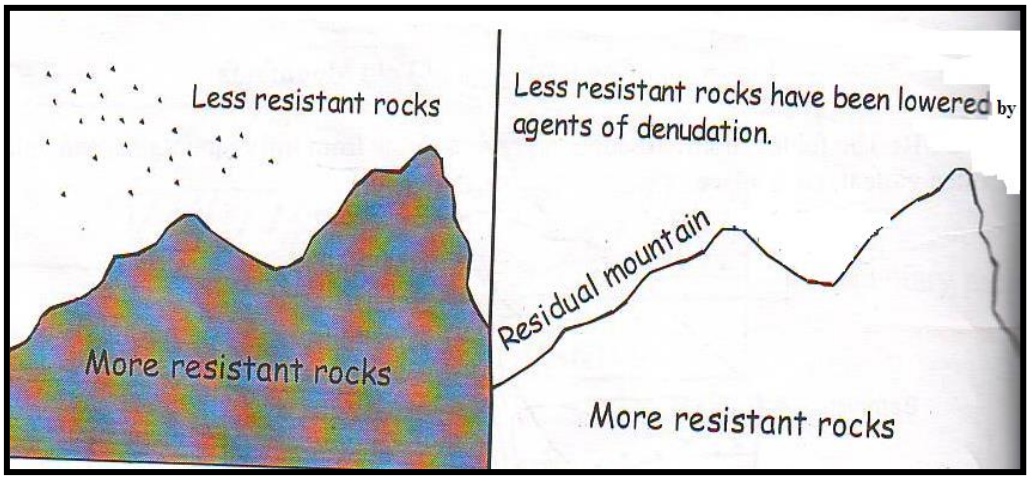
OTHER TYPES OF MOUNTAINS

1. VOLCANIC MOUNTAINS

These are mountains formed because of the **accumulation of lava from volcanoes**. They are also called **mountain of accumulation due to the piling up of magma or lava for them to be formed.** The mountains are step–sided and very high. Examples of such mountains include Kenya, Elgon, Cameroon, and Kilimanjaro.

2. RESIDUAL MOUNTAINS

These are mountains formed because of **denudation** which lowers mountains and other landforms by removing the **weaker rocks** or soil leaving more **resistant rocks**. This takes place over **millions** of years. The more resistant parts made up of **resistant rocks** remain as **mountains** after the removal of weaker or less resistant parts. The weathering and erosional agents such as **water, wind** and **ice** play **important role of removing the weaker parts** so that resistant parts remain. These mountains are also called **circum-denudation** or **circum-erosion**.



EXAMPLES: Mulanje Mountain, Zomba plateau, Scottish and Scandinavian highlands

VOLCANISM OR VOLCANICITY

This refers to all the various ways by which **molten rock called magma and gases** are forced into the earth's crust and on to the earth's surface.

Volcanism therefore includes volcanic eruptions or formation of volcanoes, lava plateaux, geysers and springs.

WHAT MAKES ROCKS TO TURN INTO SEMI-MOLTEN STATE CALLED MAGMA

- **High temperature** below the crust as temperature **increases with depth** below the earth's crust. Temperature increases at an average rate of ℩c for every 20 metres of descent. This makes rocks to turn into magma.
- **Great pressure** exerted on the rocks by the crust which in turn generates heat.
- **Friction** along rock surfaces at the **boundaries of tectonic plates** which raises the temperature.

Magma creates both **intrusive** and **extrusive** features and landforms.

INTRUSIVE LANFORMS FORMED BY MAGMA

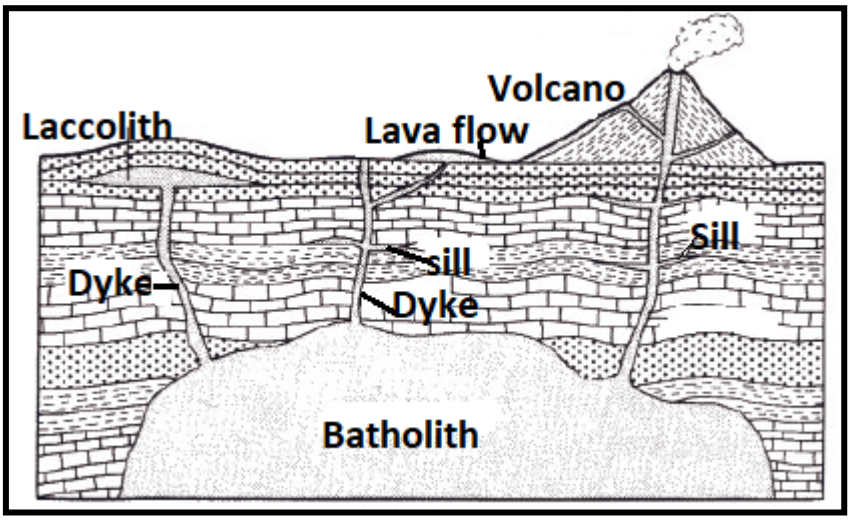
Intrusive are landforms formed when magma while trying to force its way up within the rock layers, **cool and solidify within the crust**. These are also called **PLUTONIC FEATURES**

CONDITION NECESSARY FOR THE FORMATION OF INTRUSIVE LANDFORMS

- **Strong rock** layers that stop magma from reaching the earth's surface.
- The magma may not have a strong force or **pressure** to reach the earth's surface.

EXAMPLES OF INTRUSIVE LANDFORMS

Batholiths, sill, laccoliths and dyke



NOTE: volcano and lava flow are **extrusive landforms**.

1. BATHOLITHS

This is a very **large mass of magma** which accumulates in the earth's crust. Sometimes it forms the **root or the core of** a mountain.

Batholiths are mainly made up of **granite rocks.**

2. SILL

This is a **horizontal sheet** formed when **magma lies and solidifies along bedding planes.**

When exposed by erosion sills form ridge like escarpments. Others through erosion remain as caps on top of hills e.g. Cape Province in South Africa.

3. DYKE

A mass of magma that **cuts across bedding planes.** Dykes may be vertical or inclined.

Dykes and sills give rise to waterfalls and rapids which are used to generate water power.

4. LACCOLITH

This is a large blister or igneous mound with a **dome shaped upper surface and a level base** fed by a pipe- like feature from the batholiths.

HOW CAN INTRUSIVE FEATURES BE EXPOSED ON THE EARTH SURFACE?

Through **erosion processes** in which the top weak soil is removed through the action of wind, water and ice.

IMPORTANCE OF INTRUSIVE LANDFORMS

1. Form waterfalls after erosion as intrusive are harder making the water to fall over a great height. For example, dykes.

2. Form **good tourist destination** which is a source of money to nations, for example, the Cape Ranges in South Africa.

3. Formed **in association with minerals** such as copper, gold which are mined and put into productive uses.

EXTRUSIVE LANDFORMS FORMED BY MAGMA

Extrusive landforms are formed **when magma reaches the earth's surface** due to some weaknesses in the layers of the earth's crust.

Examples: volcanoes, lava flows which usually results into lava plateaux, geysers, hot springs.

MAGMA: **molten** material, **very hot** and not exposed on the earth's surface.

LAVA: magma that emerges the earth's surface cools and solidifies

TWO TYPES OF LAVA

These are 1. Basic lava
2. Acid lava

CHARACTERISTICS AND DIFFERENCES BETWEEN ACID LAVA AND BASIC LAVA

BASIC LAVA	**ACID LAVA**
1.highly **fluid**, often runny	Highly **viscous** with a high melting point
2.rich in **iron and magnesium**	high **silica** percentage
3.dark coloured	**Ligh**t coloured
4.Affect **extensive areas**	Affect **small areas**
5. The resultant volcano is **greatly sloping** with a wide diameter with a flattened dome.	The resultant volcano has **steep slopes**

SAMPLE QUESTIONS

Define the term volcanism (2marks)

Mention any two differences between acid lava and basic lava (4marks)

Mention any three characteristics of basic lava (3marks)

With the aid of a diagram, show any two features formed when magma fail to reach the earth's surface (6marks)

Explain the importance of the intrusive features formed by volcanism. Give any two points. (4marks)

Describe how the intrusive features can be exposed on to the earth's surface (3marks)

Differentiate the terms (i) lava and magma (2marks) (ii) extrusive and intrusive landforms(4marks)

Differentiate between (ii) sill and dyke (2marks) (ii) batholith and laccolith (4marks)

Explain the role played by water, wind and ice in the formation of residual mountains (4marks)

EXAMPLES OF EXTRUSIVE LANDFORMS FORMED BY MAGMA OR LAVA

- Volcanoes or volcanic cones
- Lava plateaux
- Geysers
- Hot springs

A VOLCANO

This is a **cone- shaped mound** formed when magma together with gases and a mixture of rocks tone from the crust by the molten **magma emerges at the surface**.

FORMATION OF A VOLCANO

Magma under the earth collects into a large chamber called **magma chamber**. Then under pressure assisted but faults in the crust, magma moves out into the earth surface.

KINDS OF VOLCANIC MATERIALS

Some materials that erupt from a volcano include:

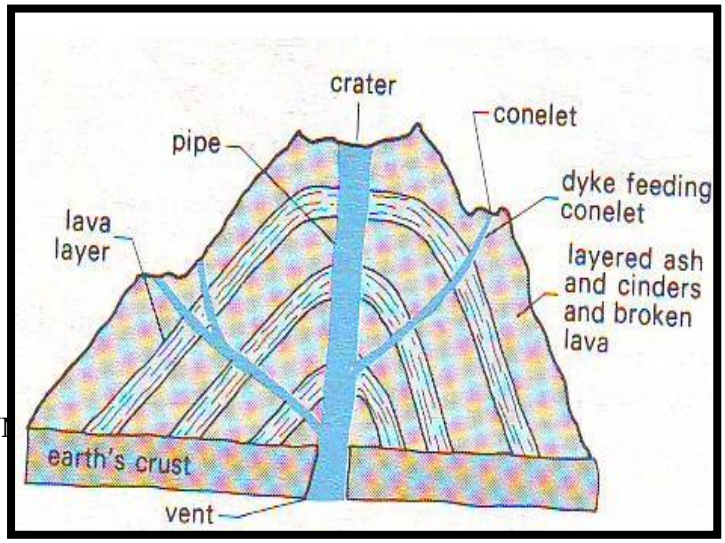
- Lava or Molten magma
- Rock fragments
- volcanic ash
- Volcanic bombs
- Gases
- Dust particles
- Liquid mud

AVOLCANIC ERUPTION

PARTS OF A VOLCANO

1. **THE CENTRAL VENT**
   This is the **opening** through the **earth's crust** through which magma escapes on to the surface to form a volcano.
2. **CONDUIT OR PIPE**
   This is the **channel** formed by magma through which the larva moves.
3. **CRATER**
   This is a **shallow depression** formed at the exit of the pipe or the top part of a volcano.
4. **CONELET**
   This is a **parasitic cone** formed because of some magma escaping through the subsidiary dykes.

PARTS OF A VOLCANO



CALDERA:

This is formed when a large part of crater collapses or is blown off in a violent eruption and leaves behind a **huge depression**. When filled with water, it becomes a **caldera lake**.

KINDS OF VOLCANOES

There are three main types or groups of volcanoes

1. Ash and cinder cones
2. Shield volcanoes
3. Composite volcanoes

1. SHIELD VOLCANOES

Formed when a large amount **of free- flowing lava** spills from a vent and **spreads widely.**

This results into the formation of volcanoes with **gently sloping sides and broad flattened tops**.

Example include Mauna Loa in the Hawaii islands.

2. ASH AND CINDER CONES

Formed from the **alternating layers of ash and cinders resulting** into volcanoes **with large crater and steep slopes** central.

Formed from a less fluid lavas which are so **viscous that they solidify after a short distance** hence having **steep slopes**

Examples: Paricutin in Mexico which is about 410m above its base.

Volcanoes near Ruwenzori in East Africa

3. COMPOSITE CONE

It is formed of alternate **layers of lava and ash.** The volcano begins each eruption with great violence forming a **layer of ash**. As the eruption proceeds, the violence ceases and lava pour out forming a layer of lava on top of ash.

Lava also escapes from the sides of a cone through **subsidiary dykes** where it builds up **small conelets**

Composite form the **highest volcanoes** in the world.

Examples include: Mt Kilimanjaro, Mount Cameron in West Africa, Vesuvius, Etna and Stromboli in Italy.

STAGES OF A VOLCANO'S LIFE CYCLE

Volcanic activity can be classified **according to how often it erupts.** They can as well be regarded as stages through which volcanoes pass whether composite, shield or cinder cones. With this a volcano may be classified as

Active, dormant, extinct and intermittent

1. ACTIVE VOLCANO

Volcanoes are **said to be active if they frequently erupt or when they have erupted within recent time**. The eruption is generally **quiet** but occasionally becomes **violent**. Examples include Stromboli, on an island off the west of Italy, nyiragongo and nyamlagira in Democratic republic of Congo, Asama in Japan.

2. DORMANT VOLCANOES

Volcanoes are said to be **dormant or sleeping when they have been known to erupt and show signs of possible eruption in future.** Examples include Larsen Peak in California. Mount Kilimanjaro in Tanzania and Puricalim in Mexico.

3. EXTINCT VOLCANOES

These are those that have not erupted at all in historic times but retain the features of volcanoes. Examples include: Mount Kenya in Kenya, Mt Elgon in East Africa and Aconcagua which is in Argentina.

4. INTERMITTENT VOLCANOES

These erupt **regular** periods

OTHER FORMS OF VOLCANIC ACTIVITIES

a.HOT SPRINGS

Also called **thermal springs**

These are formed when **water sinks deep enough beneath the surface to be heated by either magma** or very **hot rocks** below the ground.

The heated water rises to the surface **without any explosion.** For example, Mphizi or Chiweta hot spring in Rumphi, in Malawi

b.GEYSERS

In this, the heated water is **thrown out explosively periodically accompanied by steam.** Geysers thus differ from a hot spring in that its water is **ejected explosively.**

Geysers often form **natural fountains**. Geysers and hot springs are common in Iceland, north islands of **New Zealand** and the **Yellow stone** national park of **USA.**

DISTRIBUTION OF VOLCANOES IN THE WORLD

Volcanoes are in a fairly clearly- defined pattern around the world, closely related to regions that have been intensively folded or faulted, on a long plate boundary some of the areas include:

(a) **Circum-pacific region** popularly termed the **pacific ring of fire**. This is called the ring of fire because it has **many volcanoes, earthquakes and other geological activity, encircling the Pacific Ocean** extending from southern circle through central America to Alaska then turning eastwards to Kamchatka peninsula down to Japan and proceeds to Philippines, up to new Guinea and ends in New Zealand. This Pacific Ring of Fire has many **plate boundaries** where **folding** and **faulting** takes place, **making rocks to be displaced** bringing a lot of **earthquakes** and **volcanic eruptions**.

(b) The Mediterranean region e.g. Vesuvius, Etna, Stromboli

(c) To the Asia Minor including the Himalaya Mountains.

(d) East African rift valley e.g. Mt Kilimanjaro, and Mt Kenya both extinct.

(e) West Africa e.g. Mt Cameroon with active

(f) Malagasy

(g) West Indian islands e.g. Mt Pelee and St Vincent

(h) Interior of continents North America, Europe and Australia.

EFFECTS OF VOLCANISM

The influence of volcanic eruptions to people can be looked at in terms of **destructive** (negative) and **constructive** (Positive)

DESTRUCTIVE INFLUENCES

1. Some eruptions cause **great loss of life** through their hot lava or magma, ashes and dust e.g. Vesuvius in 79AD which killed about 4,000 people: Krakatoa in 1883, on a small island in the Sunda strails, midway between java and Sumatra. This killed about 40,000 people, Mt Pelee in West Indies in 1902 which killed about 30,000 people.
2. Some eruptions cause **great damage to property** e.g. Vesuvius buried Herculaneum and Pompeii cities with ash.
3. Add a lot of **poisonous gases** in the atmosphere contributing to air pollution which among other effects contributes to global warming.
4. Formations of some features like mountains create **rain shadow** areas to the leeward side affecting the cultivation of crops.

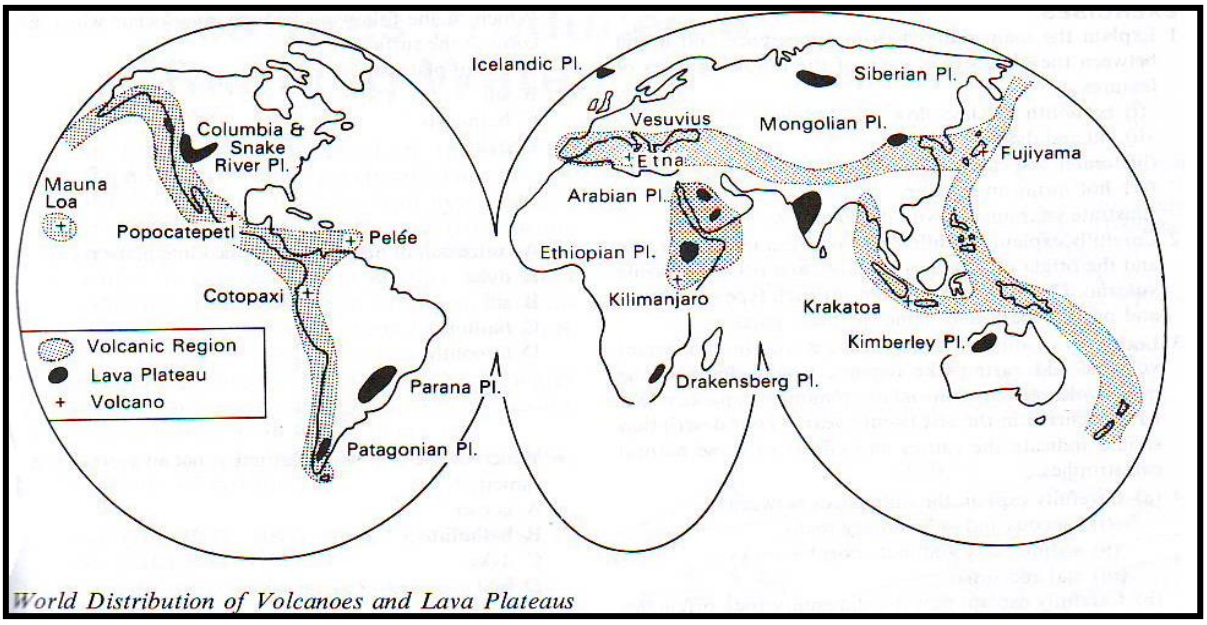
CONSTRUCTIVE INFLUENCES

1. Some lava out- **pouring has weathered to give fertile soils** which are important for agricultural value. Examples of such places include in Java, the north western part of the Deccan plateau, plains around Etna, highlands of Kenya and Ethiopia.
2. Volcanic activities sometimes **result in the formation of precious stones and minerals**. These occur in some igneous and metamorphic rocks e.g. diamonds of Kimberley, Copper deposits of Butte (USA) and the nickel deposits of Sudbury in Canada.
3. Hot springs have a wide range of values such as:
   (a) Some hot springs are utilised for **heating and supplying hot water to buildings** in New **Zealand** and **Iceland.**
   (b) Such hot springs contain **dissolved minerals** which may be of some medical value.
   (c) Hot springs and geysers have become **tourist attractions** e.g. in Japan and Hawaii.
   (d) Steam in hot springs is used to **generate electricity**. This is called **geothermal power.** For example, Kenya has a geothermal power station on **the rift valley** to the west of Nairobi.
4. Volcanic eruptions also result into the formation of **lava plateaux, plains and mountains** which have a wide range of uses e.g. they are intensively cultivated, provide timber. Examples of lava plateaux in the world include:
   - Patagonia and Parana of south America
   - Colombia and Snake of North America
   - Drankensburg and Ethiopia of Africa
   - Siberian, Deccan, Mongolian, Arabian of ASIA
   - Kimberley of Australia
   - Ethiopia in Africa

Many of the world's plateaux **have rich mineral resources** e.g. the African plateaux yield gold, copper, diamonds, manganese and chromium. In the Brazilian plateau there are iron and manganese, the Deccan has manganese, coal and iron, Kimberly of Australia is rich in iron and gold.

5. Volcanic also leads to the **formation of lakes.** These include **crater or caldera** e.g. lake Bosumtwi in Ghana, Toba in Sumatra (Indonesia)
6. Volcanoes serve as **"windows" to the earth's interior.** The materials they erupt help scientists to learn about conditions within the earth.
7. Rocks formed from lava are commonly used in building roads.

WORLD DISTRIBUTION OF VOLCANOES AND LAVA PLATEAUX



World Distribution of Volcanoes and Lava Plateaus

SAMPLE QUESTIONS

Explain how volcanoes are formed (3marks)
Locate two areas with volcanic activity (2marks)
Explain the difference between a hot spring and a geyser in volcanism (2marks)
Suggest one reason for some areas to be major volcanic areas. (2marks)
Draw a volcano and show any three parts (4marks)
Mention three examples of material ejected from a volcano (3marks)
In what two ways do people who live in volcanic regions benefit from volcanism (4marks)
Explain two ways in which it is important to stay away from areas with volcanism (4marks)
Describe how crater lakes are formed (3marks)
Explain the difference between a crater and a caldera (2marks)
Describe with the diagram, the formation of volcanic mountains (5marks)
Explain any two ways in which volcanicity contributes to human activities (4marks)
Using a well labelled diagram, describe how a composite volcano is formed (5marks)
What makes geysers and hot springs to be associated with plate boundaries? Explain one reason (2marks)
Account for the existence of hot springs and geysers in New Zealand and Yellowstone national park. (3marks)

EARTH QUAKES

Earth quakes are **sudden earth movements** or vibrations in the earth's crust caused by **shock waves** which originate from **below the surface of the earth**.

CAUSES OF EARTH QUAKES

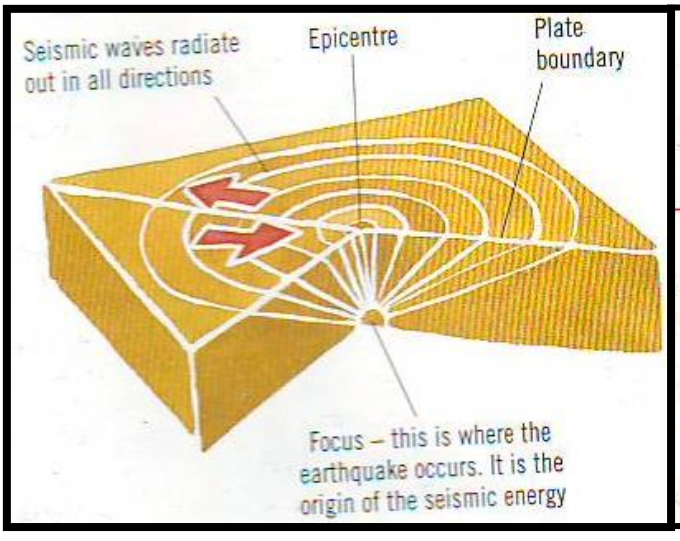
1. Creation of **faults or cracks** in the crust. This occurs when one tectonic plate slides over, pass another or collide into another.
2. **Volcanic eruptions**. This involves the movement of molten rocks below or on to, the earth's crust, which is accompanied by **a lot of force** making the ground to **shake.**

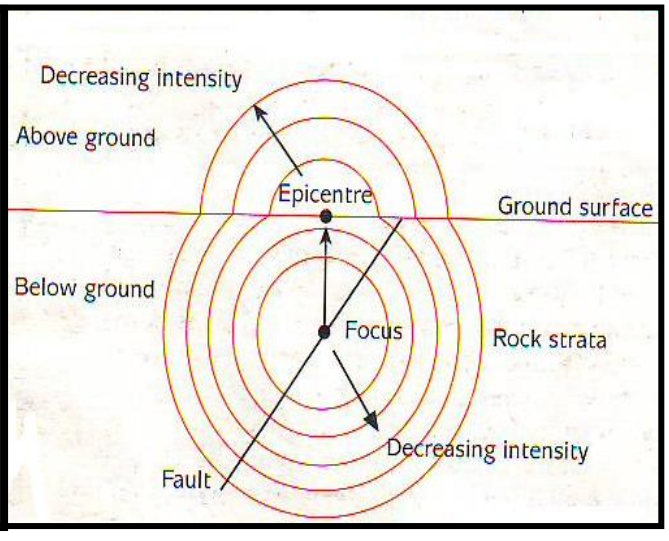
NATURE OF EARTHQUAKES

The point at which an earthquake **originates** is called the **FOCUS** which is **below the surface**.
The point on the **earth's surface immediately above** the focus is called the **EPICENTRE**
The epicentre is where shockwaves **first hit the surface**.

HOW AN EARTHQUAKE SPREADS

When an earthquake occurs, the violent **breaking of rock releases energy** that travels through the earth in form of vibrations called **SEISMIC WAVES**. Seismic waves move out from the **focus** to the **epicentre** and to **all directions**. As the waves travel **away from the epicentre, they grow gradually weaker in strength.** For this reason, the ground generally **shakes less far away** and therefore causes **less damage** as compared to the epicentre.





TYPES OF SEISMIC WAVES

There are **four** types of seismic waves propagated by an earthquake. These four types are grouped into **two** namely **Body waves** and **Surface waves**.

1. Body waves

These moves through **the interior or body of the earth**. There are **two** types of body waves

(i)**Primary waves (P-Waves)**

These are the fastest travelling at 5km per second in **a push** and **pull manner** making the crustal rocks to move **back and forth** in the direction of the wave movement. Due to this **push** and **pull movement,** Primary waves are also called **Compressional waves**. They travel in **solids, liquids and gases**.

(ii)**Secondary waves (S-Waves)**

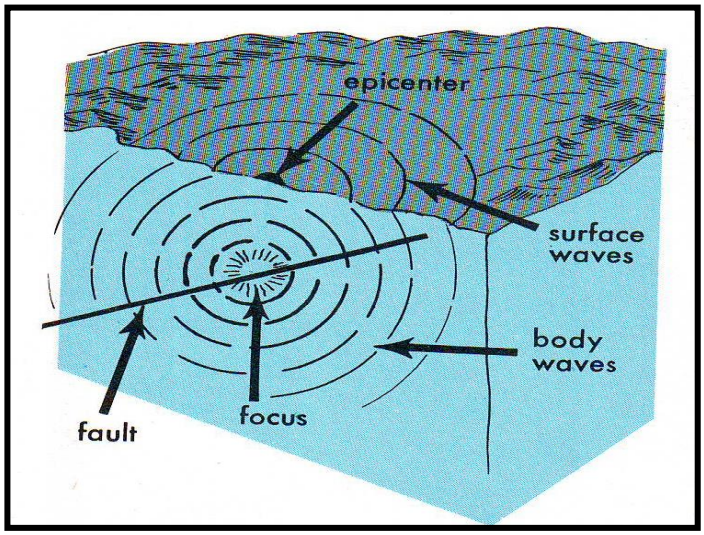
These cause the rocks to **move from side to side at right angles** to the direction of the movement. These travel through the earth like **waves in a rope** at a speed of 3km per second meaning they **are slower than primary waves**. They only move through **solids** and cannot pass through **liquids** because liquids are **not rigid** enough to propel them.

2. **Surface waves also called longitudinal waves**

These are restricted to **near the ground surface** travelling **like ripples of water** in a pond or a lake after throwing a stone on it. These travel more **slowly than body** waves but cause a lot of destruction to buildings and infrastructure. Surface waves are divided into two types

(i)**Love waves (L-Waves)** which move the ground from **side to side** in a horizontal manner. These are not propagated through water, much faster than Rayleigh waves, the other type of surface waves.

(ii)**Rayleigh waves** which move both **vertically** and **horizontally**. Apart from being slower, they affect bodies of water such as lakes and oceans.



MEASUREMENT OF EARTHQUAKES

Earthquakes are measured in terms of **intensity** and **magnitude.**

Intensity refers to a measure of the **strength of an earth quake** in terms of the way **it shakes** the **ground**. It is a measure of the **degree of damage** to the surface and the effects on human beings. The intensity of an earthquake is measured by an instrument called a **SEISMOGRAPH.**

The **magnitude of an earthquake** refers to **the total amount of energy released by an earth quake**. The magnitude is measured by a scale called **RICHTER SCALE**. The Richter scale has a range from 0 to 9. The higher the **number on the scale**, the **more destructive** the earth quake.

The **intensity** of an earthquake varies from place to place depending on the geological structure of an area, depth of the focus, material through which the waves are transmitted and designing and strength of buildings. The magnitude does not vary.

Lines drawn on a map joining places which experience the same strength of shaking are called **ISOSEISMS**.

EFFECTS OF EARTHQUAKES

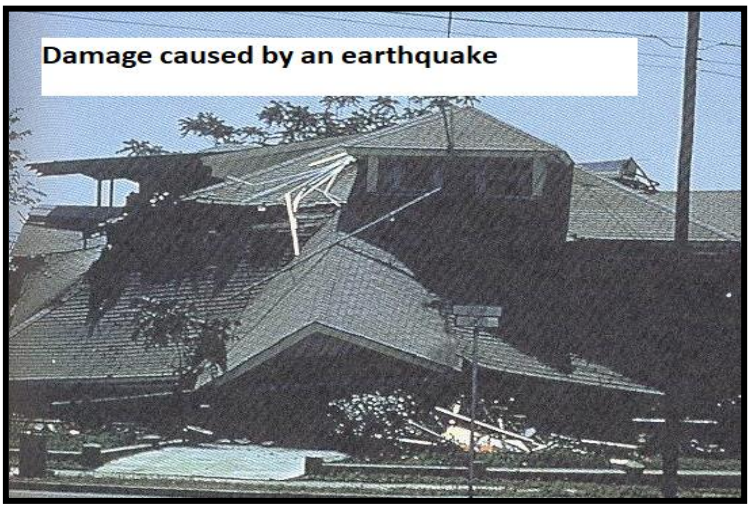
1. They can displace **parts of the earth's crust vertically or laterally.**
2. They can **raise or lower parts of the seafloor**. The Agadir earthquake in Morocco in 1960 raised the sea floor off the coast. In some areas the depth of the sea decreased from 400m to 15m after the earth quake.
3. In the oceans earthquakes cause **waves** called **TSUNAMIS**. These rise to heights of about 12metres or more and break on to the land causing great destruction to ship at anchor and buildings near the shore.
4. They can raise **or lower coastal rocks.** In the Alaskan earthquake of 1899, some coastal rocks were raised by 16m

5. They can cause **landslides** and open up deep cracks in the surface. These landslides tend to bury **settlements** and **infrastructure** with debris or sand. For example, in the country of north china in 1920 and 1927, the El Asnam earthquake in Algeria opened the surface cracks up to 3m deep.

6. They can cause the devastation of **cities through fires.** This happen when earthquakes displace electric cables and power lines.

7. Earthquakes cause outbreak of **diseases.** This happens when people free themselves from earthquakes and are given shelter as refugees. The congestion in such places contribute to outbreak and spread of diseases.

8. Through these **damages a lot of lives** for both animals and people can be lost



The effects of earthquakes can be grouped into **primary** and **secondary**

PRIMARY EFFECTS. These are **immediate damages** caused by earth quakes such as collapsing of buildings, destruction of roads and bridges resulting into communication problems.

SECONDARY EFFECTS. These are **the after effects** of earthquakes. They include fires, tsunamis, landslides and outbreak of diseases. These are far **more destructive** than primary effects.

IMPORTANCE OF EARTHQUAKE WAVES

1. Through useful information obtained by studying the **behaviour of waves, the knowledge of different layers inside the earth** such as the crust, mantle and core have been known.
2. Earthquakes signal the **geological forces** that build up features such as **mountains.**

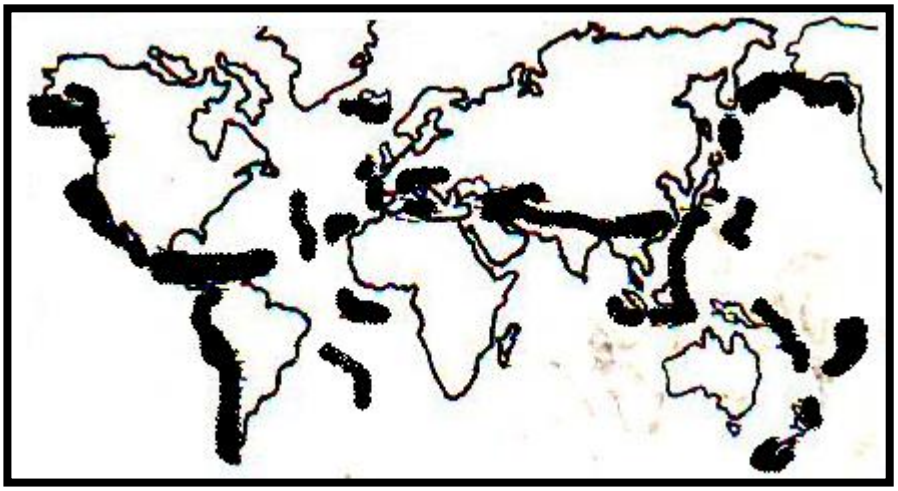
OCCURENCE OF EARTHQUAKES

Most earthquakes occur in narrow belts which mark the boundaries of tectonic plates. The main types of regions where they occur are:

1. The mid-oceanic ridges such as the mid-Atlantic Ocean ridge.
2. The ocean deeps and volcanic islands
3. Regions of crustal compression

4. Circum- pacific Ring of fire areas
5. Belts of mountains such as those from Mediterranean to Himalayas
6. In Africa: north west Africa in the region of Atlas Mountains, Morocco, Algeria and Tunisia
7. In east Africa, along the African rift valley
8. In West Africa: Ghana near Accra, Cameroon.

AREAS AFFECTED BY EARTHQUAKES IN THE WORLD



EARTHQUAKE PREDICTION

These are measures **which are to alert some one about an earthquake.** They can well be considered as signs of an earthquake. These include:

1. Observing the **historic records** of the **frequency of earthquakes** that have happened.
2. Observing the **constructed seismic rise maps** which indicate the likelihood and potential severity of future earthquakes based on the intensity of the past earthquakes.
3. **Abrupt changes in election and tilting of land** surface which are measured by **TILTMETERS**
4. Observing some features which include **fluctuations in the water level of wells**, changes in the magnetic field and changes in the electrical resistance of the ground.

PRECAUTIONARY MEASURES IN ORDER TO REDUCE THE DAMAGE

1. Not **constructing houses** in those places that are subjected to earthquakes. Such areas can be known by observing the earthquake maps.
2. Building houses with **resistant earthquake** structures. These include the use of **steel rods** and concrete, **shock absorbers** between the building and the foundation.
3. Putting **foodstuffs, medicine, tents in store** to be ready for an earth quake.

DURING AN EARTHQUAKE, THE FOLLOWING SAFETY MEASURES CAN BE TAKEN

a. By standing under a **doorframe** or **crouching under a chair** or **table** until the shaking stops.
b. Avoid **going out doors** until the shaking has stopped completely.
c. People who are outdoors when an earthquake hits should quickly move away from **tall trees**, **steep slopes**, **buildings** and **power lines**.
d. If near a large body of water, people should move to higher ground.

AFTERSHOCKS: these are small earth quakes that follow large earthquakes.

REASONS FOR EARTHQUAKES CAUSING MORE DESTRUCTION IN DEVELOPING NATIONS

1. Poorly **built structures or houses** that cannot withstand the seismic waves.
2. The structures are **not built with protective equipment** to withstand shockwaves.
3. Not able to provide **a quick response** in terms of rescue missions.

RELATIONSHIP OF VOLCANIC ZONE, EARTHQUAKES ZONE AND FOLD MOUNTAIN

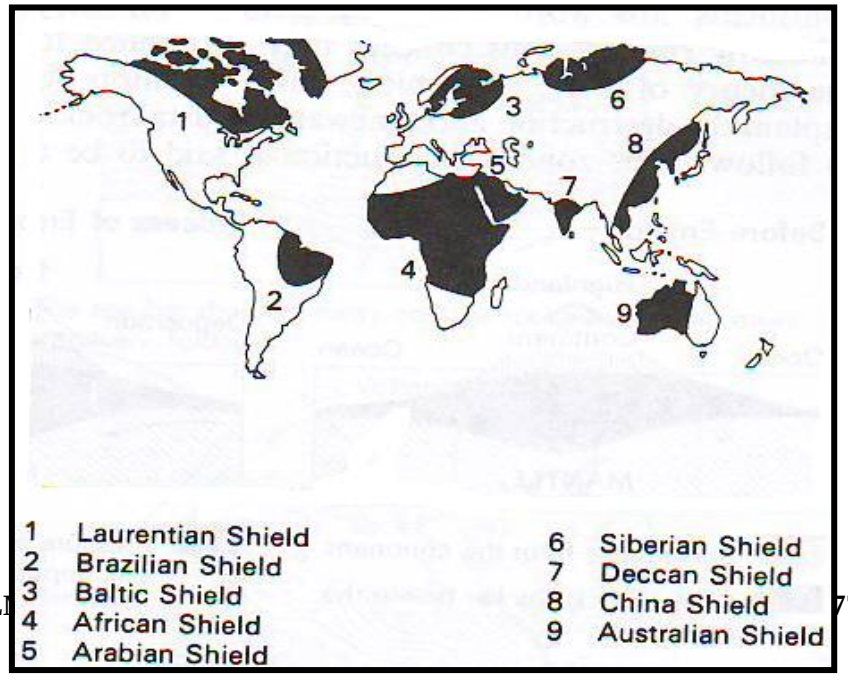
Plate movements give rise to **fold mountains**. During the collision of plates friction takes place **raising the temperature** making some rocks to turn into **magma.** In this **faulting** also develop which provide **passages** for the molten rock called **magma** move towards the surface giving rise to **volcanic activities.** When magma moves to the surface it generates a lot of **force making** the ground to **shake** resulting into **earthquakes.** Thus, areas that are associated with **Fold Mountains** have **earthquakes**, and so have **volcanic activities**. These usually take place in plate boundaries.

SAMPLE QUESTIONS

Define the following terms in earthquakes (i) Focus (2marks) (ii) Epicentre (2marks)
Mention any two differences between a focus and an epicentre in earth quakes (2marks)
Explain the major cause of earthquakes in some parts of Malawi (3marks)
What do you understand by primary effects of earthquakes? (3marks)
Describe any two secondary effects of earth quakes (4marks)
Why is it that volcanoes and earthquakes occur in the same areas? (3marks)
What do you understand by the following terms in earthquakes (i) intensity (2marks) (ii) magnitude? (2marks) (iii)Seismic waves (2marks)
What is the importance of the following in earthquakes (i) Richter Scale (2marks) (ii) seismograph? (2marks)
What happens to the strength of an earthquake moving away from the epicentre? (3marks)
Why is it that areas close to the epicentre experience a lot of destruction from an earth quake than areas far from the epicentre? (2marks)
Explain two differences between an intensity of an earth quake and the magnitude of an earth quake (4marks)
Explain one difference between Primary waves and secondary waves (2marks)
Why are surface waves very destructive? Explain any one reason (3marks)
Explain how earth quakes cause the following (i) Tsunamis (2marks) (ii) Diseases (2marks) (iii) fires(2marks)

SHIELDS

These are **most stable areas with severely** eroded remains of very ancient mountain systems. Most of such areas are stable because of **not severely affected by geologic problems** such as earth quakes as **some are far from plate boundaries**.



ECONOMIC IMPORTANCE OF SHIELDS

1. Contains rich eroded **soils** used for agriculture.
2. They contain **minerals** that are mined and processed into many products.
3. As stable areas they are good **for settlement** as volcanoes and earth quakes are not severe.

ROCKS

A rock refers to **any naturally formed aggregate of mineral particles** which constitute the earth's crust.

TYPES OF ROCKS

Rocks can be classified into their major groups:

a. Igneous rocks
b. Sedimentary rocks
c. Metamorphic rocks

A. IGNEOUS ROCK

These are rocks which are formed **by the cooling and solidification of molten rock called magma from beneath the earth's crust**. Igneous rocks from the Latin word **"Ignis"** which means **fire.**

CHARACTERISTICS OF IGNEOUS ROCKS

1. The rocks are **CRYSTALINE** in nature. Such crystals form on cooling
2. The rocks **do not occur in layers** or strata. They are not stratified because formed **from hot magma** which is not layered when cooling.
3. The rocks **do not contain fossils** (are fossiferous). This is because they form below the crust where no fossils exist. Moreover, magma is hot, and it **burns some fossils** in contact with it.
4. The rocks are **harder** than those of sedimentary rocks.

TYPES OF IGNEOUS ROCKS

Based on **origin** and **formation**, there are **two** types of igneous rocks:

1. Plutonic or intrusive igneous rocks
2. Volcanic or extrusive igneous rocks

1. PLUTONIC IGNEOUS ROCKS

These are rocks formed because of **magma cooling and solidifying at some depth in the earth's crust.**
They are also called **INTRUSIVE or ABYSSAL** because they are formed **below the crust** and tend to **intrude into** other rock masses.
Such rocks are seen on the surface only after being exposed by **prolonged erosion**.
Below the crust magma **cools very slowly** so much so that **large crystals** are formed as the crystals are **given lots of time** to cool.

EXAMPLES OF PLUTONIC IGNEOUS ROCKS

Granite, gabbro, diorite, peridotite

2. VOLCANIC IGNEOUS ROCKS

These are formed when the molten rock called **magma is poured out from volcanoes on to the earth surface where it becomes lava.** Since such rocks are formed on to the earth's surface, they are also called **EXTRUSIVE** or **HYPABYSAL** rocks. Such rocks **solidify rapidly** on the earth surface as they are **exposed to air** such **that cooling takes place very fast** and the **crystals are small**.
Examples include: Rhyolite, Andesite and Basalt

B. SEDIMENTARY ROCKS

These are rocks formed from the **accumulation of sediments** which are **transported**, **deposited, cemented** and **lithified** in **geosynclines**.

CHARACTERISTICS OF SEDIMENTARY ROCKS

1. Sedimentary rocks are **stratified or layered**. This happens because **sediments are of different sizes** such that when any change occurs in the kind of sediments being laid down in one place, new rock layers are formed. For example, **if coarse clay is deposited on a fine one then layers are formed**. Such sediments are also **deposited at different times**. The layers which are deposited form **BEDDING PLANES** which are usually horizontal.
2. Sedimentary **rocks contain fossils of plants and animals.** As sediments pile up on continental shelves, on lake bottoms, or on swamps floors, **animals and plants that die there are buried by the sediments**. The other way is when the sediments are carried by water, ice and wind. They are **carried and deposited together** with remains **of plants** and **animals.**
3. Sedimentary rocks are generally **very soft rocks.**
4. The rocks are not **CRYSTALINE** in nature.

GOLDEN RULE: The characteristics of **sedimentary** rocks **are in opposite to** the characteristics of **igneous** rocks.

KINDS OF SEDIMENTS THAT FORM SEDIMENTARY ROCKS

A. **Clastic sediments** formed from **other rocks** such as clay or gravel
B. **Chemical sediments** which form from mineral grains that precipitate out of solution by **evaporation** or **chemical reaction**.
C. **Organic sediments** formed from the remains of **plants and animals**.

TYPES OF SEDIMENTARY ROCKS

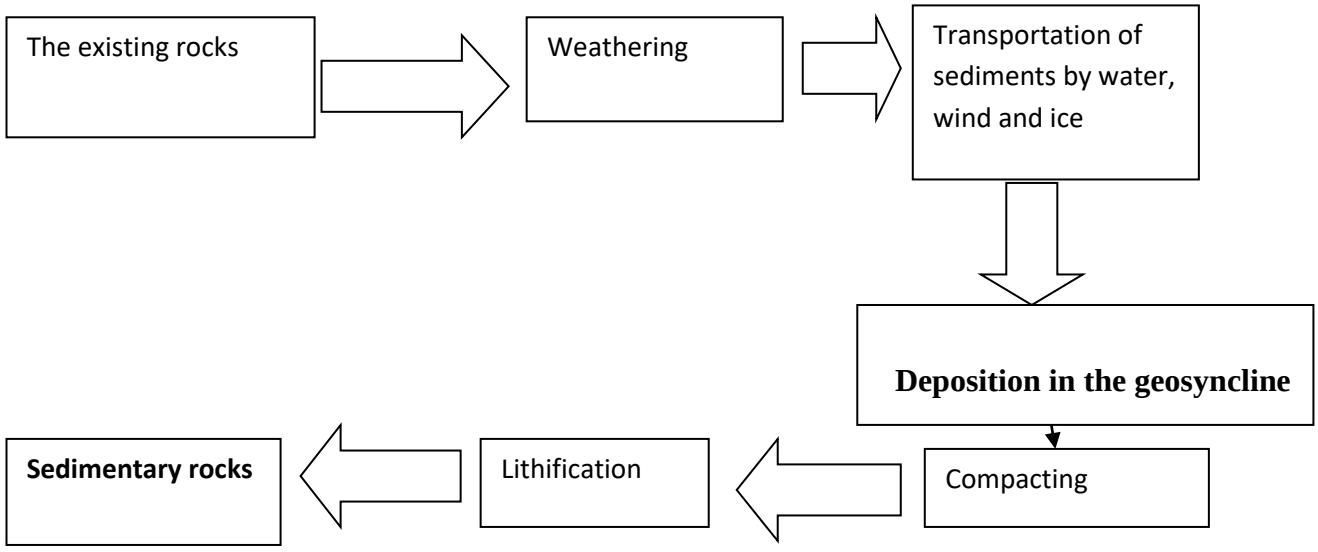
There are **three** types:

1. Mechanically formed sedimentary rocks
2. Chemically formed sedimentary rocks
3. Organically formed sedimentary rocks.

1. MECHANICALLY FORMED SEDIMENTARY ROCKS

These are sedimentary rocks formed **from clastic sediments which are transported and deposited by wind, ice, and running water.** The sediments are laid down in layers, hardened, lithified and form rocks.

STEPS BY THE USE OF A FLOW DIAGRAM ON THE FORMATION OF MECHANICALLY SEDIMENTARY ROCKS



COMPACTION: This is the process in which **the weight of the top layers compresses** the lower layers making them to get squeezed.

CEMENTATION: The process in which **coarse sediments are joined together by dissolved minerals** through compaction. This stage contributes to **stratification** or formation of **bedding planes.**

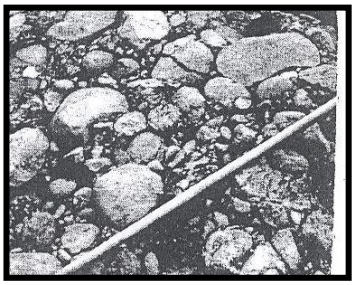
LITHIFICATION: The process through which **sediments are changed into rocks through the addition of small amount of heat**. This is the **final stage** in the formation of sedimentary rocks.

Therefore, in the formation of mechanically sedimentary rocks, **erosion and transportation agents such as wind, ice and water play an important role.**

Examples of such sedimentary rocks.

EROSIONAL AGENT	**EXAMPLES OF SEDIMENTARY ROCKS**
1. Wind	Loess
2. River (water) or sea deposits	Clays, gravel, alluvium, shale, sandstone, conglomerate.
3. Glacier	Moraine, sand, gravels alluvium

CONGLOMERATE: The **coarses**t of the clastic or mechanically sedimentary rocks. It is a cemented mixture of round pebbles and sand grains with some quartz.



2. CHEMICALLY FORMED SEDIMENTARY ROCKS

These are formed from the **precipitation** of minerals dissolved in water. The dissolved minerals are left behind after the **evaporation** of water especially in shallow seas, lakes and swamps. The minerals known as **evaporites** are **deposited**, **cemented** and **lithified** to form sedimentary rocks. This type of sedimentary rocks is also called **hydrogenic** when they are **formed in water**.

EXAMPLES OF CHEMICALLY FORMED SEDIMENTARY ROCKS

LIMESTONE: formed from tiny grains of calcite deposited from sea or lake waters.

ROCKSALT: is a natural form of common table salt (sodium chloride). It consists entirely of the mineral halite.

ROCKGYPSUM: like rock salt, occurs in sedimentary layers and in veins of gypsum.

NITRATE

POTASH

3. ORGANICALLY FORMED SEDIMENTARY ROCKS

These are formed from the **remains living organisms such corals, shell fish, Oysters, clams, algae and sea** snails whose fleshy parts have been decomposed leaving **behind the hard shells.** Such hard shells of plants and animals **accumulate, are cemented and lithified** to form rocks.

Those formed from the remains of animals are called **CALCAREOUS**. Examples include limestone, chalk and coral

Those formed from the remains of the plants are called **CARBONACEOUS.** Examples include Coal, lignite.

C.METAMORPHIC ROCKS

Metamorphic rocks are those whose original texture, composition and mineralogy have been changed by conditions of **high pressure and temperature** (higher than conditions of formation of starting material). The materials from which metamorphic rocks form are **igneous rocks, sedimentary rocks,** and previously existing **metamorphic rocks**.

Meta means **change** while **morph** means **form**.

When igneous, sedimentary and other metamorphic rocks have been **subjected to further intense heat and pressure,** these undergo some **physical and chemical changes** which results into new rocks called **metamorphic.**

In the formation of metamorphic rocks, **heat, pressure, water and air** play important roles.

Heat: makes minerals to **recrystallize** bringing foliation or brands.

Pressure: Change the rock **structure** in general

Water: **Dissolve some rock minerals** changing the chemical composition of the rock.

Air: move in the **pore spaces** changing the **chemical composition** through chemical reactions.

CHARACTERISTICS OF METAMORPHIC ROCKS

1. They are **foliated rocks** in which minerals are arranged in parallel layers or in **branded appearance**.

2. Are very **hard rocks**, possibly the hardest.

3. Are **changed rocks** from either igneous or sedimentary rocks.

4. Contain **new minerals** formed out of original ones.

EXAMPLES OF METAMORPHIC ROCKS AND THEIR ORIGINAL (PRE- EXISTING) ROCKS

PRE EXISTNG-ROCK	METAMORPHIC ROCK
Shale, **mudstone** which are mechanically formed sedimentary rocks	Turns to **slate** and **schist** after being metamorphism
Limestone, an organically formed sedimentary rock**.**	Turns to **marble**
Sandstone, a mechanically formed sedimentary rock	Turns into **quartzite**
Granite which is an igneous rock	Turns to **gneiss**
Coal, an organically sedimentary rock.	Turns into **graphite**
Basalt, an igneous rock	Turns to **serpentine**
conglomerate, a sedimentary rock	Turns to **gneiss**

METAMORPHISM

It is the process **whereby the mineralogical, chemical and structural** adjustments are made in solid rocks **with the help of intense heat and pressure or both** to change the physical and chemical conditions of a rock for it to become **the metamorphic rock**

FORMS OF METAMORPHISM

There are **three forms** through which metamorphism takes place.

1. Thermal or contact metamorphism
2. Dynamic metamorphism
3. Regional metamorphism

1. THERMAL OR CONTACT METAMORPHISM

This takes place when **hot magma from the mantle forces its way into or between layers of overlying rock.** The **heat** of the magma **'bakes'** the intruded rocks which turn into metamorphic. This affects a small area.

2. REGIONAL METAMORPHISM

Happens **when rocks along an entire margin of a continent has been modified especially** due to colliding of tectonic plates which produce a lot of heat.

Regionally metamorphosed rocks occur in very large belts, 10 - 100's km wide by 100 - 1000's km long.

3. DYNAMIC METAMORPHISM

This happens through **the movement of heat which happens due to friction between the moving rock** layers.

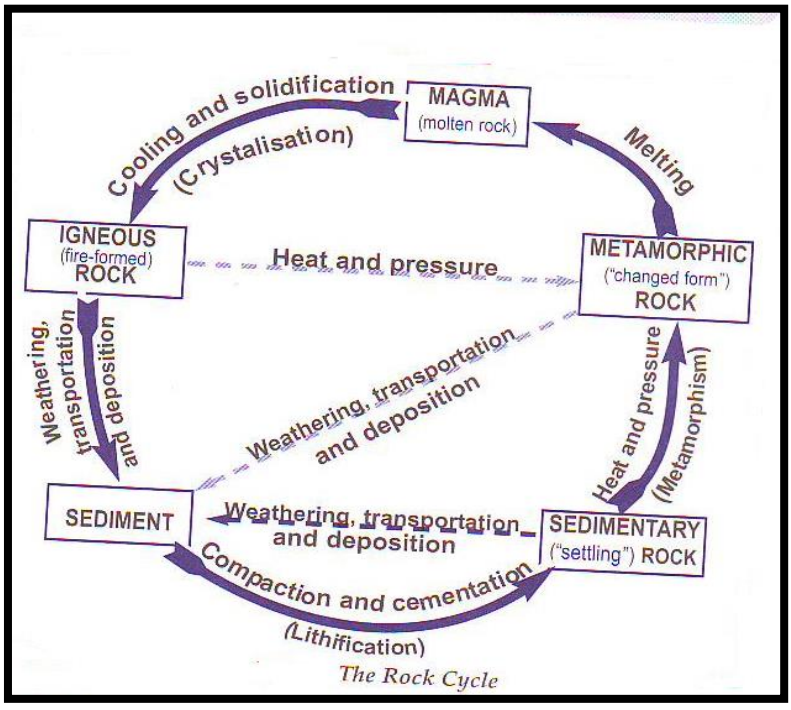
It is associated with zones of high to moderate strain such as fault zones.

Depth less than 5km, dynamic metamorphism is not often produced because the confining pressure is too low to produce frictional heat.

THE ROCK CYCLE

This refers to the **movement of minerals from one rock type to another**. The rock cycle can start from any type of a rock. For example, igneous rocks may be thought of as the primary or parent rocks of the crust. As the igneous rocks are attacked by **weathering and erosion**, **sediments** form and harden into secondary rocks which are called **sedimentary rocks**. If these rocks are buried beneath the crust, involved in the movement of plates and exposed to a lot of **heat and pressure** they are metamorphosed to become **metamorphic rocks.** These metamorphic rocks **melt** due to being exposed to **high temperature** making them to form **magma.** The magma **cools and crystallises to** form **igneous rocks,** and the process starts again

The diagram below illustrates this rock cycle



The rock cycle has shortcuts, such that igneous rocks may be metamorphosed directly.

ECONOMIC IMPORTANCE OF ROCKS

1. Weathered **volcanic soil produces deep well drained** fertile soil for the growing of cash crops such as coffee.
2. Various types of **construction materials** are obtained from different types of rocks.
    a. **Clay** is used for **brick making**
    b. **Sandstone** and **gravel** are used in **road surfacing**
    c. **Limestone** is used for making cement and for **water storage**.
    d. **Granite, gabbro, marble** is used in **making monuments and tombstones.**
3. Some rocks are **porous and help** to keep water in form of **aquifers** under the ground which can be **pumped out** and used or come out through **springs.**
4. Some rocks are rich in **gypsum, potash and nitrates** which can be applied to crops and **improve the soil fertility**. Such rocks are also manufactured into fertilisers.
5. Igneous rocks contain **mineral deposits** such as gold, silver, zinc, and copper. These are mined and economically used. For example, diamond in South Africa.
6. **Coal,** a sedimentary rock, is used for power or **thermal energy production.**
7. Sedimentary rocks are used to **date the past** since they occur in layers. The lowest or the most bottom layer is the oldest and upper most, the youngest.
8. For human consumption e.g., Rock salt.
9. Rocks influence the **landscape of an area.** Some rocks are easily weathered while others are resistant or hard. Upland areas and some lowland areas are because of the removal of some weak rocks making resistant to remain thereby giving the **shape of the area.**

SAMPLE QUESTIONS

Mention any two uses of mechanically formed sedimentary rocks to human activities(2marks)

With the aid of an illustration show how rock minerals can move from one rock type to another (5marks)

In the rock cycle, explain the difference between compaction and lithification (2marks)

Mention any two uses of rocks to man (2marks)

Explain any two differences between plutonic igneous rocks and volcanic igneous rocks (4marks)

Mention any two examples of volcanic igneous rocks (2marks)

Describe how the following rocks are formed (i) coal (3marks) (ii) basalt (3marks) (ii) gneiss (3marks)

Explain how the following types of rocks are formed (i) mechanically sedimentary rocks (3marks) (ii) volcanic igneous rocks (3marks) (iii) metamorphic rocks (3marks)

Explain any two characteristics of sedimentary rocks (4marks)

Mention any two uses of chemically formed sedimentary rocks (2marks)

What makes sedimentary rocks to occur in layers? Explain any two reasons (4marks)

What makes sedimentary rocks to contain fossils? Explain any two points (4marks)

For each of the following igneous and sedimentary rocks, give the resultant rock that forms after metamorphism (i) limestone (ii) basalt (iii) conglomerate (iv) coal (v) sandstone (vi) granite (1mark each)

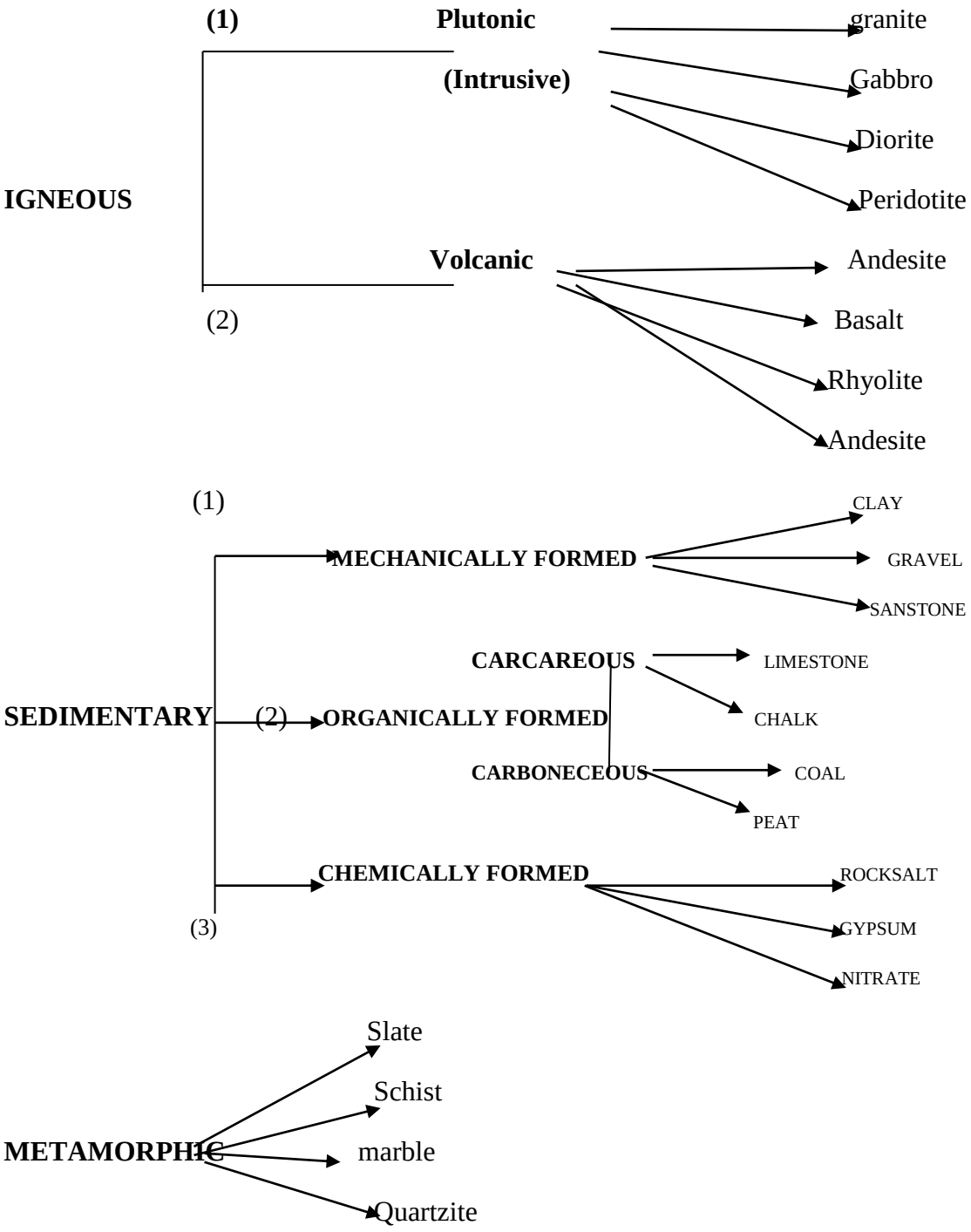
How do igneous rocks differ when magma cools at (i) depth (2marks) (ii) the surface? (2marks)

How are sedimentary rocks formed by chemical precipitation? (3marks)

Describe any two processes that produce sedimentary rocks (4marks)

What are metamorphic rocks? (3marks)

ROCK TYPES SUBDIVISIONS AND EXAMPLES



COURSES OF A RIVER

A river has a life-cycle which reveals its stages. There are **three stages** or **courses** of a river from its source to its mouth.

1. The youth or upper stage
2. The maturity or middle stage
3. The old age or lower stage.

1. THE UPPER COURSE

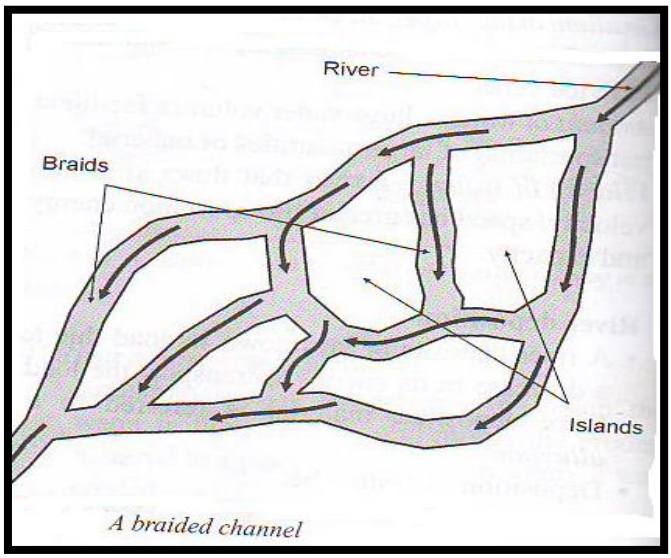
- It is also called **youthful** or **torrent** stage.
- It is called youthful stage because **it is young in the way it behaves**.
- The river flows fast as the gradient is **steep** and **deepens** the slopes.
- The stage is deep, narrow and V-shaped with interlocking spurs.
- Since there is fast flowing, vertical erosion is the main work done by the river.
- The section has gorges, rapids and waterfalls.
- The swirling of fast moving water through uneven bed leads to the development of **pot-holes**.

2. THE MIDDLE STAGE

- ✓ Also called **maturity stage**
- ✓ The river moves smoothly and slowly because **it carries heavy load** of mud and sand picked up in the highlands.
- ✓ Since the river no longer has the speed to cut its floor down further, it begins to cut sideways thereby **widening the valley**.
- ✓ The work of the river therefore is mainly **transportation** with some deposition.
- ✓ **Meanders** and river cliffs are the main features.

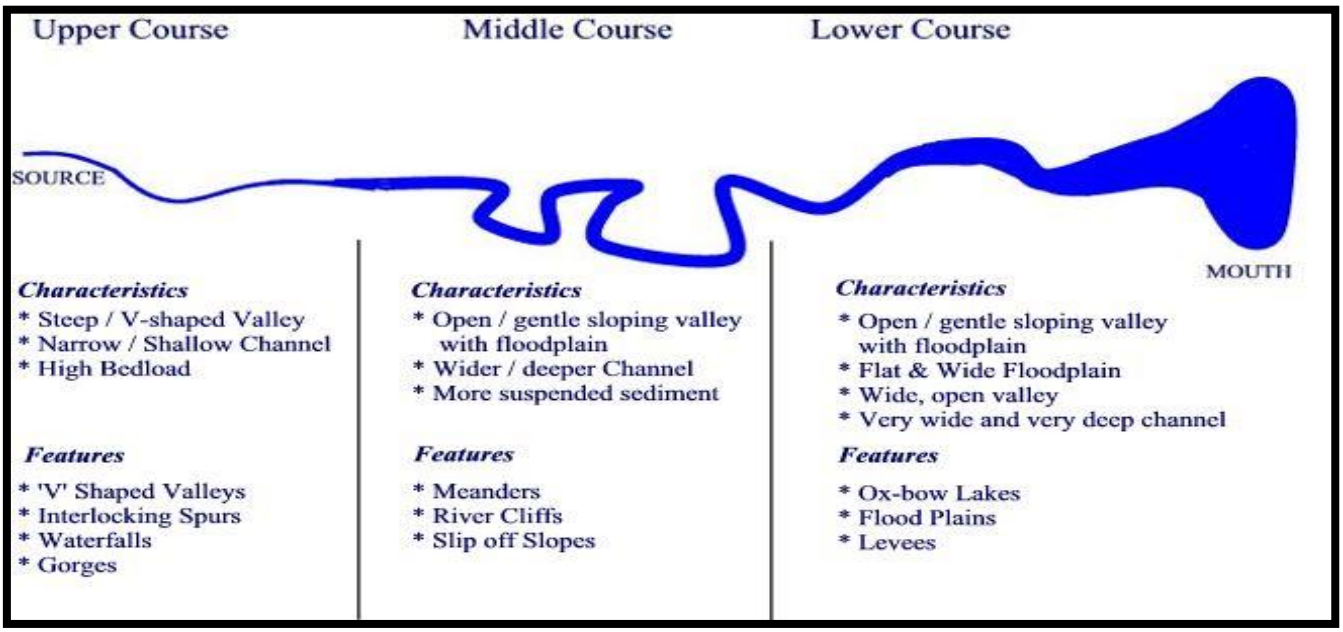
3. THE LOWER STAGE

- It is also called the **old age stage** or **plain stage** and is the section near the **river mouth.**
- The river flows over a flat **valley-plain** and **moves slowly.**
- The work of the river is therefore **deposition**, building up its bed and forming extensive **flood plains**.
- Large quantities of materials are deposited in the river channel and this often leads to **splitting of the river channels** into other river channels. This process is called **BRAIDING**.
- Flood plains, levees and deltas are the main features of a lower stage



A braided channel

STAGES OF A RIVER AND MAIN FEATURES



SMALL SCALE LAND FORMS FORMED IN DIFFERENT STAGES OF A RIVER AND THEIR IMPORTANCE. These are regarded as **riverine landforms because** they are formed **from the action of a river from the source to the mouth along its stages.**

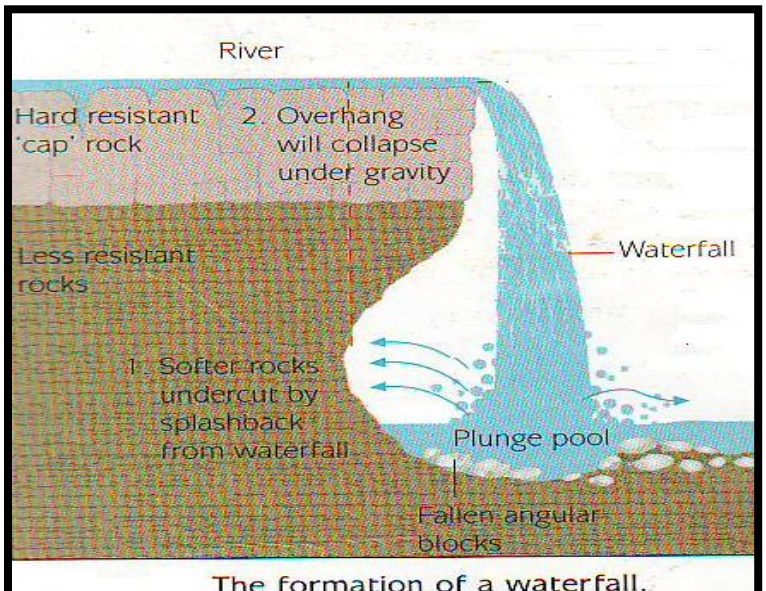
EXAMPLES OF SUCH RIVERINE FEATURES

- Deltas
- Waterfalls
- Rapids
- Cataracts
- Gorges
- Ox bow lakes
- Flood plains
- Levee

1. WATERFALLS, RAPIDS AND GORGES

a. WATERFALLS

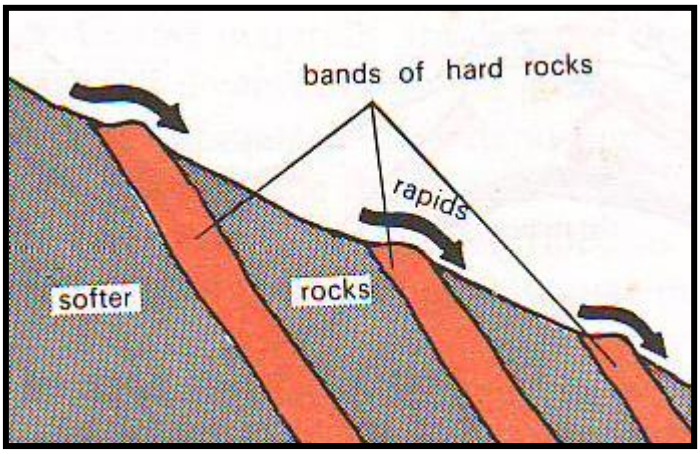
- Waterfalls form where a **riverbed crosses form hard rock to softer rock.**
- The river **wears down the softer rock** making hard rocks to stand out. This creates **a steep** that makes the water to jump **downstream over a height.**
- The falling water over a great height erodes a hollow at the base called a **PLUNGE POOL**



The formation of a waterfall.

b. RAPIDS AND CATARCTS

These are formed when the **layer of hard rocks dips gently downstream** such that water does not fall over a great height as it is with waterfalls.



c. GORGES

These are formed where the rocks are **very resistant to erosion** such that the valley is so **narrow,** and **sides** are so **deep** or steep.

Rapids, waterfalls and gorges are mainly found in the upper course of a river except in rare cases where they can be found in the middle as it is the case with Shire River in Malawi.

IMPORTANCE OF WATERFALLS, RAPIDS AND GORGES

These features are important in that

1. Are used in the production of **hydro-electric power**. E.g. Tedzani and Nkula Falls along Shire River in Malawi.
2. Are used for **tourist attraction** which brings money to the nation e.g. Victoria falls

However, the features are a barrier to navigation.

2. OX-BOW LAKES

Ox-bow lakes are formed because of the **meandering** (bending) of a river in a flood plain

Meanders are formed when the river moves very slowly in a flood plain producing **curves** instead of going straight. **Erosion** and **deposition** takes place on the bends of a river.

Three stages are usually involved in the formation of ox-bow lakes:

STAGE 1.

Large **meanders** develop, and erosion takes place wearing away the adjacent banks.

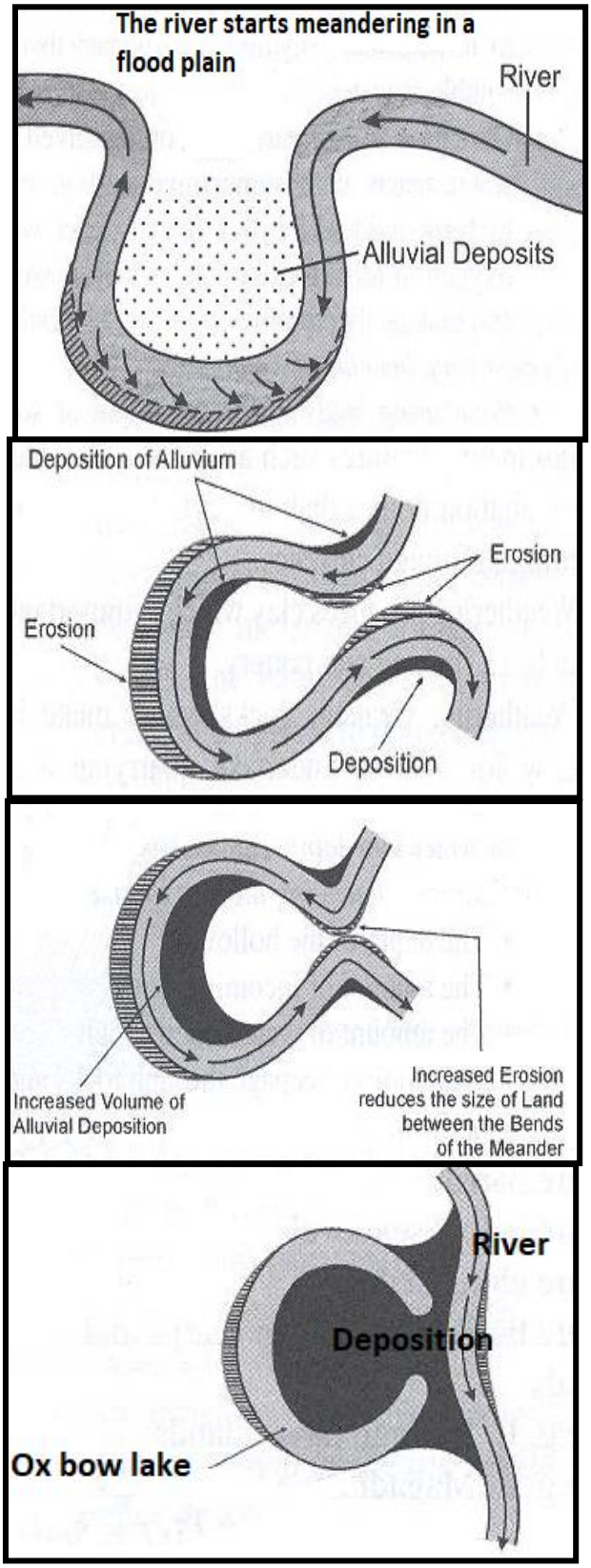
STAGE 2.

The wearing bends are brought much **closer together** because of erosion such that the river loops back very tightly.

STAGE 3.

The two adjacent banks meet, and the river flows **straight through**, leaving the **big loop** stranded and blocked off by **deposited silt**. The part that is **cut off** becomes the **ox-bow lake**.

An example of an ox-bow lake is Mgaila Lake in Kano, Nigeria.



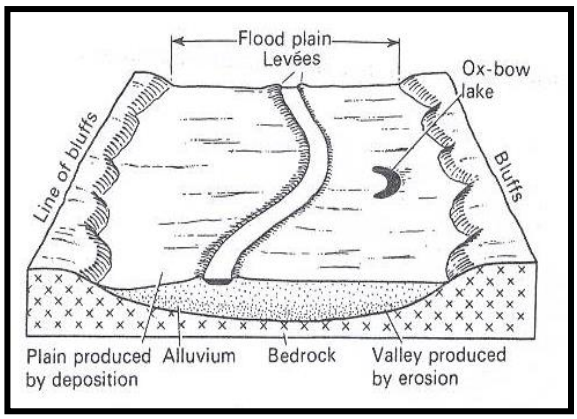
3. FLOOD PLAINS

Develop during **annual or sporadic floods, which make the load of the river to be spread over the low-lying nearby areas in the lower course of a river.** During each flood, a layer of **sediments** is deposited.

Flood plains are **good for cultivation and support large numbers of people despite** the dangers of **floods that destroy both life and property**. Examples of places where flood plains are good for cultivation include along the Nile, Ganges and Hwang-Ho rivers.

4. LEVEES

- ✓ Formed when the river **bursts over its banks dropping the bulkier or bigger pieces while pile up on each bank of the river.** These are formed in the **lower course of a river.** They appear as **raised banks** of river or mounds along the river.
- ✓ Natural levees are important in that;
    - Protect people from **floods**
    - Are also cultivated but occasionally they break, and results are disastrous loss of property and life through flooding.



5. DELTA

- It's a **fan-shaped alluvial area** at the mouth of a river. Deltas are **large low-lying** accumulation of silt **deposited by a river at its mouth**.

CONDITIONS NECESSARY FOR THE FORMATION OF A DELTA

- ➢ The river must carry **a lot of sediments** from the upper and the lower courses to provide material for deposition.
- ➢ The materials or sediments or load must be **dropped faster than can be swept** by the water currents. Therefore, tides or currents along the **coast must be very weak** so that they should **not sweep away the materials** carried by the river.
- ➢ The **river should flow slowly** as it enters the sea to allow materials and sediments to be deposited.
- ➢ Presence of **shallow water** at the point where the river enters the sea or lake **to facilitate deposition.**
- ➢ There should be **obstacles** such as **sandbars** at the mouth of the river which block the river forcing **it to deposit its load.**

FEATURES ASSOCIATED WITH DELTAS

These include **distributaries**, **sandbars** and **lagoons**

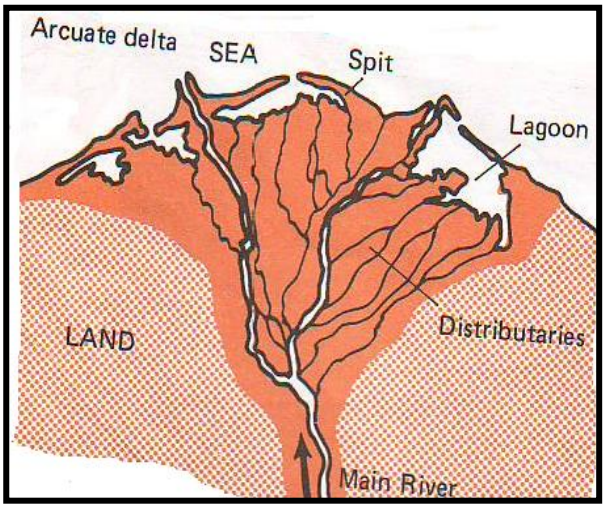
- ✓ Due to obstruction caused by the deposited alluvium, the river may empty its water through several channels called **DISTRIBUTARIES.**
- ✓ **Distributaries** are small rivers that take water from the main river joining the sea.
- ✓ **SANDBARS:** these are **long, narrow islands of sand along the shore formed as water tries to force its way through the deposited alluvium**.
- ✓ These sandbars make it very difficult for the river water to escape and encourage deposition.
- ✓ Sandbars are barriers to navigation.
- ✓ **LAGOONS:** these are **long shallow areas of enclosed water between the sandbars** and the coast.

- ✓ Lagoons are formed when **sea currents flowing parallel to the shore**, have smeared the sand blocking the mouth of a river.

TYPES OF DELTAS

1. ARCUATE

- ➢ This is the type of which the **word delta** was originated as **the shape in that of the great capital** letter **D or Δ**
- ➢ It is **triangular** with many distributaries, lagoons and sandbars.

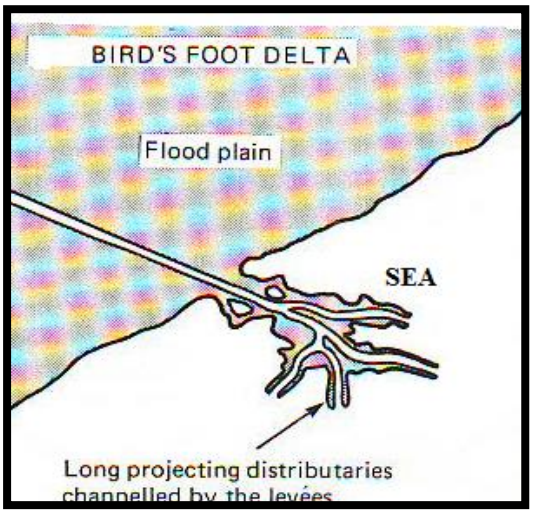


EXAMPLES OF RIVERS WITH ARCUATE DELTA

- ➢ Indus River
- ➢ Niger River
- ➢ Nile River
- ➢ Ganges River
- ➢ Mekong River

2. BIRD'S FOOT DELTA

- ❖ It is also called **Digitate**
- ❖ The deltas are formed in lakes and seas where **the waves, tides and currents are very weak.** Consequently, **two distributaries are especially powerful and build out silt** along finger like belts of deposited material.
- ❖ It is known as a bird's foot because **its shape resembles the foot of a bird**.

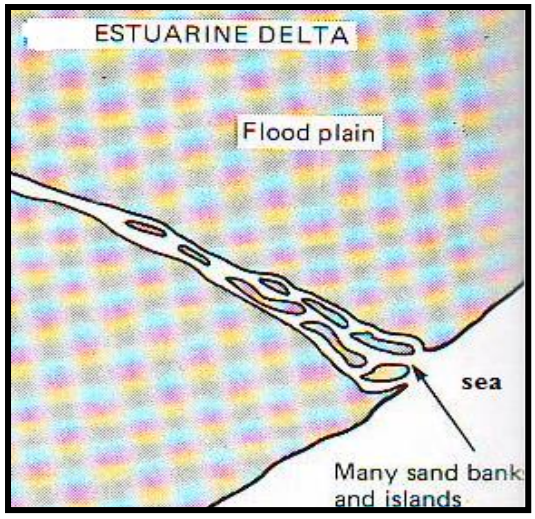


EXAMPLES OF RIVERS WITH BIRDS FOOT DELTA

- ✓ Omo (Lake Turkana) river
- ✓ Mississippi

3. ESTUARINE DELTA

- Such deltas **do not extend out to the sea so much so that the river mouth is drowned or submerged**. This is because the waves, tides and currents **remove the sediments load** as it is deposited.



EXAMPLES OF RIVERS WITH ESTUARINE DELTA

- Zambezi river
- Vistula river (Poland)
- Ob river (USSR)
- Elbe (Germany)
- Seine river (France)

4. CUSPATE DELTA

The delta is **pointed out into the sea but without distributaries**, sandbars and lagoons

EXAMPLES

River Tiber in Italy

River Ebro in Spain

ECONOMIC IMPORTANCE OF DELTAS

1. **Heavily cultivated because of** the deposited silt and support large members of people e.g. Nile Delta (Cotton, rice); Ganges delta (Jute, Rice).
2. Some deltas have **oil deposits** which is mined e.g. the Niger delta
3. Though it is expensive to maintain, some deltas have **good ports** e.g. Alexandria in Nile delta. Such ports require regular dredging to remove silt.
4. In tourism deltas provide **good ecosystems** for habitats to a **variety of marine** and wildlife such as **birds** hence centres of **tourist attraction.**
5. They form **good fishing grounds** due to the **deposition of nutrients** for the growth of planktons

PROBLEMS CREATED BY DELTAS

1. They are **prone to floods** which destroy life and property.

2. Associated with **marshes and swamps which act as breeding** places for mosquitoes which transmit malaria.

3. The slow movement of water in deltas make some animals such as **crocodiles** to be found there which **kill** people.

SAMPLE QUESTIONS

Define the term deltas in geography (2marks)

Explain any two necessary conditions for the formation of deltas (4marks)

Describe any two types of deltas (4marks)

In what way are Deltas important in the following areas (i) transportation (ii) fishing (iii) tourism (iv) farming? (v) Mining (3marks each)

Mention any two negative influences of deltas (2marks)

How can the following help in the formation of deltas: (i) Weak currents along the coast (ii) Large load of sediments (iii) Slow movement of a river (2marks each)

Using a well labelled diagram, explain how waterfalls are formed (5marks)

Describe any two effects of waterfalls on the economy of the surrounding areas (4marks)

LANDFORMS

These are the **surface features** of the land making up the **earth's surface**. Landforms are formed by the **internal forces** of the **tectonic movements** lifting the crustal masses upward and **external forces** of erosion, **denudation** and **weathering** due to action of water, wind and ice.

EXAMPLES OF LANDFORMS

Mountains, cliffs, beaches, sand dunes,hills,valleys,escarpments,spurs,islands,bays

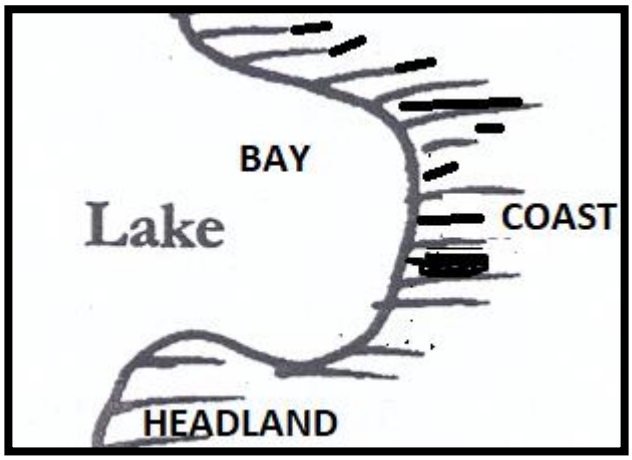
COASTAL LANDFORMS

These are formed due to **erosion** and **deposition** along **the coasts**. Erosion **eats up** the shores with **water waves** while as deposition **builds up** the coasts with eroded materials.

EXAMPLES COASTAL LANDFORMS

1. **BAYS**

A bay is an **indentation** or a **curve** along the coastline. It is semi-**circular** in shape. Bays are formed due to removal **of soft or weak rocks along the coast** making water to go **deep into the land** between two **headlands**. Bays are therefore, erosional type of landforms.



EXAMPLES OF BAYS IN MALAWI

Monkey Bay
Nkhata Bay
Chitimba
Senga Bay

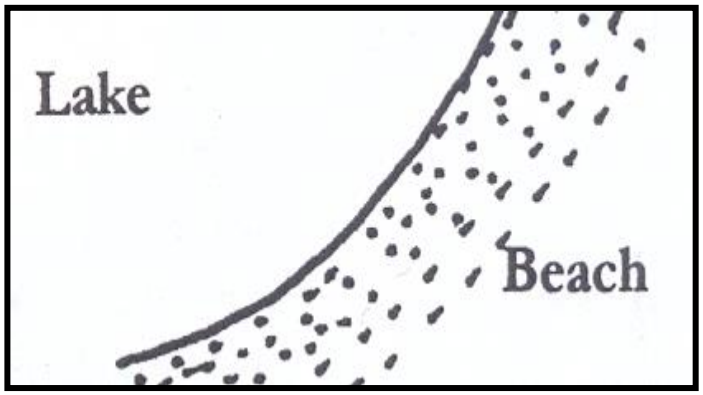
2. HEADLANDS

These are higher **grounds that extend out into the sea**. These are formed when **water erosion** takes place **removing weaker rocks** forming bays but **failing to remove the resistant** or **hard rocks** making them to stick out into the sea with steep **cliffs.** When headlands **are long and narrow they** are **called points e.g.** Bua Point, Namikonde Point

Therefore, headlands and bays form on discordant coasts, where different types of rock lie at right angles to the sea and are subjected to differential erosion. The soft rocks are easily eroded and form **bays** while the **hard rocks resist** erosion and form **headlands** which protrude **out into the sea** between **the bays.**

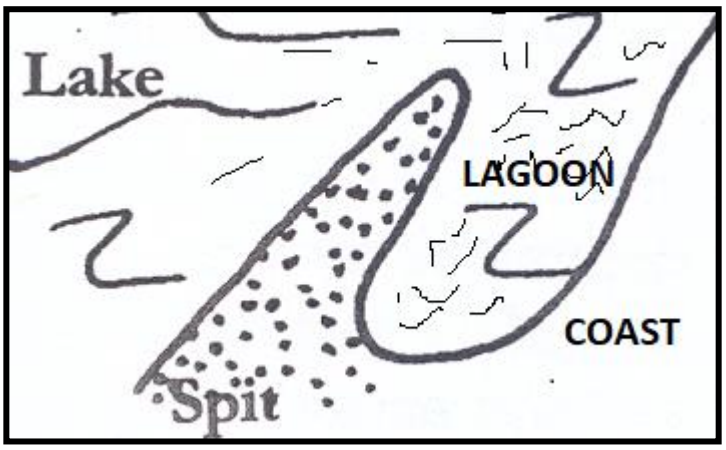
3. BEACHES

This is a **collection of sand or shingle and pebbles** along the coast formed through the deposition along the coast. This is one of the **depositional** coastal features.



4. ASPIT

This is **along and curved** deposition of **sand** along the coast. Formed through **long shore drift**, that is, **currents blowing almost parallel** to the coast, carrying the sand in the process. This is a **depositional** feature.



CONDITIONS NECESSARY FOR FORMATION OF SPITS

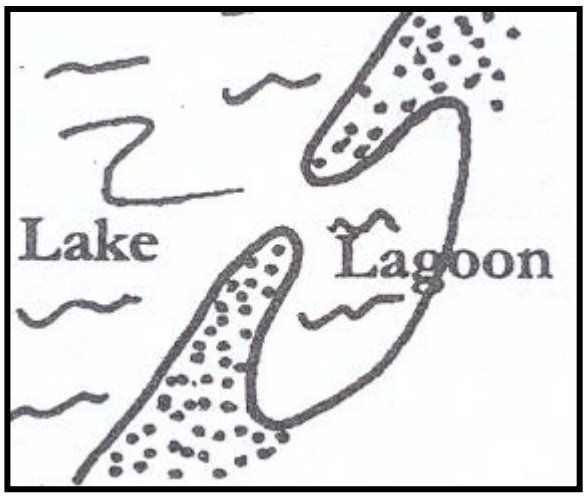
- There must be constant supply of sand from erosion further up the coast.
- Existence of winds along the coast to have long shore drift.
- Shallow waters along the coast.

5. A SANDBAR

This is a long and narrow depositional landform of **sand and shingle built across entrance** to a bay or river mouth. They appear like **islands** of **sand** and sediments.

6. A LAGOON

This is a **shallow cut off piece of water** separated from the sea or lake by a **spit** or **sandbars.** It is formed when a **ridge of sand** develops **across the entrance of a bay** or concave coastline. This enclosed water is quiet, slow moving and salty. The area accumulates sand and marshes or swamps. For example, Chia Lagoon in Malawi.



7. STRAIT

This is a narrow **body of water** that connects **two larger bodies** of water e.g. strait of Gilbratar.If the passage is long and wide, it is called a channel e.g. English Channel.

8. GULF

This is an arm of a sea or ocean that **extends into the land**. It is larger than a bay and connected with the sea with one or more straits e.g Gulf of Mexico.

9. TOMBOLO

This is a sand bar that connects an island to the mainland.

10. CAPE

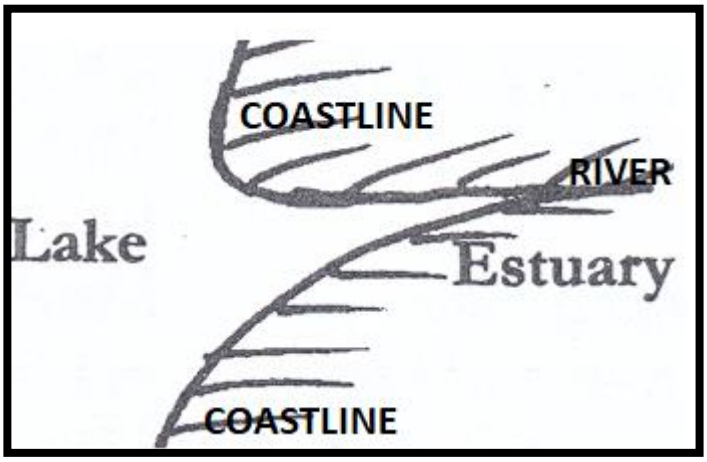
This is a piece of land like a headland extending into water body but **larger than a headland and flat topped**.eg Cape of Good Hope, Cape Maclear

11. PENINSULA

Apiece of land that is almost surrounded by water but connected to the mainland by a narrow neck of land called **isthmus**

12. ESTUARY

This is a **v shaped opening** at the mouth of a river formed where **fresh water** from the river mixes up with **salt water** from the sea.



IMPORTANCE OF COASTAL LANDFORMS

1. Some of them make **excellent natural ports** for ships. This is because they protect the ships from **strong winds** and **destructive waves** with also **having deep waters**. Such coastal landforms include **bays** and **headlands**. Examples of such ports includes Monkey Bay, Nkhata Bay and Chitimba, Cape Town, Hiroshima.
2. Used **as recreation centres** or **tourist places** of interest which bring money to nations, for example, sandy beaches of some parts of Lake Malawi.
3. They have **an influence on the fishing industry**. These are features such as bays, lagoons, estuaries and deltas where fishing is done.
4. **For settlement**. Some coastal features such as headlands, capes, peninsulas attract human beings for settlement.
5. **Generating electricity**. This happens along the coast when **lagoons** and **estuaries** are dammed to get **tidal energy**.

PROBLEMS ASSOCIATED WITH COASTAL FEATURES

1. **Dangerous to shipping industry**. Some features make the anchoring and movement of ships along the coast dangerous and difficult. For example, lagoons, sand bars and spits.
2. These tend **to harbour or keep some animals** such as crocodiles, hippos which attack people. For example, lagoons and deltas.
3. Breeding places **for mosquitoes** and **snails** which transmit **malaria** and **bilharzia** respectively.

RELIEF FEATURES OF THE OCEANIC BASINS

OCEANIC BASIN

This refers to the **nature or the view of the oceanic floor** from the shoreline to the ocean or sea. This oceanic basin has several **relief features** that lie below the water level.

EXAMPLES OF RELIEF FEATURES OF THE OCEAN FLOOR

1. **Continental shelf**

This is a broad, **gently sloping plain near the shoreline**. It is shallow making sunlight to penetrate to the bottom for the **planktons** which is food for fish. It has a depth of not more than 180meters.Examples of places with continental shelf include western coast of South America, Canada and the coast of Greenland.

2. **Continental slope**

This is a slightly **steeper area beyond** the continental shelf

3. **Continental rise**

This is a **gentle rise area at the end of a continental slope** formed by sand or mud washed down from the slope.

4. **Ocean basin or Abyssal plain**

This is **a broad flat area beyond the continental slope**. The abyssal plain has some features such as:

(i)**Abyssal hills**. These are seamounts which rise higher to more than 900meteres

(ii)**Guyots**.These are volcanoes with **flat topped surface** in the Abyssal plain. They are flat topped because of waves which remove the top part.

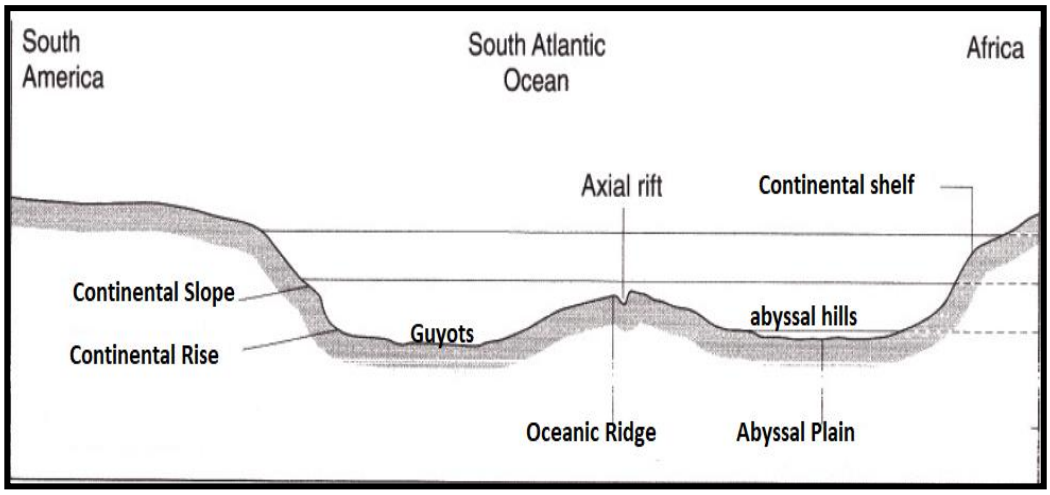
5. **Trenches**

These are **deep cracks in the oceanic floors** formed when **two plates move away** in a **divergent** boundary. However, are also formed in the convergent boundary where one plate dives under the other.

6. **Mid Oceanic Ridges**

Are **mountain ranges** that zig zag along the ocean floor. They are formed where plates are spreading apart under water. **Earthquakes** and **volcanoes** occur at mid oceanic ridges.

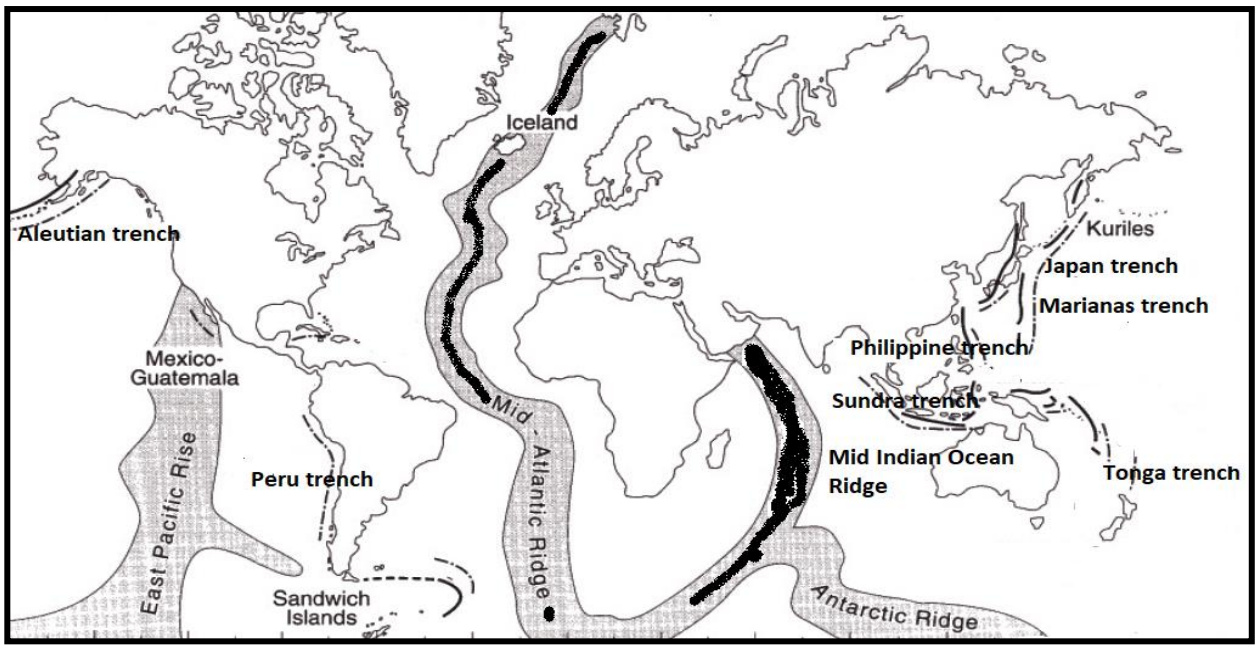
DIAGRAMMATIC CROSS SECTION BETWEEN SOUTH AMERICA AND AFRICA SHOWING OCEANIC BASIN



IMPORTANCE OF THE OCEANIC FLOOR

1. Are areas where **fishing** is done due to the penetration of light for planktons, e.g. continental shelf.
2. Harvesting some **other resources** such as sea weed, Oysters, Shrimps, minerals

LOCATION OF SOME IMPORTANT TRENCHES AND OCEANIC RIDGES IN THE WORLD



QUESTIONS

Describe any three features of the oceanic floor (6marks)

Mention any three examples of features formed in the oceanic floor (3marks)

Define the following terms: Oceanic basin, Continental slope, Continental shelf (2marks each)

KEY WORDS

Continental shelf. Continental slope, continental rise, guyot, abyssal hills

OCEAN CURRENTS

Ocean currents are **large bodies of surface water that circulate in regular patterns around the oceans.**

A DRIFT is a large-scale movement of ocean water resulting **primarily from prevailing winds.** An example of a drift is the North Atlantic Drift. Drifts are **faster** in movement while ocean currents are **slower.**

Streams are **continuous** flow of the current in a specific direction; usually between **two land masses flowing faster** as it leaves the **constriction area**. An example of a stream is **Gulf Stream** which flow between Florida and Cuba.

TYPES OF OCEAN CURRENTS

There are **two** types of ocean currents:

1. Warm ocean currents
2. Cold ocean currents

1. WARM OCEAN CURRENTS

Such ocean currents **flow from the tropics which are hot areas to Polar Regions** which are colder regions.

They **have high temperatures** which they carry to their blowing areas.

Examples include:

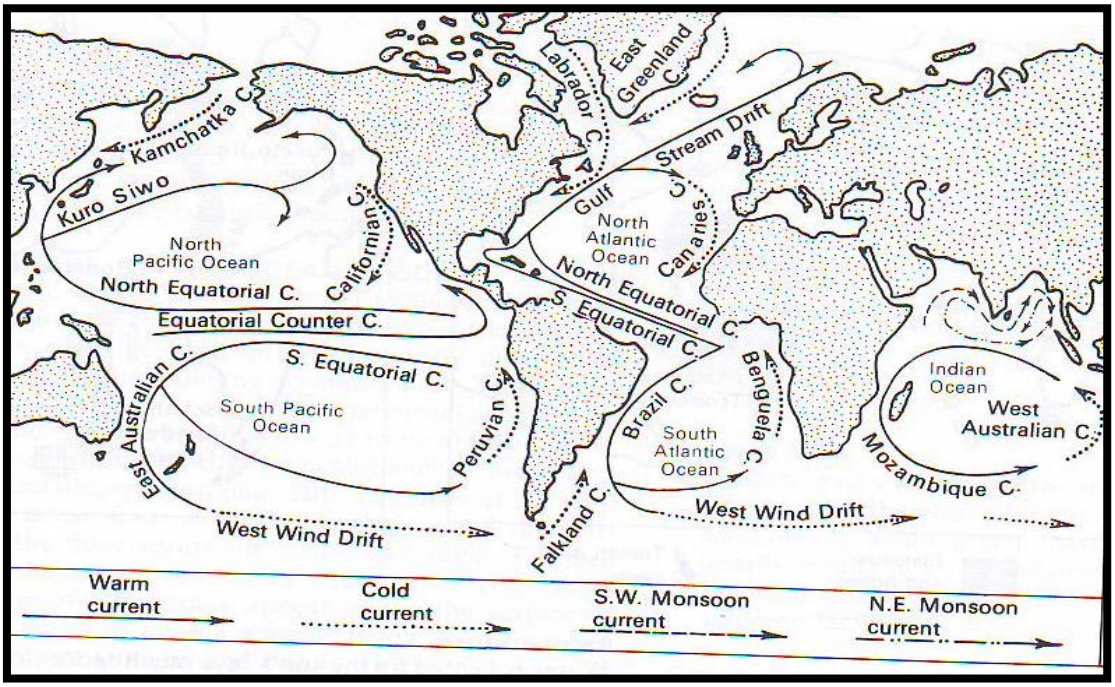
- Brazilian
- Agulhas or Mozambican
- Kurosiwo
- North Atlantic drift
- Gulf stream
- East Australian

2. COLD OCEAN CURRENTS

- Such ocean currents **flow from the cold Polar Regions to warm tropical regions**.
- They have **low temperatures which they carry towards their blowing areas**.

Examples include:

- Peruvian or Humboldt
- Labrador
- Canaries
- Kamchatka
- Benguela
- West Australia



CAUSES OF OCEAN CURRENTS

1. **TEMPERATURE**

   This causes ocean currents **in terms of density.** Warm water from the equatorial or tropical regions is **lighter or less dense** as its temperature is higher.

   Cold water from the Polar Regions is **heavier or denser as its temperature is low.** Therefore, temperature contributes to a general movement in oceans as **warm lighter equatorial water move along the surface towards the Polar Regions while the heavier cold waters of the polar region creep slowly along the bottom of the oceans or seas towards the equator.** This creates a continuous movement of water**.**

2. **SALINITY**

   Salinity refers to **the degree of salt concentration in the ocean**. Water of **high salinity** is **denser** than that of **low salinity** for this reason water of low salinity **flow on the surface while that of high salinity flow at the bottom.** This in turn causes a general movement of water in sea and oceans. For example, in the Mediterranean region, there is a great difference in salinity between the water of the enclosed Mediterranean Sea and those of the open Atlantic. The **less saline water of the Atlantic flows on the surface into the Mediterranean, and this is compensated for by an outflow of denser bottom** water from the Mediterranean which is **more salty** due to great evaporation that leaves more salt.

3. **WINDS (PLANETARY WINDS)**

   Winds are capable of **moving surface water of oceans in a particular direction**. The prevailing winds especially the **westerlies** and **trade** winds are the most important.

   The trade winds which flow **from the horse latitudes towards the equator cause oceanic water to move.** For example, the canaries, benguela and Peruvian carrents move towards the equator from the tropics while **westerlies use** the **north Atlantic drift** to move towards the **Polar Regions** from the tropics.

4. **ROTATION OF THE EARTH**

As the earth rotates, **it makes freely moving bodies or such as winds also to move**. As the movements continue, such bodies **deflect to the right in the Northern hemisphere and to the left in the southern hemisphere.** For example, the **canaries** deflect to the right as it is in the northern hemisphere while the **Brazilian** current **deflects to the left** as it is the southern hemisphere.

FACTORS THAT INFLUENCE THE DIRECTION OF OCEAN CURRENTS

The direction taken by any ocean current is influenced by the **shape of the continent, prevailing winds, temperature** and **rotation of the earth**.

a) SHAPE OF THE CONTINENTS (LAND MASSES)

The land mass always **obstructs** and **diverts** a current. This makes the current to follow the shape of the continents. For example, the flow of the **Mozambican** is obstructed and diverted by Madagascar and the Eastern coast of Africa.

b) WIND DIRECTION

As the winds flow across the open seas the **surface water is dragged along until** a land mass is reached. The prevailing winds such as **trades, westerlies** and polar force the path of ocean currents so that they flow with them.

c) TEMPERATURE

Temperature across the oceans are **variable water tend to flow from hot regions to cold regions** and vice versa due to density.

d) ROTATION OF THE EARTH

This is according to **coriolis force** which makes **freely moving bodies such as water and wind to deflect to the right in the northern hemisphere and to the left in the southern hemisphere.** For example, Kuro siwo deflects to the **right-hand side in the Northern hemisphere** while as the **west Australian** deflects to the **left in the southern hemisphere**. The Coriolis force only works when the earth is rotating.

IMPORTANCE OF OCEAN CURRENTS

Ocean currents influence the climate of an area, fishing grounds and shipping routes.

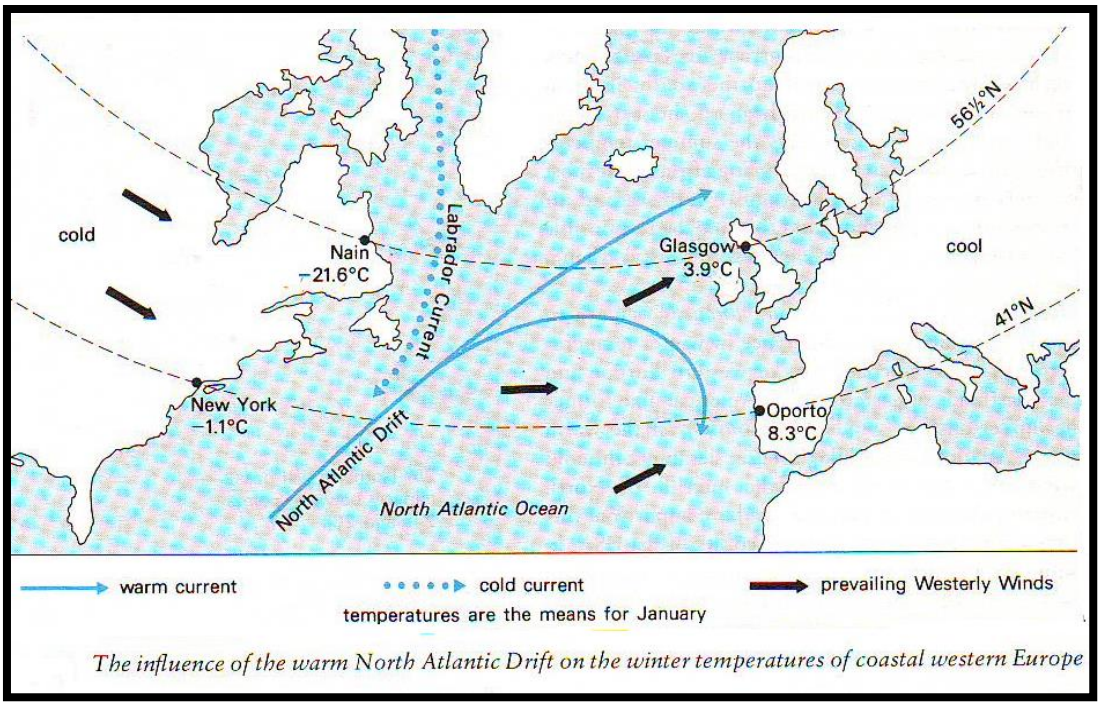
1. INFLUENCE ON THE CLIMATE OF AN AREA

(i)Warm ocean currents carry **tropical heat** to the polar cold regions of high latitudes. The heat is important because:

- **Raise** the very low temperatures of high latitudes especially in winter. For example, the warm **North Atlantic drift** help to **raise the temperature** in Europe and Alaska. This warming influence **decreases inland from the coast**.
- Help to **melt** the winter ice hence making some **ports to be ice-free** thereby using them throughout the year even in winter. For example, **Vancouver** port in America is an **ice-free port** due to the flowing of **North Pacific** warm current to the area.

(ii)Cold ocean currents help to **reduce the high tropical temperatures** which are important in summer. For example, the Labrador Ocean current reduces the summer temperatures of **Nain port in America**. The map below illustrates this influence.

INFLUENCE OF NORTH ATLANTIC DRIFT WARM OCEAN CURRENT AND LABRADOR COLD OCEAN CURRENT



The influence of the warm North Atlantic Drift on the winter temperatures of coastal western Europe

Note: the towns of Nain with **-21.6^{0}C** and Glasgow with **3.9^{0}C,** these towns are in the **same latitude** of **56 ^{1}/2^o N.** But have different temperatures because Nain is influenced by **Labrador Cold Ocean** current which **lower the temperature** of the town while Glasgow is influenced by the **North Atlantic drift which helps to raise the temperature**.

New York and Oporto also **lie in the same latitude** 41^{o}N. New York is influenced by the **Labrador** which is a cold ocean current which the temperature of Oporto is raised by the **North Atlantic drift** warm ocean current.

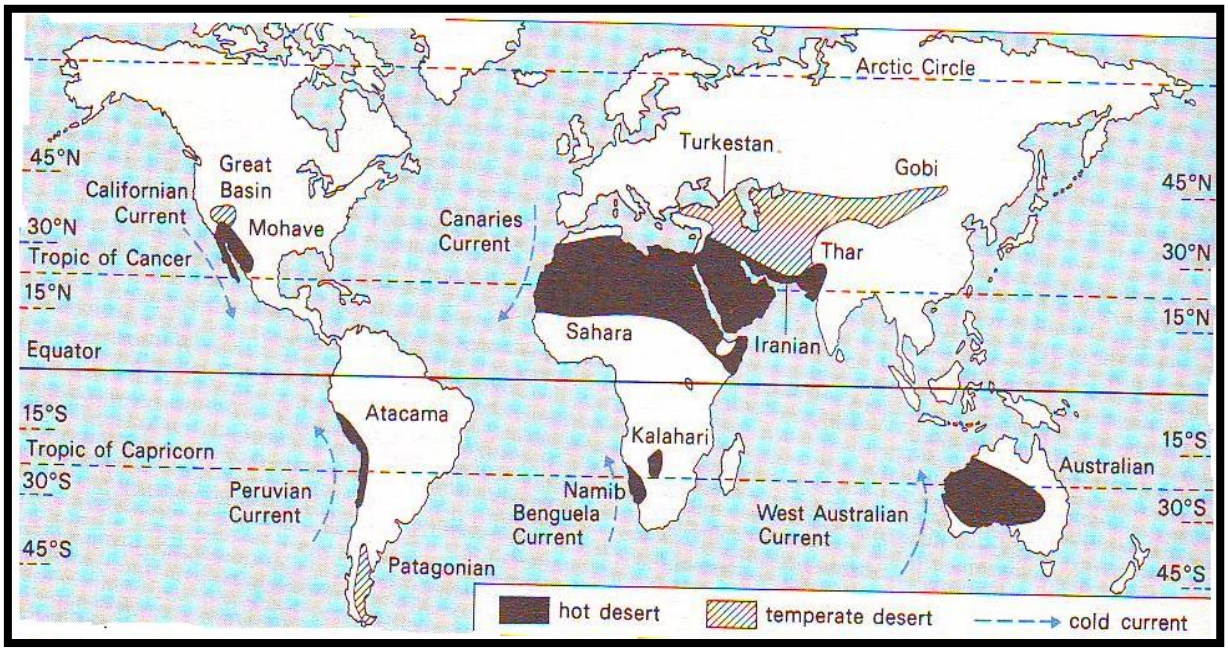
(iii)Warm ocean currents help to **bring precipitation towards where they blow**. Winds passing over warm ocean currents become warm and **absorb moisture from oceans**. If such winds are forced to rise when they cross the land as they are on-shore, cooling and condensation takes place resulting into **heavy rainfall.** Examples

- Brazilian warm current brings heavy rainfall to Brazilian coast
- Algulhas (Mozambican) warm current bring heavy rainfall on the south east coast of Africa.

(iv) **Cold ocean currents do not bring rainfall** to areas where they blow. This is because they are dry **winds and do not absorb moisture.** With this, they **contribute to the formation of deserts along the western side of the continents.** Examples

a) the **Benguela** cold ocean current is responsible for the formation of **Namib** and **Kalahari** deserts
b) the **Peruvian** for the **Atacama** Desert
c) The **California** for the **Californian** desert.

MAP OF THE WORLD INDICATING DESERTS AND COLD OCEAN CURRENTS



2. INFLUENCE ON FISHING GROUNDS

Ocean currents influence the **fishing grounds**. The richest fishing grounds are located in areas where **cold and warm ocean currents meet.** This makes such areas to have **a lot of nutrient salts for the growth of planktons.** Plankton is a name given **to marine animals and plant life that is eaten by fish.** Examples of such places include off the coast of the Labrador Current meets the North Atlantic drift and Japanese coast where the **cold Kamchatka current** meets the warm Kurosiwo current. Furthermore, cold ocean currents after creeping **under and upwelling on the surface of oceans stir up mineral salts for plankton growth.** This encourages the breeding of fish e.g. off the coast of California.

3. INFLUENCE ON FOG FORMATION

When warm and cold ocean currents meet **fog is formed**. E.g. off the coast of Newfound land where the Gulfstream and Labrador currents meet. This **affects the shipping industry as ships find it difficult and dangerous to move.**

4. INFLUENCE ON SHIPPING INDUSTRY

- Most of the world shipping routes **follow the path of ocean currents**. This helps ships the cheapest form of transport to travel faster delivering goods and people.
- **Icebergs** drift south with cold currents from Polar Regions and constitutes a threat to shipping.

POSITIVE INFLUENCE OF OCEAN CURRENTS

1. Help to **raise the temperature in cold regions** which is good for human survival in winter when temperatures are very low.
2. Encourage **fishing grounds** when warm and cold ocean currents meet.
3. Warm currents help to **melt ice making some ports** to be ice free thereby being in use throughout the year.
4. Warm ocean currents help to **bring rainfall** to the coastal areas.
5. Assist in **transportation when ships move following** the direction of ocean currents.
6. Cold ocean currents help **to reduce the high tropical temperatures** making areas to be used for recreation.

NEGATIVE INFLUENCE OF OCEAN CURRENTS

1. Cold ocean currents are responsible for the **formation of deserts** as they don't bring precipitation to coastal areas.
2. Bring **very low temperatures** to temperate and polar regions which are not good for survival and agriculture.
3. The meeting of warm and cold currents create **fog** in oceans which **disturbs visibility.**
4. Cold currents **bring icebergs** which give a threat to **shipping industry.**
5. **Slow down the movement** of ships when **sailing against the ocean currents.**

Keywords:
Drifts,Streams,Oceancurrent,salinity,prevailing,obstructing,diverting,Coriolis,deserts,iceberg, fog,planton.

SAMPLE QUESTIONS

Explain how the following cause ocean currents (i) temperature (ii) prevailing winds (iii) salinity (3marks each)
Why are some ocean currents warm and others cold? (2marks)
Explain any three factors that influence the direction of ocean currents(6marks)
Explain any two negative effects of ocean currents (4marks)
How do human beings depend on ocean currents? Explain any three ways (6marks)
Mention any two examples of (i) warm ocean currents in the northern hemisphere (ii) cold ocean currents that affect Africa (1mark each)
What is the difference between an ocean current and an ocean drift? (2marks)
Name any one example of the following (i) Drift (ii) Stream (1mark each)
What is the difference between an ocean stream and an ocean drift? (2marks)
Give one example of the following (i)a warm ocean current (ii)a cold ocean current (iii)a stream (1 mark each)

AIR PRESSURE

This is the **amount of force exerted by the atmospheric air on the earth's surface.**

MEASUREMENT OF AIR PRESSURE

Air pressure is measured by using an instrument called a **BAROMETER.** It is measured into units called **MILLIBARS** (mb).

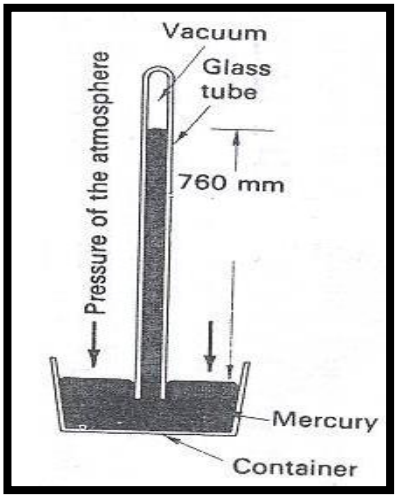
The pressure of **air at sea level is 1013.25 mb** which is equivalent to the weight of a column of mercury **76.0 cm** (760mm) high.

TYPES OF BAROMETERS

a. Mercury barometer
b. Aneroid barometer

a. MERCURY BAROMETER

It is made up of a glass tube, mercury and a container. It is made by taking a glass tube filled with mercury. While sealed at the mouth, the glass tube is turned upside down in a container filled with mercury.



HOW DOES A MERCURY BAROMETER WORK?

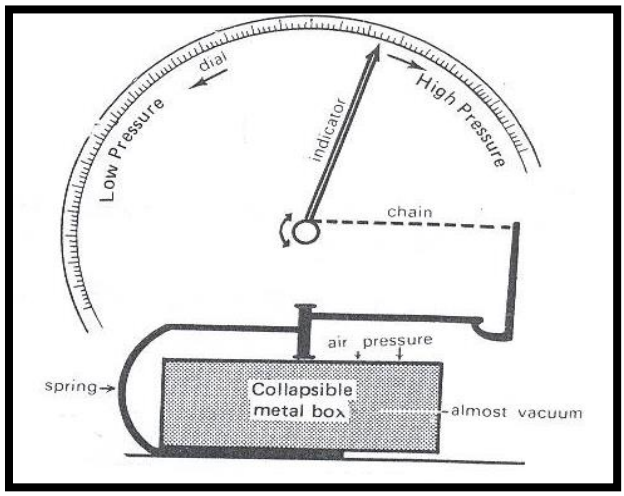
It works by balancing the weight of a column of mercury against the weight of the column of air.

When the atmospheric pressure increases, it **presses on the surface of mercury** in the container. This forces **mercury to rise in the glass tube** occupying the vacuum and recording the **high pressure.**

When the atmospheric pressure decreases, there is **little force exerted on mercury** in the container which makes mercury in the glass tube to **drop thereby recording low pressure**.

b. ANEROID BAROMETER

Consists of a collapsible metal box, with very little air inside connected to a system of levels and a pointer.



HOW DOES AN ANEROID BAROMETER WORKS?

When the air **pressure is high**, it exerts a force on the **collapsible metal** box which is pushed **downwards.** This makes the **spring to contract which pulls a system of levels** making the pointer to go to the **right-hand side recording high pressure** across a graduated scale.

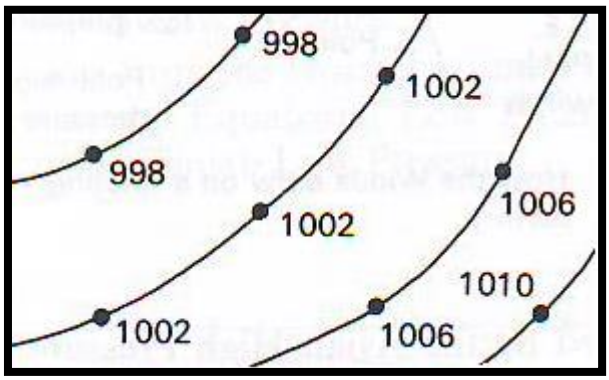
When the air pressure is **low,** little force is exerted in the box, making the spring to **relax** thereby releasing a **system of levers making a pointer** to go to the left-hand side recording **low pressure**.

USES OF BAROMETERS

1. In weather **forecasting**, the barometer's chief function is to determine the sea level pressure and its change. A change in pressure usually means a change in water. For example, when the pressure is low, the weather becomes **cloudy and often associated with heavy rainfall**. A **high pressure** is associated with **clear skies or fine weather**.

2. It is used to measure the **altitude** since atmospheric pressure is lower at higher altitudes and higher at lower attitudes. Pilots use a kind of barometer called **Altimeter** to determine their altitude of flight.
3. It can be used to **determine the direction and strength** of wind measured from two points.

ISOBARS: these are lines drawn on a map connecting all areas with the same pressure.



IMPORTANCE OF ISOBARS

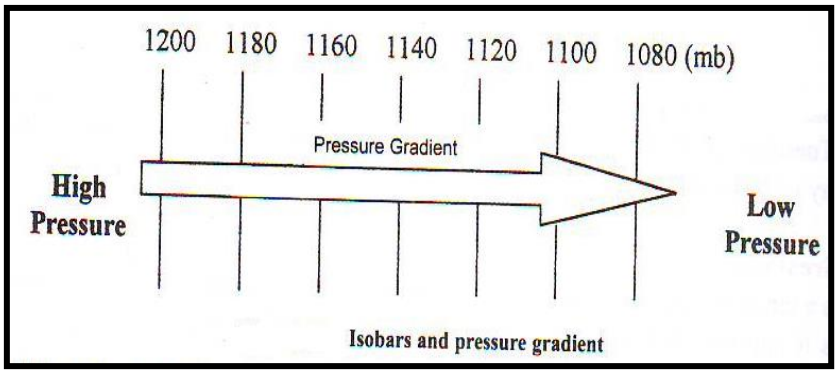
a. Help to determine the position of **high pressure** and **low pressure** on the map.
b. Help to **determine the direction** of the wind and strength
c. Help to indicate the **pressure gradient**.

PRESSURE GRADIENT

This is the **rate at which the atmospheric pressure changes horizontally in a certain direction as indicated by isobars.** It is calculated by subtracting the two adjacent isobars. As for the isobars above, the pressure gradient is **004.**

when the isobar are **close to each other it indicates that the wind is strong** in that area but when they are far apart it **indicates that the wind is blowing slowly**.

PRESSURE GRADIENT FORCE. This is the **initial force** that cause air to move from high pressure regions to low pressure regions



FACTORS INFLUENCING AIR PRESSURE

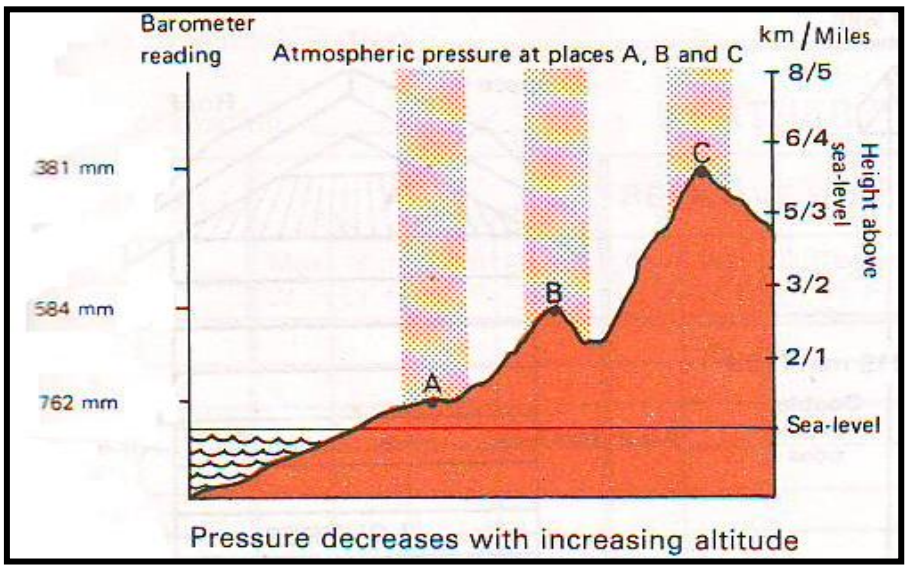
Air pressure is affected by:

1. Altitude
2. Temperature
3. Rotation of the earth.

1. ALTITUDE

Altitude is the **height above the sea leave.** Air pressure at a **low altitude such as along the sea** level is higher than at a **higher altitude** such as a mountain which has a **low air pressure**.

Air pressure at sea level is high because **air must support a large column of air which exerts a greater force.** Air pressure is low at a high altitude such as on top of a mountain because **the area supports a thin column of air which makes less force.**



2. TEMPERATURE

When air is heated it expands and rises thereby spreading over a large area making the volume to increase. This makes pressure to volume to increase. This makes pressure to be **low** because air pushes out with little force since there is **plenty of room**.

When **air is cooled** it, contracts reducing the volume. This makes pressure to rise as the air pushes out with a lot of force since there is lack of enough room. Therefore, **the higher the temperature the lower the pressure.**

However, when air contracts, molecules are very close together increasing the frictional force which can as well make the temperature to rise.

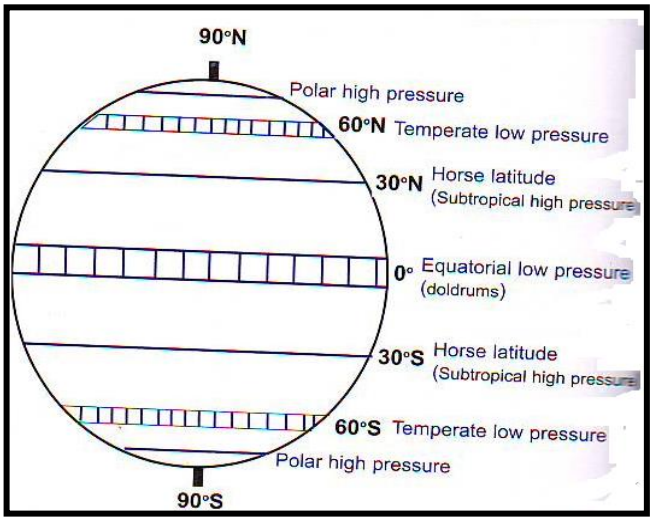
3. ROTATION OF THE EARTH

When the earth rotates air **piled up- in the Polar Regions is thrown towards the equator**. This in turn makes the pressure to change creating **low pressure** areas especially around latitude 60^{o} N and S of the equator.

PRESSURE BELTS

World pressure belts are areas with high pressures and areas with low pressures are formed as a result of the combination of **altitude, temperature and rotation of the earth**. The following are the world pressure belts:

a. Polar high pressures
b. Temperate low pressures
c. Sub-tropical or horse latitude high pressure areas
d. The equatorial doldrums low pressure



HOW DOES SUCH PRESSURE BELTS DEVELOP?

1. **POLAR HIGH-PRESSURE BELT**
   This develops at 90-degree N or S of the equator. The high pressure develops because of the **combination of the small space and low temperatures in such Polar Regions**. This makes air to contract thereby making the **pressure to rise**.
2. **TEAMPERATE LOW PRESSURE BELT**
   This develops at 60 degrees N and S of the equator. A low pressure develops in this region **because air that moves from the Polar Regions, because of the rotation of the earth crosses a parallel which is longer.** This makes the air to occupy **a larger space** thereby exerting little force that contributes low pressure.
3. **HORSE LATITUDES HIGH PRESSURE BELTS**

Also called sub-tropical, develops at 30^{o} N and 30^{o} S of the equator. **A high pressure develops because of the air that moves from the equator. This air which is squeezed out of the equator because of high temperature moves towards the sub tropical latitudes and occupies parallels (latitudes) which are shorter.** This makes air to exert a **lot of force** since the volume is smaller thereby making a high pressure to develop.

4. **DOLDRUMS EQUATORIAL LOW-PRESSURE BELT**

This develops along the equator 0^{o}. It develops because of **high temperature which heats up the air, making it to rise and reducing the pressure.**

THE SHIFTING OF THE PRESSURE BELT IN RELATION TO THE POSITION OF THE SUN

The **apparent movement of the sun** especially along the tropic of cancer in the northern hemisphere and Capricorn in the **southern hemisphere** makes the shifting of the pressure belts in the world.

The sun exerts **high temperature** in certain areas which results in a **belt of low pressure** to develop. Areas very far from the sun experience low temperatures and a high pressure develops. This is noticed in the months of July and January.

PRESSURE IN JULY

Since the sun appears to be overhead at the **tropic of cancer on 21 June** in the northern hemisphere, the equatorial **low-pressure belt extends well in the Northern hemisphere**.

These doldrums low pressure develops due to high temperatures. The low-pressure belt links up with low pressure belts over north-west India, Pakistan and south west USA.

The sub-tropical high-pressure cells of the southern hemisphere combine to form one belt which extends across the three continents of South America, Africa and Australia. This happens because it is winter in the southern hemisphere with very low temperatures.

PRESSURE IN JANUARY

The doldrums low pressure belts extend in the southern hemisphere. This is because it is summer in the southern hemisphere as the sun appears to be overhead along the tropic of Capricorn 22 December.

A low pressure is particularly well developed over Australia, central Africa and part of South America.

The low temperatures over the hearts of the northern hemisphere (continents) produce strong high-pressure systems.

The sub-tropical high pressures are formed only over the oceans.

EFFECTS OF THE SHIFTING OF PRESSURE BELTS.

Low pressure belt is associated with **heavy rainfall**. This is brought about by the **winds which converge in the area.** Therefore, the area where the low pressure develops experiences **cloudy conditions and heavy convectional rainfall**. For example, the **ITCZ brings a lot of rainfall in central Africa in December to January.**

High pressure belt is associated with **clear skies and fine weather without rainfall.** This is because **air blows out of** such regions blowing with clouds towards low pressure regions.

HOW DOES PRESSURE AFFECTS THE DIRECTION OF THE WIND?

Air pressure affects the direction of the wind in that **wind moves form a high-pressure region to a low-pressure region except in rare cases in high altitudes.**

THE INTER-TROPICAL CONVERGENCE ZONE (ITCZ)

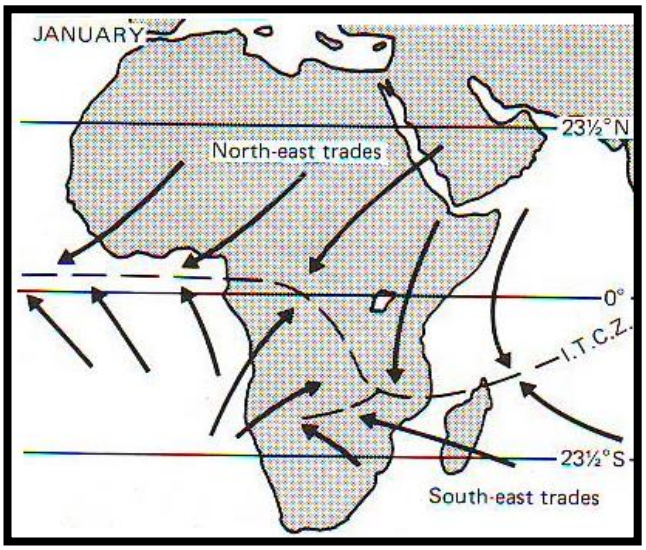
This is the zone at which the **air meets** because of the development of **a low pressure**. It follows the **overhead sun**, shifting slightly to the **north** of the equator from **June to July** and slightly south of the equator from **November to January**. This has the **main influence** on the climatic changes.

WEATHER CONDITIONS ASSOCIATED WITH THE ITCZ

- Massive rain bearing **cumulonimbus clouds** associated with **heavy rains**.
- Very **strong winds**
- Violent thunderstorms

POSITION OF THE ITCZ IN JANUARY

It is pushed to the **southern hemisphere**. This is because the **sun appears to the overhead in the over the tropic of Capricorn in the southern hemisphere**. This brings **intense heat** thereby making the area to develop a **low pressure.** Winds such as the **S.E. trades,** the **Congo air mass,** and **N.E. trades** converge in the area.



EFFECTS OF THE DEVELOPMENT OF ITCZ OVER CENTRAL AFRICA

This **brings heavy rainfall** in the area. This is because some winds blow into the **area are moist** as **such air masses cross water bodies such as oceans** e.g. the Congo air mass, which brings conventional rainfall. These are the **main rains** that affect Malawi during the **warm wet season.**

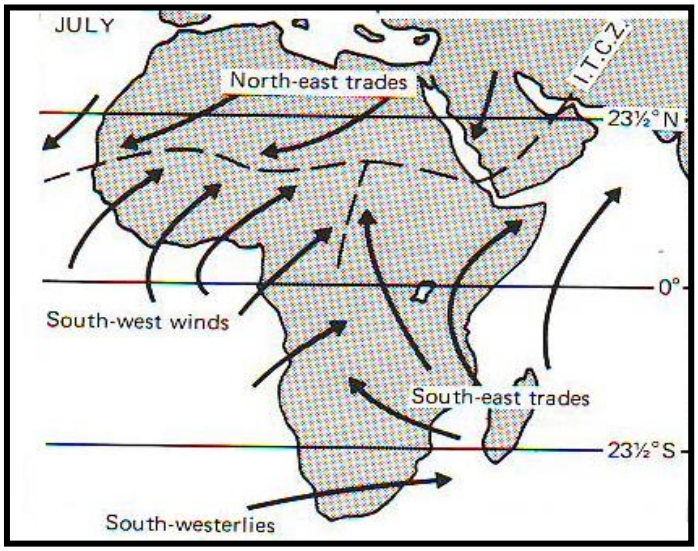
Thus, during **November to April** southern Africa receives rains while the North which has **high pressure** is under the influence of hot and dry air masses experience no rainfall.

POSITION OF THE ITCZ IN JULY

The ITCZ now shifts to the **North of the equator** where now it is hot as the sun appears to be **overhead at Cancer**. North Africa receives **heavy rainfall** due to the meeting of moist winds over the area. Currently over southern Africa including **Malawi, Zambia and Zimbabwe a high pressure** develops as the air is cool. Any winds that blow from this **high-pressure area will be dry**. This makes central Africa to experience generally **dry sunny weather during the cool season**. At times, however, the S.E. winds move inland and bring the cloudy, moistly, rainy weather known as **CHIPERONE**.

There is not much rain in October in Central Africa, despite the heat, because the **low pressure has not developed sufficiently to allow the in-blowing of the moist winds** which bring convectional rain.

WINDS AND CONVERGENCE ZONE IN JULY



Key words:

Barometer, Mercury,Aneroid,Isobars,Pressure gradient, Pressure gradient force, Pressure belt,Doldrums,Horse latitude, ITCZ.

SAMPLE QUESTIONS

With the aid of a diagram, explain how a mercury barometer works to measure air pressure(5marks)

Explain how the following factors affect air pressure (i) temperature (ii) Altitude (iii) rotation of the earth (3marks each)

Draw a stationary globe. On it name and locate the following (i) pressure belts (ii) prevailing winds (8marks)

Explain how air pressure influences wind direction (2marks)

Define the term pressure gradient(2marks)

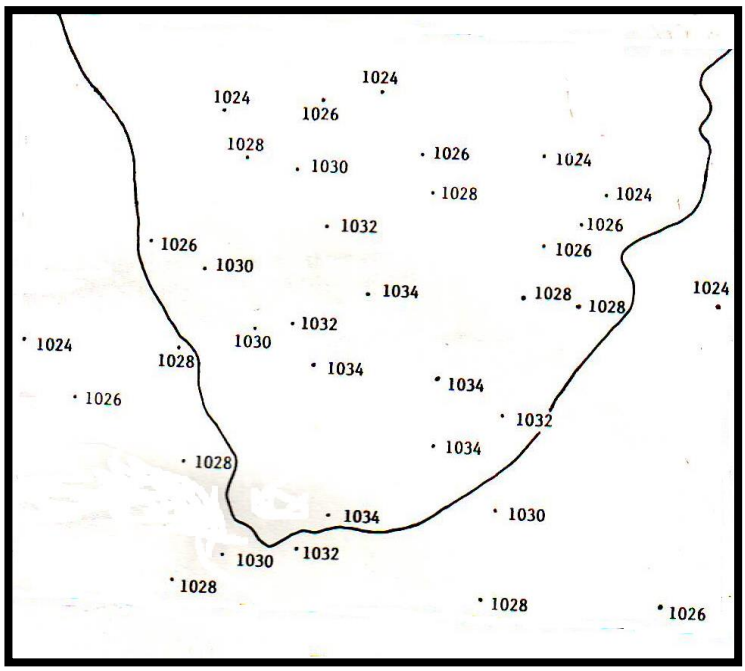
Describe the interpretation of isobars on a pressure map (3marks)

Mention three general characteristics of prevailing winds (3marks)

Suppose a high-pressure cell develops over Southern Africa from November to February. Describe the weather conditions that would be expected during the named months. (3marks)

Explain the importance of the development of the ITCZ over central Africa (2marks)

The figure below shows a modified pressure reading for Southern Africa. Use it to answer the questions that follow



a. Draw lines joining places with the same atmospheric pressure(3marks)
b. What are these isolines called? (1mark)
c.What would be the interpretation of the wind when these lines are close to each other (2marks)
d.On the map itself (i)Insert H over an area of high pressure (1mark)
(ii)An arrow to show the direction of wind (1mark)

THE PREVAILING WINDS

A prevailing wind is a wind which **blows more frequently from specific direction** in a particular area. Such winds rise due to the position of **high pressure belts** on the earth.

TYPES OF PREVAILING WINDS

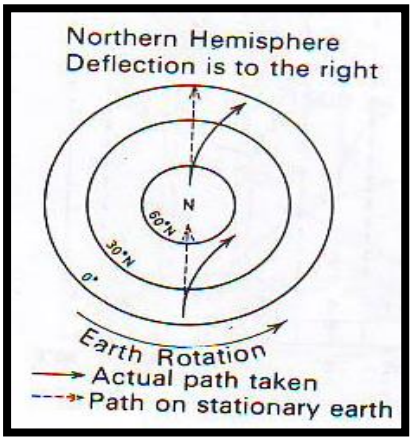
1. The polar winds
2. The westerly
3. The trade winds

The prevailing winds blow from **high pressure belts towards low pressure** belts and their direction is affected **by the rotation of the earth.**

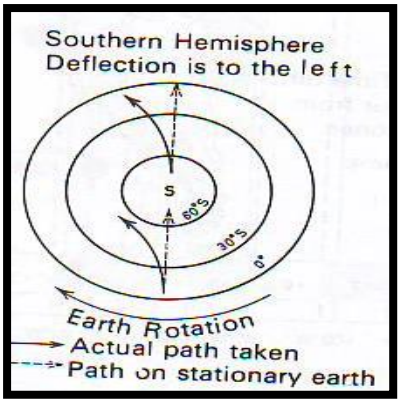
HOW DOES ROTATION OF THE EARTH AFFECT THE DIRECTION OF THE PREVAILING WINDS

The rotation of the earth causes freely moving water and air to be deflected from their original courses. This is summarised by **FERRELE'S LAW** which states that **freely moving bodies are deflected to the right in the northern hemisphere and to the left in the southern hemisphere from their normal courses**. With this, the effect of the rotation of the earth is **that it makes these winds to deflect** to the **right-hand** side in the northern hemisphere and to **the left-hand** side in the southern hemisphere. The **force** which makes winds to be deflected from their normal courses is called **CORIOLIS FORCE**. This force only exists when the earth is **rotating**.

DEFLECTION IN THE NORTHERN HEMISPHERE



DEFLECTION IN THE SOUTHERN HEMISPHERE



CHARACTERISTICS OF THE PREVAILING WINDS

1. **POLAR WINDS**

1. They blow from the **polar high-pressure belts** to temperate **low-pressure belts**.
2. They are better developed in the **southern hemisphere** than in the northern hemisphere. This is because **more part of the southern hemisphere is occupied by water than land**.
3. They are **deflected to the right to become the North East Polar winds** in the Northern hemisphere and to the left to become the **South East Polar winds** in the southern hemisphere.
4. They are **irregular** in the Northern hemisphere.

2. **WESTERLIES**

1. They blow form the **horse latitude high pressure** belts to **temperate low-pressure** belts.
2. They are **deflected to the right to become the south westerlies** in the northern hemisphere and to the left to **become the north westerlies** in the southern hemisphere.
3. They are variable in both **direction** and **strength**
4. They contain **depressions** or cyclones.

3. **THE TRADE WINDS**

1. They usually follow a **regular path** as the word **"trade" comes from the Saxon word "tredan"** which means to tread or follow **a regular path**.
2. They blow from the **horse latitudes high pressure** belts to **doldrums low pressure** belt.
3. They are **deflected to the right** to become the **North East trade** winds in the northern hemisphere and to the left to become the **South east trade winds** in the southern hemisphere.
4. They are very **constant in strength** and direction.

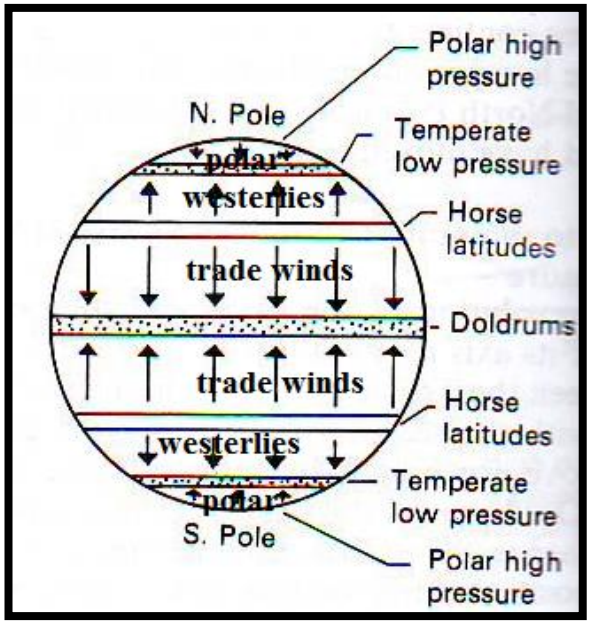
5. They sometimes contain **intense depressions or cyclones**.

HOW ARE PREVAILING WINDS INFLUENCED BY PRESSURE BELTS?

Prevailing winds **move from high pressure** belts and blow towards **low pressure belts**. With this, high pressure belts such as the Horse latitudes act as **zones of divergence** while as low-pressure belts such as the Doldrums act as **zones of convergence**.

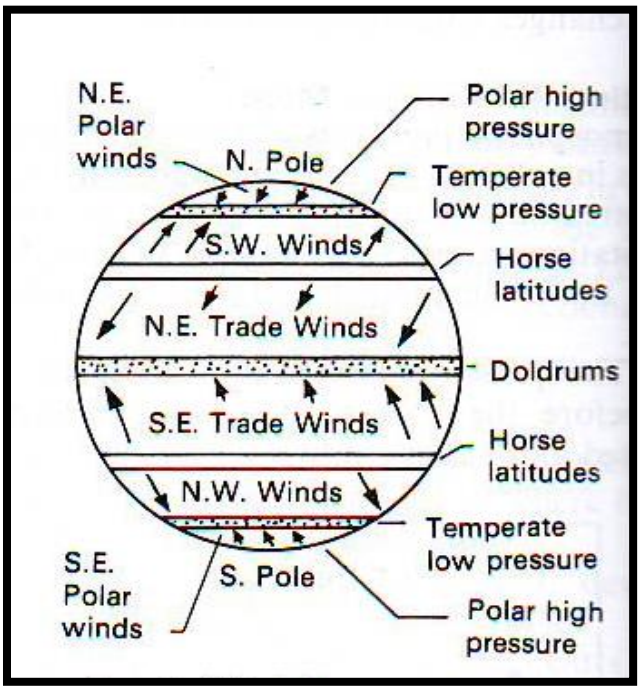
PATTERNS OF THE PREVAILING WINDS ON A NON-ROTATING GLOBE

On a non-rotating globe, prevailing winds take a **straight path without deflecting** either to the left or right. This is because on a non-rotating globe there is **no effect of Coriolis force** hence no deflection.

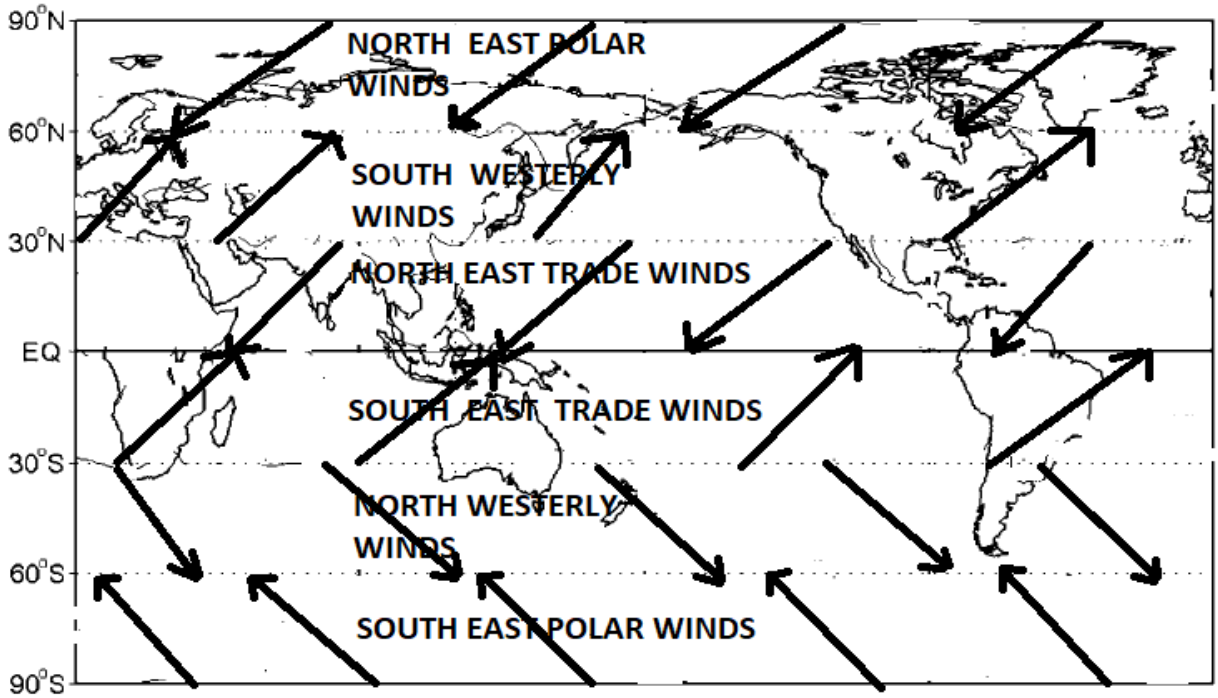


PATTERNS OF THE PREVAILING WINDS ON A ROTATING GLOBE

On a rotating globe, prevailing winds **deflect to the right in the northern hemisphere** and to **left in the left in the southern hemisphere due to the Coriolis force.**



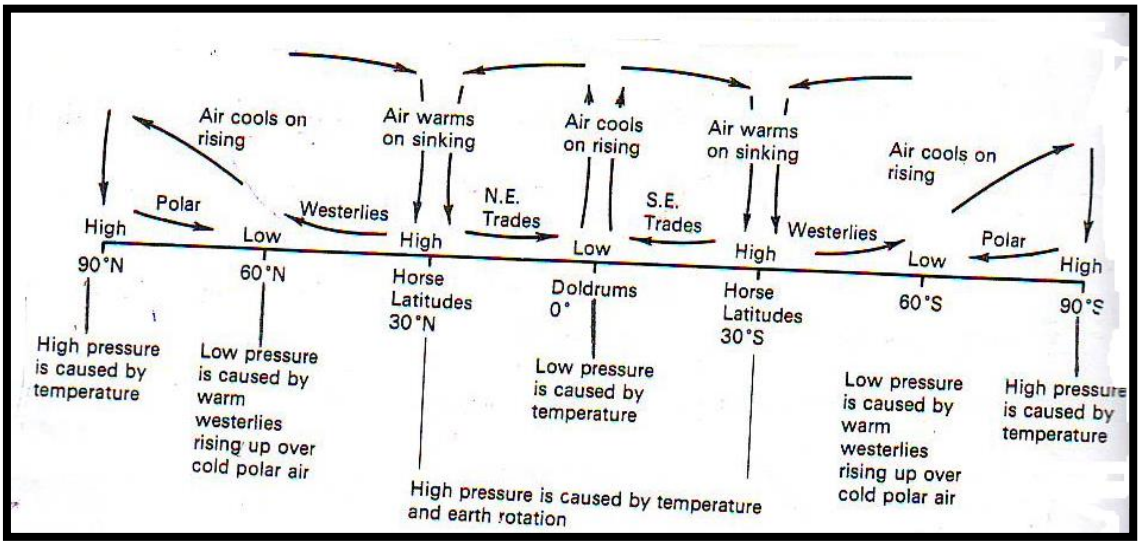
LOCATION OF PREVAILING WINDS ON MAP OF THE WORLD



GENERAL CHARACTERISTICS OF THE PREVAILING WINDS

1. They blow from **high pressure belts** towards **low pressure belts**.
2. They **deflect to the right in the northern hemisphere** and to the **left in the southern hemisphere.**
3. Some are **irregular in direction** and strength e.g. the polar winds.
4. Some **contain depressions or cyclones** e.g. the trade winds and the westerlies while others do not e.g. the polar winds.

A SIMPLIFIED VERSION OF PRESSURE BELTS AND AIR MOVEMENT



IMPORTANCE OF PREVAILING WINDS

1. Good **in air transport** when aeroplanes **move following the direction** of the prevailing winds arriving faster and cutting fuel expenses.

2. Help to **bring rainfall** to some areas. For example, trade winds bring **convectional rainfall** to the tropics while westerly and polar bring **frontal rainfall** to **temperate low-pressure areas.**

3. Help in **shipping transport** as ships the cheapest form of transport take advantage of such winds by sailing following their direction and **moving faster.**

PROBLEMS CREATED BY THE PREVAILING WINDS

1. Associated with **cyclones and depressions** which are very **destructive**, for example trade winds and westerlies.

2. **Slow down air transport** when aeroplanes move against them.

3. Create **high tides** and **strong currents** in oceans which apart from making **ships to delay**, pose a threat to shipping industry in terms of accidents thereby losing **goods** and **killing people**.

AIR MASSES

These are **large bodies of air** with similar **temperature** and **humidity** characteristics throughout.

FORMATION

These forms when air remains over a part of the earth's surface with **little movement** for some days where it tends to **get certain characteristics from that area** which affects **temperature** and **humidity**. Air masses form over **source regions**

SOURCE REGIONS. These are the areas where the mass of **air remains stationary** for a period of time, acting as **originating** places.

TYPES OF AIRMASSES

Air masses are classified based on the following:

1. Latitudinal position of the **source region.** This is in terms of whether an air mass originates from the **tropics** or the **polar region**. Examples such air masses include:

(i)Polar Air Mass (P) originating near the **Polar Regions**. Such air masses are **very cold**.

(ii)Arctic (A) or Antarctic (AA) Air mass: These air masses originate over the **cold Arctic** and **Antarctic** regions. They are also **very cold**.

(iii)Tropical Air masses. These originate from the **lower latitudes** near the equator and are **warm**.

2. The **nature** of the underlying surface, that is, whether **Continental** or **Maritime**. This affects the **humidity** of the air mass. Examples of such air masses include:

(i)**Continental (C) air masses**. These originate from the **land masses** and are generally **dry.**

(ii)**Maritime (M) air masses.** These originate from water **bodies,** that is, **seas** and **oceans** and are generally **very moist**.

The combination of the **two** classifications gives out **six types** of air masses

1. **Continental polar (cP)**

This moves from the **North Pole** over **northern Canada, Siberia** and **Alaska.** It is a **cold and dry air** mass, **holding no moisture**.

2. **Maritime polar (mP)**

Develop over cold **polar** of the Northern **Pacific**

As they pass over the ocean, they pick up moisture. It brings **heavy precipitation to the west coast**. As it moves east, it rises over the **Rockies** and loses its moisture. This moisture becomes **heavy snow** on the Rockies. It is also a **very cold air** mass.

3. **Maritime tropical (mT)**

Come from the tropical **waters of the Pacific, Atlantic and Gulf of Mexico**. It has high **humidity** and yield a lot of **precipitation.**

4. **Continental tropical (cT)**

It has its source region over **sub-tropical deserts of continents**. It is a hot and dry air mass with **low humidity, clear skies** which encourages **drought conditions**.

5. **Maritime equatorial (mE)**
Originates from the **warm oceans in the Equatorial zone**. It is **warm** and **very moist, and very unstable,** resulting into **heavy rainfall.**

6. **Continental Arctic (cA)** and continental **Antarctic (cAA)**
Originate in regions near **north and south poles.** The air masses are very **cold, very dry** in winter. These air masses are like Continental polar air masses. The only difference is that they originate over the **permanent ice cap** near the north or south poles.

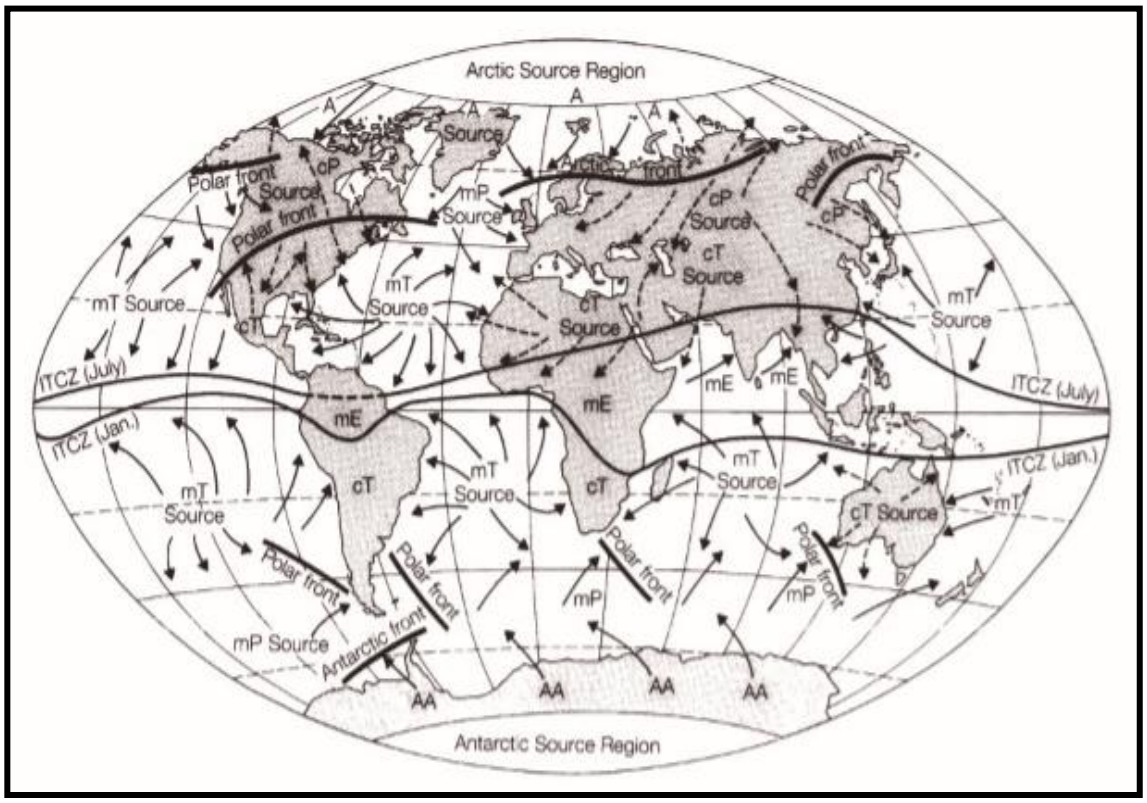
In terms of latitude, air masses that originate from the **tropical regions** or lower latitudes are called **tropical** e.g. tropical continental while those originating from the **higher latitudes** of polar regions are called **polar air masses** e.g. continental polar.

In terms of **humidity**, those air masses that originate from **water bodies** or oceans are **moist** and have **high humidity**. Such air masses bring **precipitation** to land masses e.g. maritime tropical while those air masses that originate from the **interiors** of continents are usually **dry** with **low humidity** there by not bringing **precipitation** e.g. tropical continental.

THE TABLE BELOW IS A SUMMARY OF TYPES OF AIR MASSES, SOURCES AND PROPERTIES OR CHARACTERISTICS

MAJOR GROUP	**SUB-GROUP**	**SOURCE REGIONS**	**PROPERTIES AT SOURCES**
Polar (P)	Maritime polar **(mP)**	Oceans of North Pacific pole ward	Cool, rather damp or moist unstable
	Continental polar **(cP)**	Continents in vicinity of Arctic circle and Antarctic	Cold and dry, very stable
	Arctic (A) or Antarctic **(AA)**	Polar regions, north and south poles	Very cold, dry and stable
Tropical (T)	Maritime tropical **(mT)**	Warm trade wind belt and sub-tropical oceans	Moist and warm
	Continental tropical **(cT)**	Low altitude deserts, chiefly Sahara and Australian deserts	Hot and very dry
	Maritime equatorial **(mE)**	Warm oceans in equatorial zone	Warm, moist

MAP OF THE WORLD SHOWING AIR MASSES



HOW THE AIRMASSES INFLUENCE THE WEATHER OF AFRICAN CONTINENT

The continent is affected by the **Maritime Tropical (mT)** air mass and **maritime equatorial (mE)** air mass. These originate from the **Atlantic** and **Indian Oceans** and bring **heavy rainfall** to the continent. The continent is also affected by the **tropical continental** air mass originating from the Sahara, Namib and Kalahari deserts. These bring **dry conditions** as they do not have moisture.

STABILITY AND INSTABLITY OR UNSTABLITY OF AIRMASS

STABLE AIR MASS. These are air masses **which fail to rise further** and instead they **sink back** to the ground. Air masses fail to rise because **its temperature is lower than that of the surrounding.** This makes it to be **denser or heavier** thereby failing to rise.

Stable air masses **do not produce convectional rainfall** because **it does not rise high enough** to rise with moisture and reach the **condensation level**.

UNSTABLE AIRMASS. This is the air mass that **continues to rise higher** as its temperature is higher than the surrounding therefore **less dense**. The air mass yields **heavy rainfall** and **thunderstorms**. This because as the air mass rises it **accumulates moisture** which then reaches the **condensation level**.

Key words

Source area, stable air mass, unstable air mass, air mass

Sample questions

Define the term air mass (2marks)

How are air masses classified? (2marks)

Give any two examples of air masses (2marks)

With the aid of a well labelled diagram, describe what happens when two air masses of different temperatures meet.
Explain how latitude and humidity help to classify air masses (3marks)
Describe the characteristics of the following air masses
(i) Maritime polar (2marks)
(ii)Tropical continental (2marks)
Define stable air mass (2marks)
Why is an unstable air masses associated with heavy rainfall (3marks)

FRONTS

A front is a **boundary** separating **two different air masses.**

FORMATION OF FRONTS

Fronts form when one kind **of air mass enters an area occupied by another air mass**. Cold air and warm air masses do not mix easily because they have different **temperatures** making them to have **different densities.**

TYPES OF FRONTS AND THEIR CHARACTERISTICS

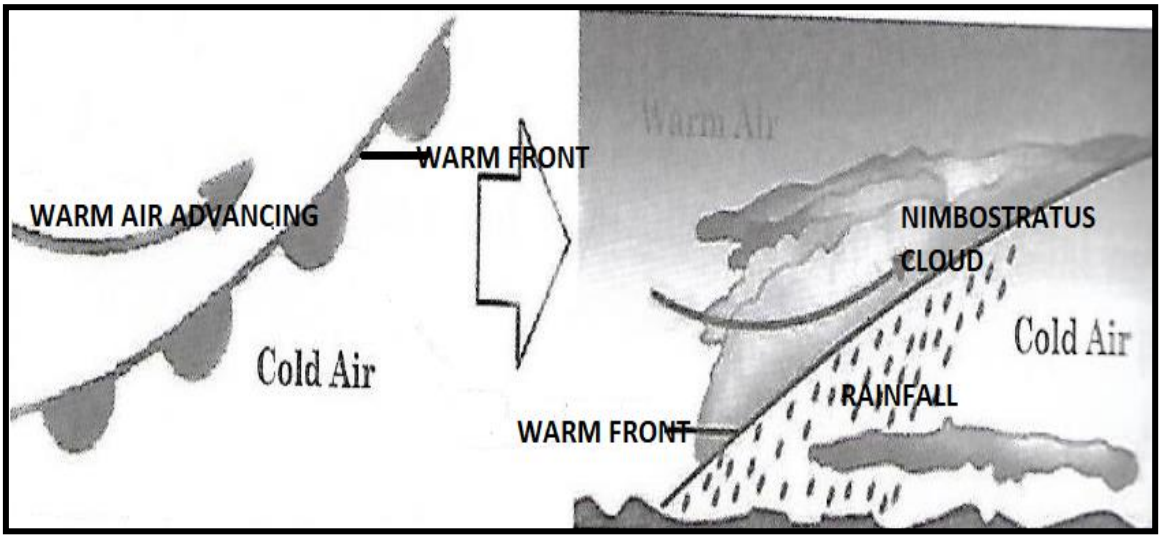
1. Warm front
2. Cold front
3. Occluded front
4. Stationary front

1. **WARM FRONT**

This is a boundary formed along **a warm air mass that is pushing out a cold air mass**. It is formed when a **warm mass of air pushes out into a colder air mass**, making the warm air to move up over the cold air as warm air is lighter and cold air is dense. It is represented by **semi circles extending** to the direction towards which the front is moving.

WEATHER CHARACTERITICS ASSOCIATED WITH A WARM FRONT

1. Brings warm air which makes **temperatures to increase**.
2. There is a **drop-in air pressure** determined by a fall in barometric reading.
3. Associated with more **extensive nimbostratus clouds** and **precipitation** particularly frontal rainfall
4. A change in the **direction of wind**.



2. **COLD FRONT**

This is the type of front formed when **a colder and denser air mass move towards and invades a zone occupied by a warm air mass**. It is **faster** and **heavier** than a warm front. It is presented by solid **triangles extending** to the direction where the front is going.

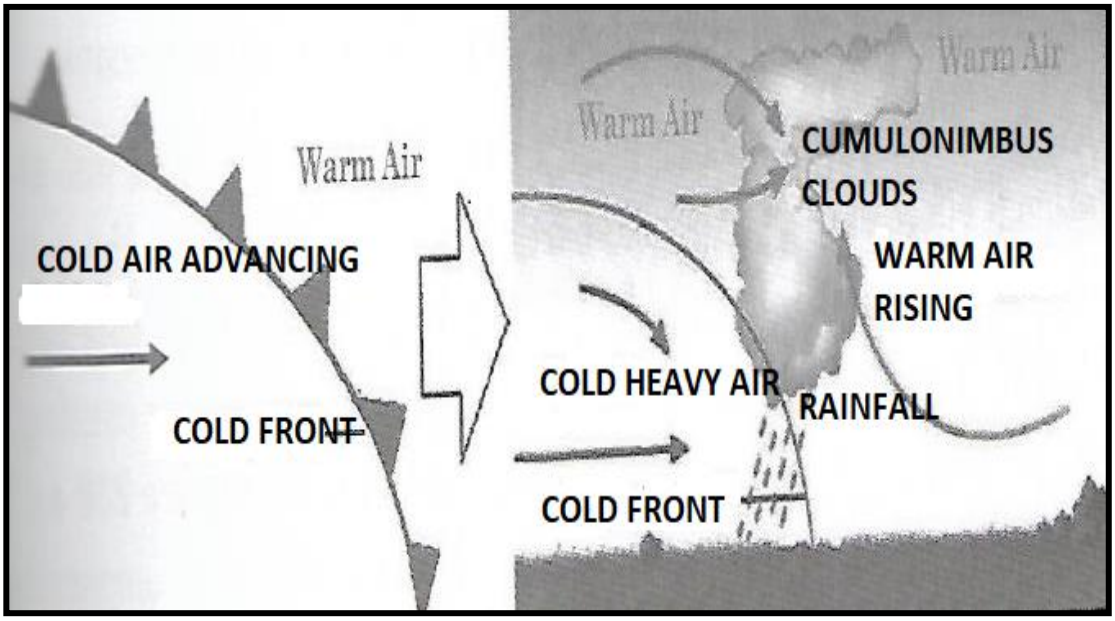
WEATHER CHARACTERISTICS ASSOCIATED WITH A COLD FRONT

1. Brings cold air which decreases the temperature.

2. A decrease in humidity as cold air does not contain as much moisture as warm air.

3. It lifts warm air resulting into the formation of **cumulonimbus** clouds bringing **heavy rainfall** accompanied by thunder and lightning.

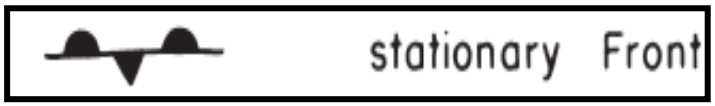
4.There is a change in the **direction of winds** called wind shifts through **backing**, that is, changing to the **left** in the Southern hemisphere and **veering**, that is, changing it to the **right** in the Northern hemisphere.



3. **STATIONARY FRONT**

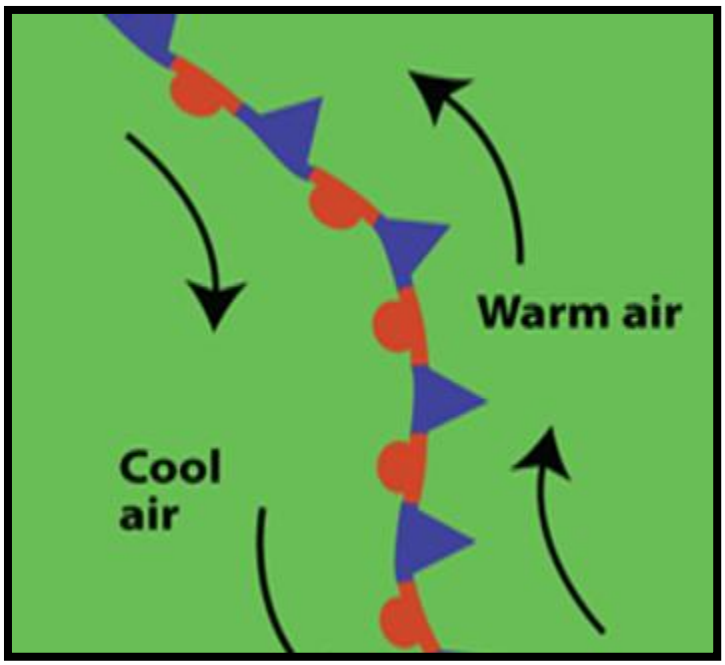
This is a boundary formed **when two air masses remain over a region for several days**. This happens when two masses of air are **pushing against** each other. Neither air mass **displaces the other**.

Stationary fronts are portrayed on a weather map by **a combination of warm and cold front** symbols **alternating on the opposite sides**.



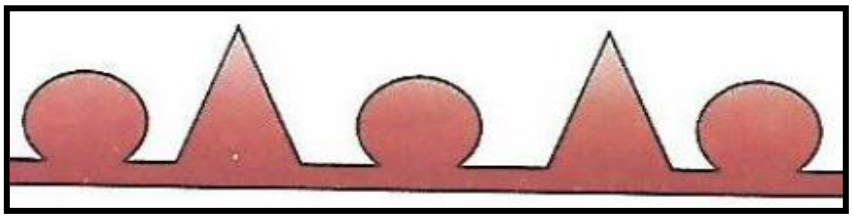
WEATHER CHARACTERISTICS ASSOCIATED WITH A STATIONARY FRONT

Along steady rain or snow which is followed by changes in the direction of wind and then clearing of the sky.



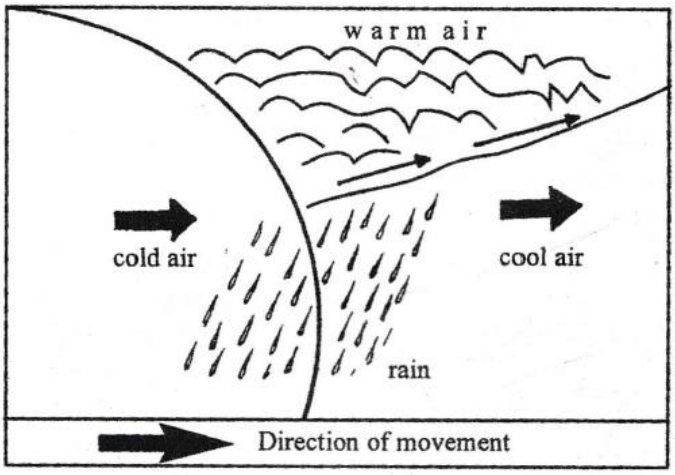
4. **OCCLUDED FRONT**

This is formed when a **cold front overtakes a slower moving warm front**, lifting it completely off the surface. It happens when a cold front follows right behind a warm front. Because cold fronts move faster, the cold front overtakes the warm front. It is shown on a weather map by **a combination of a warm and cold front symbols** but **alternating on the same side of the line**.



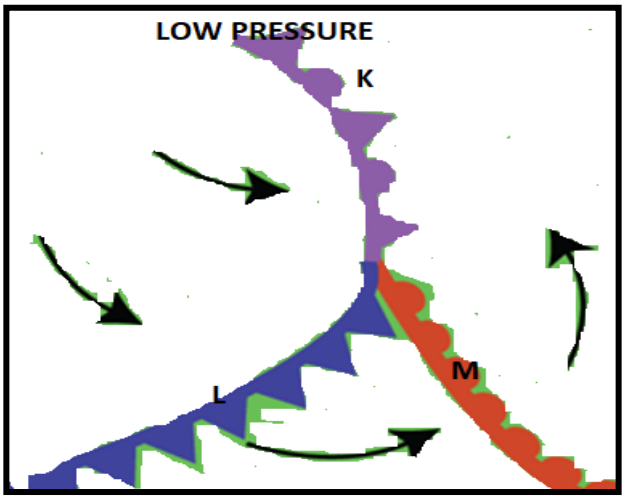
There are two types of occlusions

(i)The **cold occlusion** which happens when the overtaking **cold air** has some **cold air in front** after lifting the warm air



(ii)The **Warm occlusion** happens when the overtaking cold air has some **warm air in front** after lifting the warm air.

Sample questions
Define the term front (2marks)
Describe the following types of fronts
(i)Warm front (3marks)
(ii)Cold front (3marks)
What is the difference an occluded front and a stationary front (2marks)
The figure below shows some fronts. Study it and answer the questions that follow



(i)Identify the type of fronts marked K and L (2marks)
(ii)Explain any two conditions associated with the type of front marked M (4marks)

LOCAL WINDS

A local wind is a wind which is a **characteristic** of a particular place or area.
Local winds affect **only limited areas** and blow for a **short period of time**. Local winds are given **local names** in areas where they blow.

EXAMPLES OF LOCAL WINDS

- Chiperon
- Chinook
- Sirocco
- Berg

- Harmaltan
- Fohn
- Pampero
- Zonda
- Santa Ana

GENERAL CHARACTERISTICS OF LOCAL WINDS

- They have **local names** from the areas they blow e.g. Chinook
- They affect **small areas.**
- They blow for **a short period** of time.
- Are caused by **immediate influence of the surrounding topographical** features such as deserts, mountains and seas.
- Some are regarded **as doctor winds** as they help to **moderate or change the weather conditions** in certain areas. For example, Harmattan winds in West Africa affecting Guinea Coast.

TYPES AND CHARACTERISTICS OF LOCAL WINDS

A. HOT WINDS

These are **hot** and **dusty**

Always emerge from the **deserts**

If they cross an area of sea surface, they become **humid.**

EXAMPLES OF HOT LOCAL AND AREAS WHERE THEY BLOW

Santa Ana ⟶ North America

Zonda ⟶ South America

Sirocco, Leveche, Khamsin, Harmattan ⟶ North Africa

Brickfielder ⟶ Australia

B. COLD LOCAL WINDS

These are very **strong**

They are **gusty**

They are **bitterly cold**

EXAMPLES OF COLD LOCAL WINDS AND AREAS WHERE THEY EXIST

Pampero ⟶ South America

Bora, Mistral ⟶ Europe

Southerly Burster ⟶ Australia

C. DESCENDING LOCAL WINDS

These are warm winds which **descend from mountain slopes** on to the lowlands after condensation, if such winds cross a sea surface, they bring rainfall to the side of the mountain facing the winds i.e. the wind ward side. When the air descends, they become warm and dry.

EXAMPLES OF DESCENDING LOCAL WINDS AND AREAS WHERE THEY EXIST

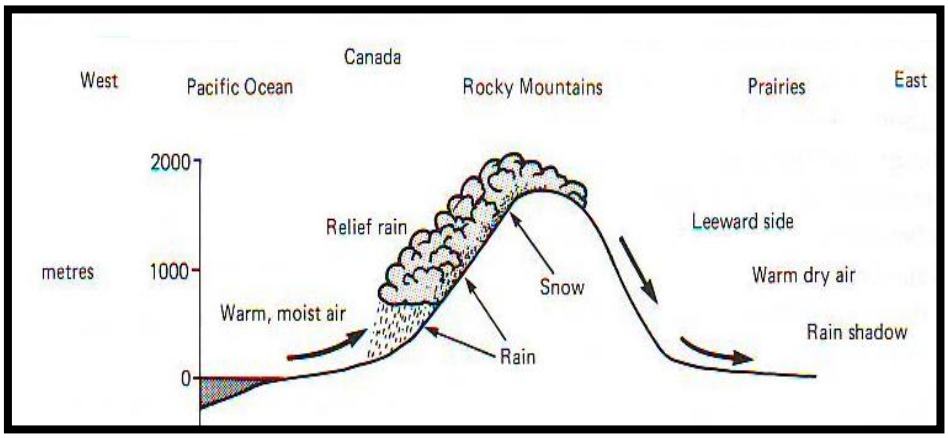
Berg -- South Africa descending from the **Drakensberg** mountains

The Fohn winds – Switzerland descending the **Alps.** Helps **to melt snow** for the growth of **pasture in Switzerland.**

The Chiperon winds – result from the South East trade winds which become the chiperon after descending the chiperon highlands in Mozambique. They affect Malawi in **cold dry season** bringing drizzles (rain showers) with very low temperatures.

The Chinook winds – North America descending in the **Rocky Mountains.**

1.THE CHINOOK



The wind originates from the **Pacific Ocean** and descends the eastern slopes of the **Rocky Mountains** in **North America** towards Canada in **Winter** and **Spring**. They are called the **SNOW EATER** because the **winds help to melt snow which is important for wheat cultivation in the Prairies.** The melted snow also **provides moisture for grass** or pasture to grow for animals.

EFFECTS OF THE CHINOOK WINDS

1. The wind becomes warm and dry in the Eastern side and helps to melt up **snow** in Winter, hence the name ***snow eater.*** This snow helps in **the cultivation of wheat** and the growth of **pasture for animals in the Leeward side of the Eastern part of the Rockies.**
2. The Chinook winds bring **relief rainfall** to the **windward** side of the **Rocky Mountains** where the winds are **warm and moist** from the **Pacific Ocean.**

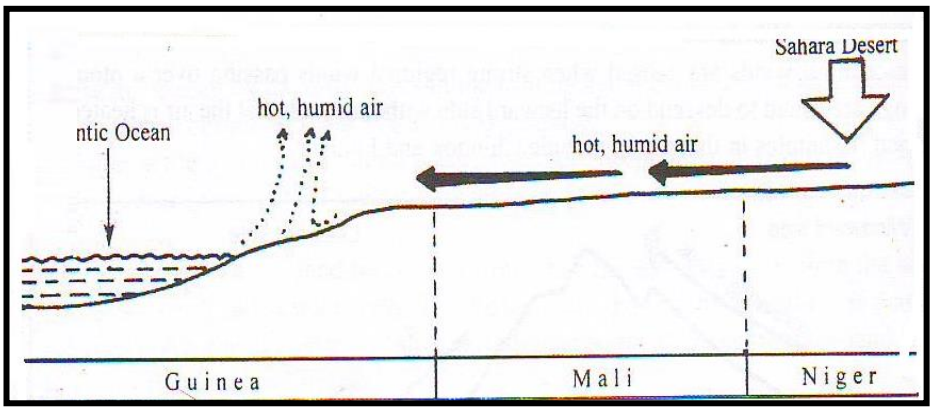
2. THE HARMATTAN WINDS

A **hot**, very **dry** and **dusty** wind rising from the **Sahara Desert** and blowing towards **West Africa.** The most affected countries are **Ghana, Cameroon**, **Niger, Mali, Nigeria, IvoryCoast** and **Guinea**.

EFFECTS OF THE HARMATTAN WINDS

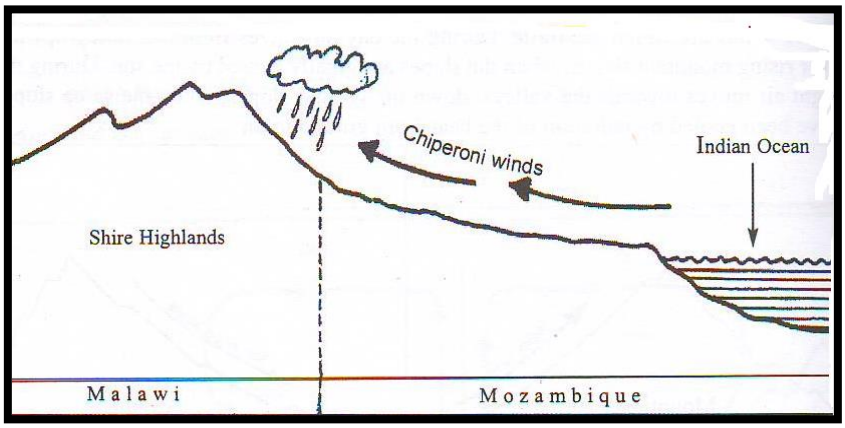
1. To some countries like Ghana and Nigeria the **wind destroys some crops** e.g. **cocoa** by removing them from the branches

2. Brings **hot air** that helps in the **evaporation** and hence helps to **bring rainfall** to the coastal countries like Guinea. Due to this influence of encouraging evaporation which results into rainfall, the wind is regarded as **Doctor Wind**.



3. **THE CHIPERONE WINDS**

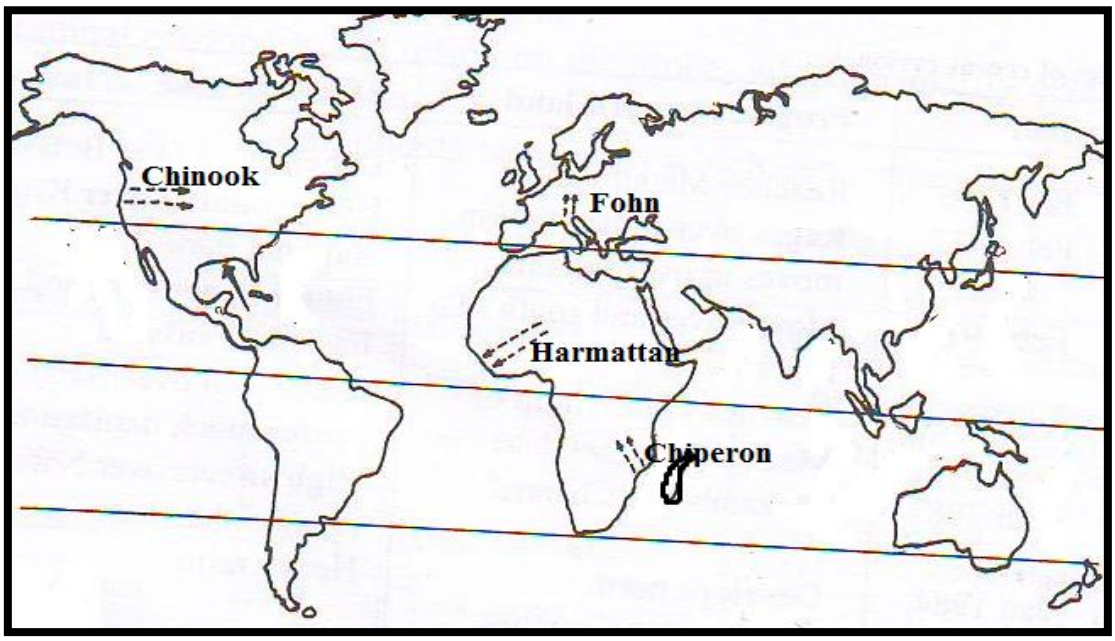
Caused by the development of a **low pressure** and the **ITCZ** in the **northern hemisphere** in the months of **May to August** (cool and dry season in Malawi) The wind is a branch of the **South East trade winds** from the Indian ocean, which after crossing the **Chiperone highlands in Mozambique** it becomes the Chiperone winds in Malawi. It is a **warm and moist wind**. The affected countries are **Malawi**, **Mozambique** and a small part of **Zambia.** In Malawi, it affects Shire Highlands, that is, Mulanje, Thyolo, and Blantyre and many parts of the Southern Malawi.



EFFECTS OF THE CHIPERONE WINDS IN MALAWI

1. Very low persistent clouds called **stratus** which is associated with some showers.
2. **Drizzles** which is a condition of very low temperatures accompanied by little rainfall.
3. The rise of ***Mwera*** winds over Lake Malawi.

NAMES AND PLACES OF SOME LOCAL WINDS IN THE WORLD



OCCURRENCE OF LAND AND SEA BREEZES

Land and water surfaces have quite different properties in absorption and radiation of heat.

Land surfaces are rapidly and intensely heated under the sun's rays because:

- The land does not move
- Molecules are close together which help to transfer heat faster

Water surfaces are only slowly and moderately heated because:

- The water moves inform of waves which affects the distribution of heat
- The sun light rays struggle to reach the deeper parts of water
- Molecules of water are far apart compared to land and this affects the transfer of heat.

Land again cools off (loses heat) faster and reach lower temperature than water.

BREEZE: it **is a gently blowing wind**. Land and sea breezes deal with the **circulation of air from the land or the sea depending on temperature and pressure.**

Breeze gets its name **from the area it blows.**

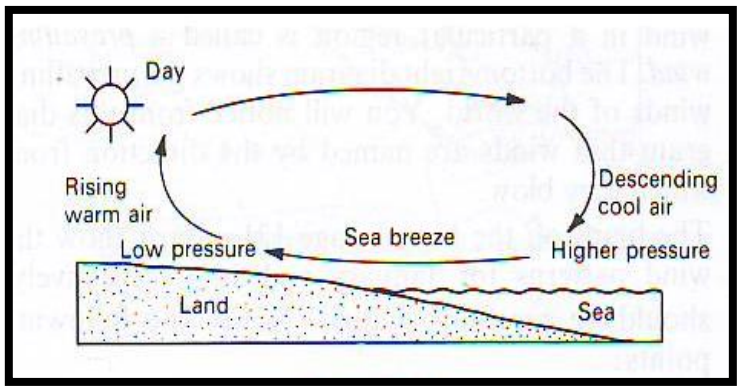
A. SEA BREEZE

This is the movement **of the air from the sea to the land which happens during day time.**

It happens during the day time because the land **gets warmer** since it absorbs heat faster than the sea. This means a **high pressure** develops over the **sea** while a **low pressure** over the land. This in turn makes the air to blow **from the sea which is a high-pressure region towards the land which is a low-pressure area.**

There is a circulation of air because as the land is heated **up air rises on the land**. This makes the air from the sea **to take the place of rising air on the land**. The rising air over land meets cooler layers in the atmosphere since temperature decreases with height. This makes such **air to become cold** and **descends** over the sea.

DIAGRAM OF A SEA BREEZE



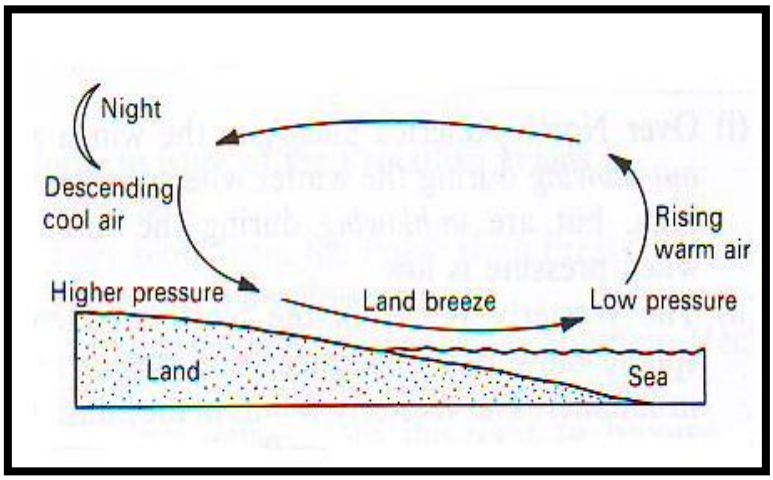
B. LAND BREEZE

This is the movement of **air from the land to the sea which happens at night**.

It happens at night because **the land cools more quickly than the sea**. This makes a **high pressure** to develop over the **land** and a **low pressure** over the **sea** making air to move **from the land, a high-pressure area to the sea, a low-pressure area.**

As the temperature is high over the sea, warm air starts rising whose place is taken by the air form the land. The rising air form the sea meets colder layers in the atmosphere making it to cool and descend over the land thereby completing the circulation.

A DIAGRAM OF A LAND BREEZE



EFFECTS OF LAND AND SEA BREEZES ON LOCAL WEATHER AND HUMAN ACTIVITIES

1. Help to **bring rainfall** to the coastal areas due to the moisture collected from the sea when forced to rise above a mountain barrier.
2. Help to **lower the temperature** of coastal areas especially during summer making people to use such places as **recreation centres.** That's why people go to the lake in summer to enjoy a breeze during the day.
3. In the tropics, breezes **assist fishermen to sail with them to the lake or back from the lake** to the land without problems since they are following the **direction of the breeze**.

IMPORTANCE OF LOCAL WINDS

1. Affect the **movements of pollutants** such as fumes far away from their sources.
2. They moderate or change the **unhealthy or unpleasant** weather conditions of certain places hence are called ***doctor winds*** e.g. Chinook and Harmattan

DIFFERENCES BETWEEN LOCAL WINDS AND PREVAILING WINDS

1. Local winds are caused by the **immediate influence of the surrounding topography** while as prevailing winds rise or are caused **by pressure belts.**
2. Local winds **affect small areas** hence **local** while prevailing winds affect **very large areas**.
3. Local winds **have local names** from areas where they exist while as prevailing winds have **global names.**

NOTE:**Katabatic winds**. These move from uplands to lowlands while **Anabatic winds** move from valley or lowlands to uplands areas.

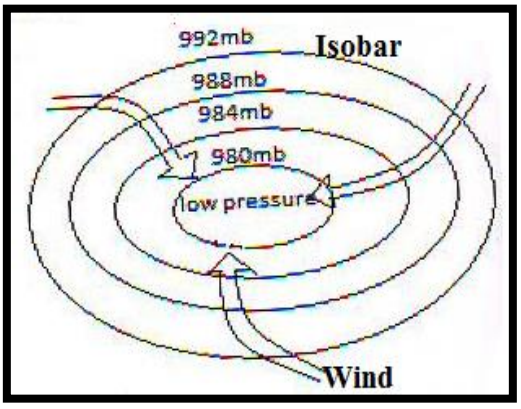
SAMPLE QUESTIONS

Locate the following local winds on a map (i) Chiperon (ii) Chinook (iii) Fohn (iv) Harmattan (2marks)
Why local winds are called *doctor winds (3marks)*
Describe any two characteristics of local winds (4marks)
Describe the occurrence of sea breezes (4marks)
Explain any two effects of land and sea breezes on human activities (4marks)
In what way are the Chinook winds a blessing in an area where they exist? (3marks)
Explain the importance of prevailing winds in (i) agriculture (ii) transport (2marks each)

CYCLONES AND ANTICYCLONES

A. CYCLONES OR DEPRESSIONS

A cyclone **is an area of low pressure system of air whose shape of isobars on a map is oval or circular.** The pressure is **low at the centre** and increases towards **outside.** With this wind blow form **outside going towards the centre where there is a low pressure.**



Cyclones or depressions are also referred **to as zones of convergence** as air converge inside from outside. In a cyclone, pressure gradient becomes **very steep which contributes to great pressure changes within a small area.** This causes winds to tremendous force of approximately 120-280Km/hr. The high winds cycle the centre in a **swirling motion.**

LATITUDINAL AREAS WHERE CYCLONES DEVELOP

Mostly develop in maritime, areas of two:

a. Temperate latitudes of **60°N and 60°S** in the belt of westerly winds.
b. In the tropics between **0° to 30° N and South** of the equator in the belt of trade winds.

REASON FOR THE DEVELOPMENT OF CYCLONES IN SUCH AREAS

In such places **humid tropical air meets cold polar air since cyclones** develop due to the mixing up of cold air from Polar Regions and hot air from the tropics.

Cyclones do not develop near the **equator,** that is, between **0^0 to 5^0** North or South of the equator. This is because in such areas the **Coriolis force is very weak** to bring **deflection of winds**.

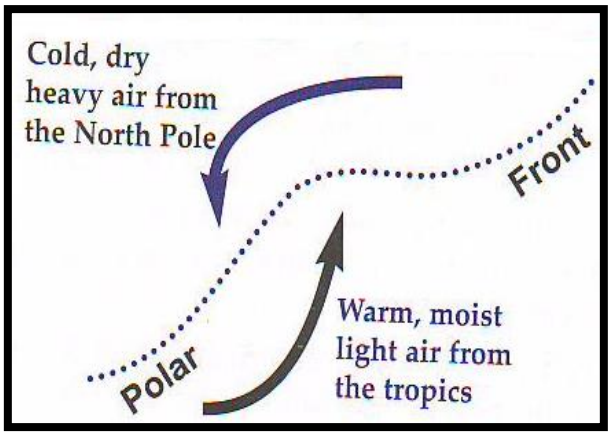
They do not form in the **higher latitudes such as Polar Regions** because the seas or oceans there are **not warm enough** since they don't have a **lot of warm air** so as to reduce the pressure.

HOW DO CYCLONES DEVELOP

The development of a cyclone occurs in **stages.**

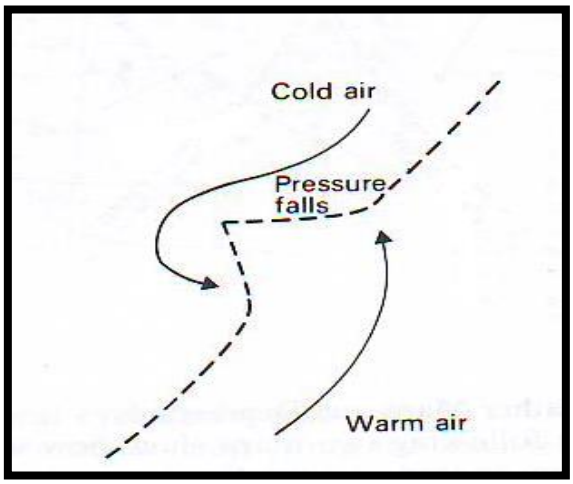
STAGE 1: BIRTH

Cold air moves in **westerly direction** from the polar areas. Warm tropical air moves in **easterly** direction towards the polar region.



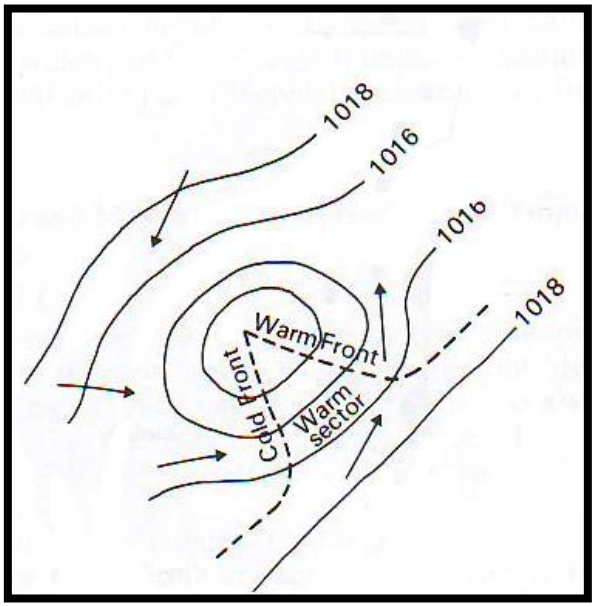
STAGE 2: YOUTH

The **frictional force** of the two different air masses causes a **wave** to develop. The wave bulges into colder air as it is heavier and gets larger. The pressure in between then falls.



STAGE 3: MATURITY

The **bulge develops** with warm air rising over cold air. A warm front is developed by the tropical air while the cold front by the cold air. The **warm parcel of air that develops between the two fronts** is called the **WARM SECTOR.**

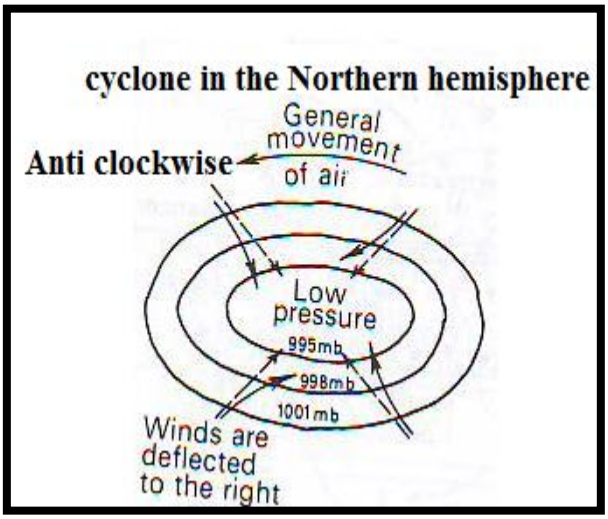


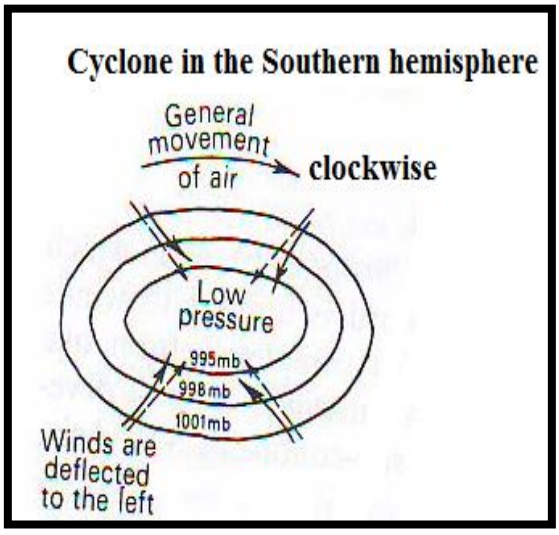
STAGE 4: OLD AGE AND DEATH

The last stage in which the cold front replaces the warm sector, temperatures even out and the front disappears, and the depression dies, sometimes often covering an area of about 240-800 Km or even more.

CHARACTERISTICS OF CYCLONES

1. Are well developed in the **westerly** winds and sometimes in the **trade** winds.
2. Are rarely stationary and tend to **follow definite tracks** usually in an **easterly direction**
3. Most often found in **maritime** areas because they are **weakened over land masses**.
4. Are associated with **cloudy conditions** and continuous rains as the **moist air** converge and rise.
5. The circulation of wind is in an **ant clockwise** direction in the northern hemisphere and clockwise in the southern hemisphere.





The approach of a cyclone is characterised by a fall in the barometric reading, dull sky, oppressive air and strong winds accompanied by rain.

TYPES OF CYCLONES/DEPRESSIONS

Basically there are two types:

1. Tropical cyclones
2. Temperate cyclones

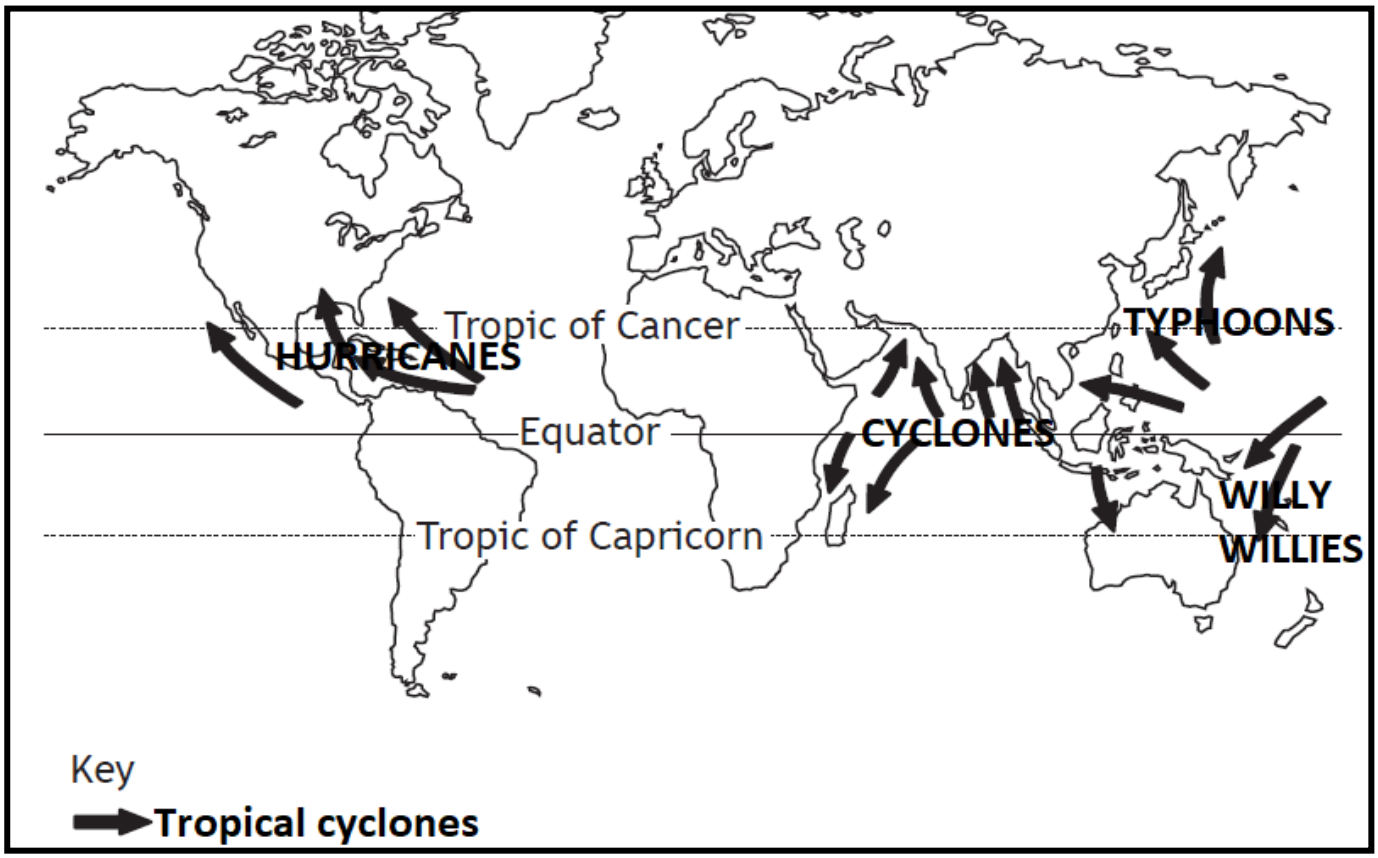
1. TROPICAL CYCLONES

- ✓ Arise in the belt of **trade winds**.
- ✓ Give rise to **winds of great force** which are extremely **destructive or violent** in nature.

Tropical cyclones are known by various names in areas where they occur

i. In **Asia** they are called **TYPHOONS**
ii. In **west Indies** they are called **HURRICANES**
iii. Off the coast of **Queensland- Australia** they are called **WILLY WILLIES**
iv. In **Indian Ocean around Madagascar** and off the coast of Mozambique they are just called **CYCLONES.**

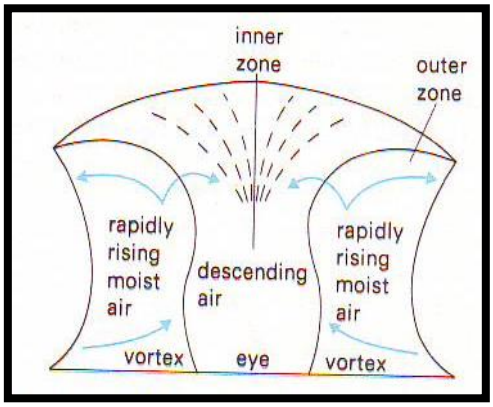
LOCATION TROPICAL CYCLONES



PARTS OF A TROPICAL CYCLONE

It has the following important parts:

a) **EYE:** the central part of it which is a very calm area
b) **VOLTEX:** on both sides of an eye. This is where the **air rises and is a very turbulent** part where the air **swirls** around an eye.



GENERAL WEATHER CONDITIONS ASSOCIATED WITH TROPICAL CYCLONES

1. Development of **cumulonimbus** and nimbostratus clouds.
2. Occurrence of **heavy rainfall.**
3. Occurrence of violet or **strong winds**.
4. **Calm conditions** that occur when the warm sector arrives.

EFFECTS OF TROPICAL CYCLONES

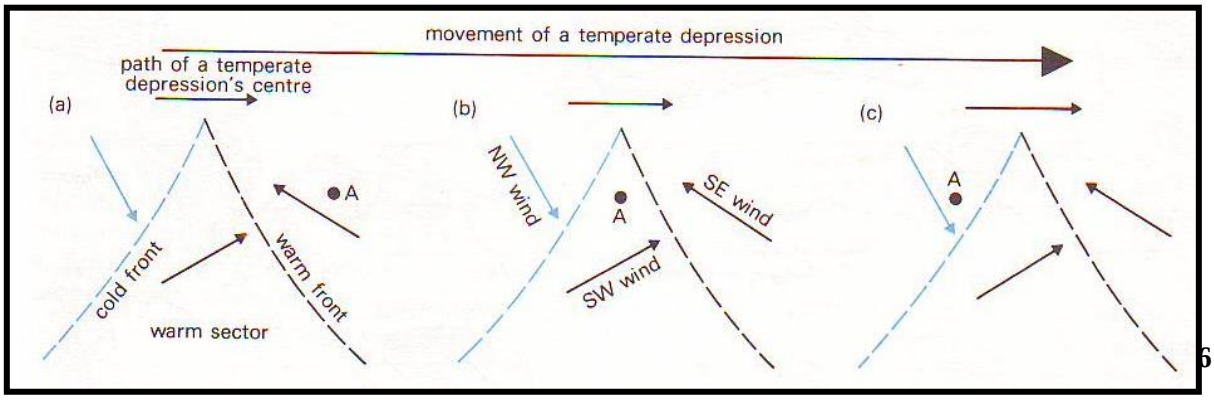
1. Coastal destruction by storm waves and **very high tides** due to the development of a low pressure. Water is pushed towards the coast by strong winds in a **storm surge** causing destruction to **settlements.**
2. High rate of **flooding** due to **torrential rains**. These cause loss of **life** and **property**.
3. Associated with **strong winds** which blow off roofs **of buildings** and destroy **infrastructure** and **power lines.**
4. **Landslides** because of **torrential rains**. These bury life and property especially houses, roads, railways disrupting even transportation of people and goods between two points.
5. An appeal for **relief items** such as food, tents, and money from some other countries and international organisations.

2. TEMPERATE CYCLONES

- Arise in the belt of **westerly winds** usually bring prolonged rain to coastal regions and often very windy weather.
- These are mild not all that very violent. In North America they are called **TORNADOES**

WEATHER ASSOCIATED WITH TEMPERATE CYCLONES

This happens **before and after a cyclone has passed a certain place**. Different **weather conditions** are experienced. The diagram below illustrates the weather conditions before and after a cyclone passes over a place taken as **A.**



a. This happens **before the warm front reaches and passes a certain place**. Thus, at **A** there will be the following weather conditions:
   1) They sky will be clear except for a little high wispy cirrus clouds
   2) The wind blow from south east

b. This happens when **the warm front passes over a place making the place A** to be in a warm sector. The following weather conditions are experienced:
   1) A lot of rainfall which then stops with the wind changing direction from south east to south west.
   2) Temperature rises, and the air is humid because the warm sector lies over **A**

c. The **cold front then passes** over the place.
   1) The weather changes rapidly as the wind blows from North west, temperature falls, and showers may be experienced.
   2) The sky clears an it remains cool.

NOTE: when the cold front tends to overtake the warm front so that it becomes an **occluded front**, the cyclones also **dies**.

GENERAL WEATHER CONDITIONS ASSOCIATED WITH TEMPERATE CYCLONES

1. **Clear sky** except for a little cirrus clouds
2. Wind blows from **South east** to South west.
3. Some **cloud** cover.
4. Light showers which progress into **heavy rainfall**.

DIFFERENCES BETWEEN TROPICAL CYCLONES AND TEMPERATE CYCLONES

1. Tropical cyclones develop **between 5^0 to 10^0 north or south** of the equator while temperate cyclones develop along **60^0 north or south** of the equator.
2. Tropical cyclones **cover small areas** while temperate cyclones **cover large areas**.
3. Tropical cyclones move in a **westerly direction** whiles as temperate cyclones move in an **easterly direction.**
4. Tropical cyclones develop in the belt of **trade winds** while as temperate cyclones in the belt of **westerly winds**.

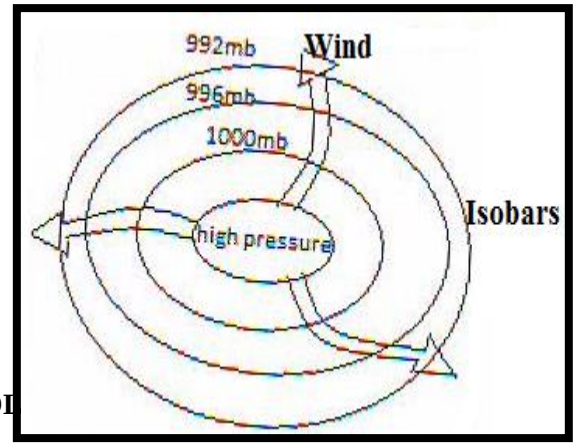
HOW DO TROPICAL CYCLONES AFFECT THE CLIMATE OF MALAWI?

Malawi is affected by the cyclones from the **Indian Ocean**. This happens between December and February. The cyclones **bring heavy rainfall, accompanied by very strong winds over Malawi after passing through Mozambique. Such rainfall results into floods which destroy a lot of property in Malawi.**

B. ANTICYCLONES

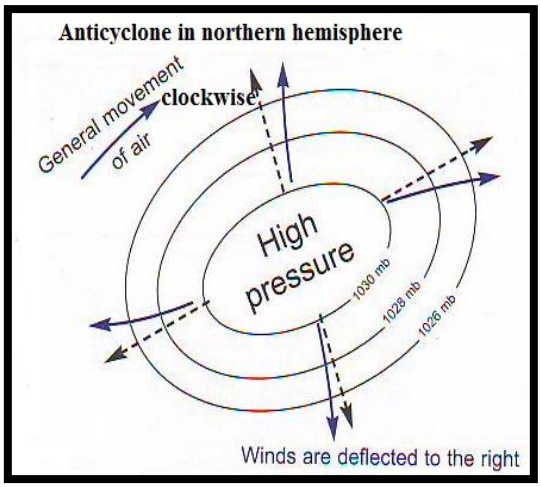
This is an **area of high pressure at the centre** which when shown on a map, has an oval or circular shape of closed isobars.

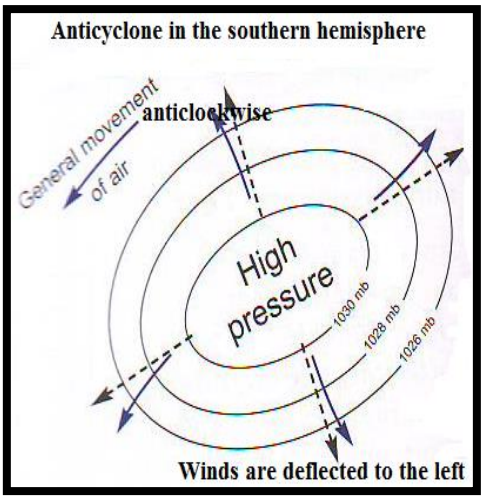
Since the high pressure is at the centre, **decreasing towards outside, wind blows from inside and goes out.** The pressure gradient is gentle, and winds are light.



CHARACTERISTICS OF ANTICYCLONES

1. They **remain stationary for a long period,** sometimes moves very slowly.
2. They often **affect the whole land mass or continents**. They affect weather over a whole continent since they cover a larger area.
3. Are associated with **clear skies and fine weather since descending air** is compressed and warmed, making cloud formation and precipitation to be unlikely. Therefore, anticyclones are also referred to as **zones of divergence**.
4. Winds move **in a clockwise direction in the northern hemisphere** and in an **anticlockwise direction in the southern hemisphere.**





CLOUDS

Clouds are **collections** of minute or **tiny visible water droplets** or tiny crystals floating in the sky.
Clouds are **collections of water vapour onto the dust particles** in the atmosphere.

DEVELOPMENT OR FORMATION OF CLOUDS

Vapour from the heated water and vegetation rises with the help of air currents.
When the rising moisture reaches the **condensation point** or **dew point** it cools and condenses around dust particles, salt particles and smoke which act as **condensation nuclei**. Far below the dew point make ice crystals to be formed. Therefore, cloud formation is related to the **hydrological cycle** in which the **moisture** released from **vegetation**, **land** and **water bodies** move to the atmosphere with the help of winds. After reaching the **dew point**, clouds are formed. When such clouds are heavy, they come down inform of precipitation.

TYPES OF CLOUDS

Clouds are classified according to

1. **Appearance, form or shape** of the clouds which looks at how the clouds appear in the sky. For example, some clouds are globular.
2. **Altitude** or **Height** above sea level. This results into high clouds, middle clouds, low clouds and clouds of great vertical extent.

3. **Weather conditions** associated with the cloud. Some clouds are associated with **clear skies** and **fine weather** while others like cumulonimbus are associated with **heavy rainfall**. Clouds with ***nimb*** in their name are associated with rainfall, for example, nimbostratus

(1) **ACCORDING TO APPEARANCE, FORM OR SHAPE**

1. **Layered clouds**. These are called **strato** clouds as they **occur in layers**. For example, Stratus clouds.

2. **Heaped clouds** also called **cumuliform clouds**. These are **globular** in shape with flat bases and fluffy upper surface. For example, cumulus clouds.

3. **Feather** like clouds also called **cirro clouds**. These feathery clouds. For example, cirrus

(2) **CLASSIFICATION OF CLOUDS ACCORDING TO HEIGHT**

Clouds are also classified in terms of height. In this, there are four basic groups of clouds.

1. HIGH CLOUDS

These are clouds found at an altitude **of 6000 to 12000 meters** (6 to 12km) above the sea level.

Because of the **small amount of water vapour** and **low temperature** at such altitudes, the clouds are **thin, white** and **composed of ice**.

These clouds are **feather like** which do not indicate **rain** but suggests the **approaching of a distance storm.**

Such clouds form a **halo** which is a **ring of light that encircles** the sun or moon.

Examples of such clouds are; Cirrus, a wispy, fibrous-looking, indicating fair weather, cirrocumulus, cirrostratus.

Cirrus clouds

- They are wispy, resembling feathers
- They are milky white clouds
- They contain minute ice crystals
- They appear in patches in the sky

Cirrostratus clouds

- They form a **halo** shape when the sun or moon shines through them
- They form thin sheets in the sky
- They cover the whole sky

Cirrocumulus clouds

- They have a thin base and are globular in appearance
- They are made up of ice crystals
- They are white clouds

2. MEDIUM CLOUDS

Found at an altitude of **2100 to 6000 meters** (2km to 6km) above sea level.

These start with the word **alto** which means **middle**. They are combined with other clouds to form which are **stratiform** or **cumuliform** to form such middle clouds.

Examples are **altocumulus**, **Altostratus**.

Altocumulus clouds

- They are arranged in waves and vary in thickness and shape
- They form at moderate altitudes
- They form flattened globular masses

Altostratus

- They contain water droplets
- They are grey-white in colour

- They are transparent, spreading over the whole sky

3. LOW CLOUDS

Found below **2100 meters** (below 2km).

These sometimes occur as **individual clouds.** Most of them are **strato** clouds associated with **sober skies** and **drizzly rain**.

Examples are Stratocumulus, Nimbostratus, and Stratus.

Stratus clouds

- They are grey resembling fog
- They have a low base

Nimbostratus clouds

- They spread all over the sky
- They are dark grey in colour
- They are usually associated with continuous heavy rain

Stratocumulus clouds

- They look very massive
- They are grey to grey white in colour
- Their structure appears loose

4. CLOUDS OF GREAT VERTICAL EXTENT

Found between **1500 to 9000 meters**.

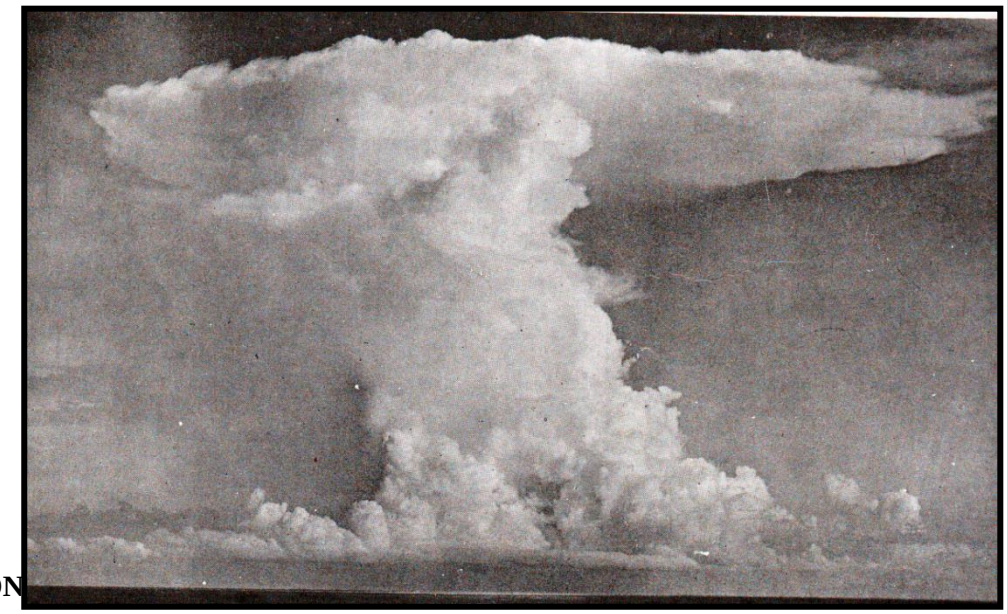
Their horizontal spread is usually restricted. They indicate **very active vertical movements** in the air.

Examples are Cumulus which indicate fair weather, **Cumulonimbus** which are storm cloud

Cumulonimbus clouds

- They have great vertical development.
- They are big and dense.
- They form anvil or wedged shaped pattern in the sky.
- They are dark at the base and may have white colour on the sides.
- They result in heavy convectional rainfall which is accompanied with thunderstorms and strong winds.

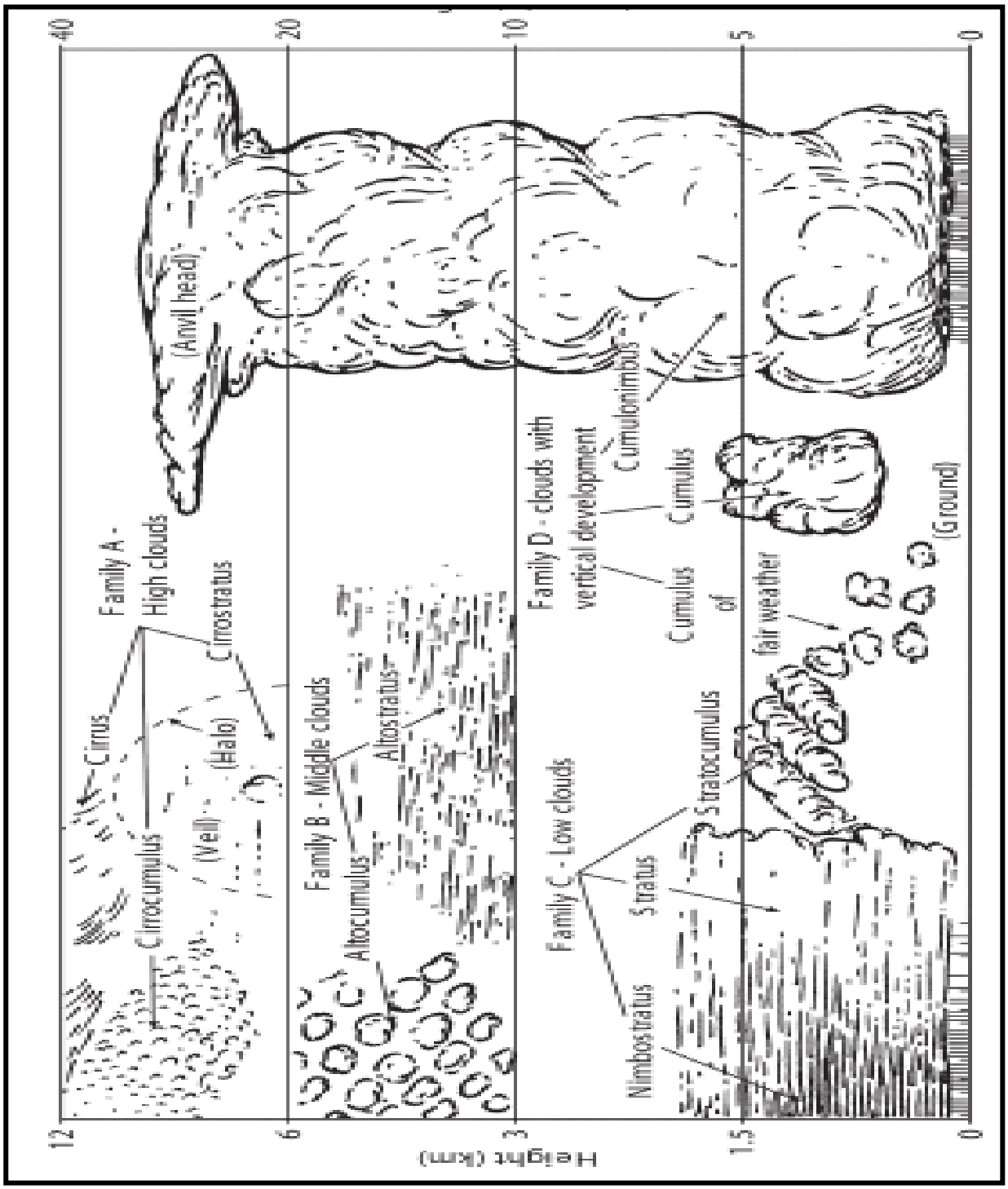
Cumulonimbus anvil shaped cloud



KLM GON

Cumulus clouds

- They are large globular masses, looking like fluffy balls of cotton.
- Their shape resembles a cauliflower.
- They have flat, even bases and dome shaped tops.
- They have a thick vertical development.
- They do not last for a long time in the atmosphere.



RECORDING CLOUDS

Clouds are recorded in one of the two ways at a weather station.

1 Their form with names associated to them

2 The amount of sky covered by the clouds

RECORDING USING THE AMOUNT OF SKY COVERED

- Cloud cover is measured in **OKTAS**. There is no instrument for measuring cloud cover.
- Cloud cover is estimated by studying the sky visually
- An **oktas** is a circle drawn to represent the sky. When there are no clouds, the cloud cover is **zero oktas.**
- An **unshaded** circle indicates clear skies
- A half-shaded circle indicates that the **sky is half covered** by clouds.

Cloud Amount (oktas)	Symbol	Cloud cover description
0	○	Clear sky
1	◴	One-eighth cover
2	◔	Two-eights cover
3	◔	Three-eighths cover
4	◑	Half of sky covered
5	◕	Five-eighths cover
6	◕	Three-quarters cover
7	◕	Seven-eighths cover
8	●	Complete cloud cover
	⊗	Sky obscured (fog)
	⊗	Missing/doubtful data

ISONEPHS

These are **lines drawn on a weather map joining places having equal cloudiness or cloud cover**, over a certain period.

IMPORTANCE OF CLOUDS

1. They are a source of **precipitation**. This happens from clouds with **'nimb'** in their name especially **nimbostratus** and **cumulonimbus.**

2. They **provide at a glance some understanding of the present weather conditions** and often are harbingers of things to come, for example, cirrus suggest the coming of a storm.

3. They are important because of **their influence on radiant energy**. They receive both insolation from above and **terrestrial radiation** from below and then they absorb, reflect, scatter or radiate this energy.

HOW DOES CLOUD COVER AFFECT WEATHER?

1. Usually huge dark clouds are associated with **rainfall** and high humidity.

2. Higher altitude clouds are associated with **fine weather.**

Sample questions

Define the term due point temperature (2marks)
Give any two examples of clouds in the following groups (i) Low clouds (ii) High clouds (iii) Medium clouds (iv) clouds of great vertical extent (2marks each)
State two groups of clouds based on height (2marks)
To which groups do the following clouds below belong?
(i) Cirrus clouds (1mark)
(ii) Stratus (1mark)
What type of rain is associated with anvil shaped clouds (1mark)
Explain how clouds are formed (3marks)
Identify the type of cloud described by each of the following
(i)Thin white sheet which causes the sun and the moon to have haloes (1mark)
(ii)Low rolling bumpy clouds which have a pronounced wavy form (1mark)

RAINFALL AND PRECIPITATION

PRECIPITATION: This is a **collective term** referring **to the falling of liquid and solid forms of water** from the atmosphere on to the earth's surface.

MAJOR FORMS OF PRECIPITATION

Precipitation is normally in form of **solid** and **liquid** coming in various forms such as:
Rain. This is the liquid part of precipitation, generally produced by nimbostratus and cumulonimbus clouds
Hail. This is also called **hailstone** are **lumps of ice** which form within **cumulonimbus** or storm clouds. Such particles of ice are formed when **water vapour** meets **super cooled clouds.** This is the solid form of precipitation. The water droplets accumulate around the ice crystals before they freeze.
Presence of strong **ascending air currents** hold the ice particles in the atmosphere to allow them to grow and become big in size.
The ice particles grow until when the clouds **cannot hold them anymore** and are therefore released onto the earth's surface as **hail**.
Fog. Formed when moist air condenses near the ground. This results into a mass of water droplets which are suspended in the atmosphere appearing like **low clouds disturbing** visibility. When smoke from industries has been mixed with fog it forms **smog** which apart from **disturbing the visibility**, it also causes respiratory problems to people.
Drizzle. This is **a light form of rain** consisting of **small droplets** associated with **stratus** cloud. Such droplets can fall for several hours.
Sleet. This refers to **ice pellets** that is, a mixture of **rain droplets** and **ice crystals** that form when rain freezes as it falls through a layer of **subfreezing air**. This is the **solid** form of precipitation.
Snow. This is made up of **ice crystals** formed where air is much colder than $\mathbf{0^0C}$.This develops when **water droplets freeze from gaseous to the solid** state forming ice crystals. The ice crystals may join to form **snowflakes** that fall on the surface of the earth.

This form of precipitation is common in the **temperate regions** where temperatures in **the lower** atmosphere is cool and therefore the snowflakes drop on to the earth's surface without **melting.** The formation of snow is a common occurrence within the **stratus** and **cumulus** clouds that have calm air.

Frost. This refers to the ice crystals that are deposited on vegetation and the surface of the earth as **white coating**.

Dew. This refers to **water droplets** deposited on the ground or objects due to **condensation of water vapour close to the surface of the earth**. It occurs due to excessive **terrestrial radiation** at night, which happens when the sky is **cloudless** lowering temperature **below dew point**. The low temperatures at night make water vapour present in the air **near the ground** to **condense** and form **droplets.** Day time should be **warm** to accelerate **evaporation** to have **enough moisture**

Mist. This refers to a mass of **water droplets** large enough to be felt **on the** face associated with **stratus clouds** which are **suspended** in the **lower part of the atmosphere. This is in a liquid state.**

HOW IS PRECIPITATION FORMED

Several processes are involved for precipitation to occur

1. When the **air is heated**, it absorbs moisture from the land, sea and plants.
2. The warm moist air rises and then it is cooled before **dew point.**
3. The water vapour changes into water droplets through **condensation** and suspended in the atmosphere in form of clouds.
4. When **clouds** become very heavy that they cannot be suspended in the air, they come down inform of precipitation.

CONDITIONS NECESSARY FOR RAINFALL TO OCCUR

1. The **air must rise to a considerable altitude** as this will enable it to absorb enough moisture.
2. The **air must be cooled** below its **dew point**.
   DEW POINT: The point at which vapour becomes condensed. This is below **0ºc.**This is also called **condensation level**
3. The air must be **saturated**, that is, humidity should be high.
4. The air must **contain small particles** of matter such as dust, salt, ice, pollen grains and soot. These small particles of matter form the **condensation nuclei** around which droplets form.

RAINFALL: This refers to the **falling of water droplets from the atmosphere** to the ground.

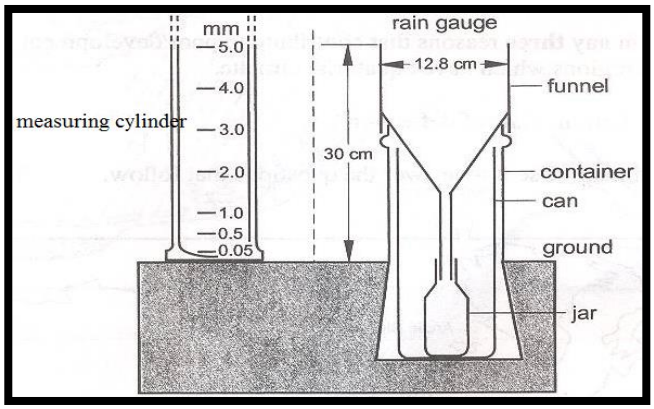
MEASURING RAINFALL

Rainfall is measured by means of an instrument called **RAINGAUGE**. Rain is measured in units called **MILIMETERS**.

COMPOSITION OF A RAINGAUGE

- It has **a copper metal** container or **plastic container** which is installed in a concrete pillar or some centimetres under the ground.
- Inside the container is **a jar** where rain **water collects**.
- The container is usually made up of **plastic or copper** because these two materials **do not rust**.
- On top of the metal container is **a funnel** through which the water goes into the jar.
- The" lip" or the edge of the funnel must be **bevelled** or must be **sharp** to catch the water from the air.

- There is a measuring **cylinder** which is sometimes kept separate. The diagram below shows parts of a rain gauge.



POSITIONING OF THE RAINGAUGE

- It should be sited in an **open area** away from trees and buildings. This is to prevent the **dripping** and **interception** of rain water as these would give the wrong readings.
- It should be installed some **305mm or 30cm** above the ground to **prevent in splashing** when rain drops hit the ground which would give wrong results.
- When installed **under the ground**, the jar should be under the ground to **prevent evaporation of the collected water**.

HOW IS RAINFALL MEASURED BY USING A RAINGAUGE?

When the rain has fallen into the rain gauge it is collected **by using the jar** after being directed into the jar by **using a funnel**. The jar is removed and water in poured in a **graduated measuring cylinder.** The readings in a measuring cylinder are always taken at the eye level, which is at the level with the meniscus of the water.

RECORDING RAINFALL

Rainfall is recorded in 24 hours period. It is then represented in two main ways:

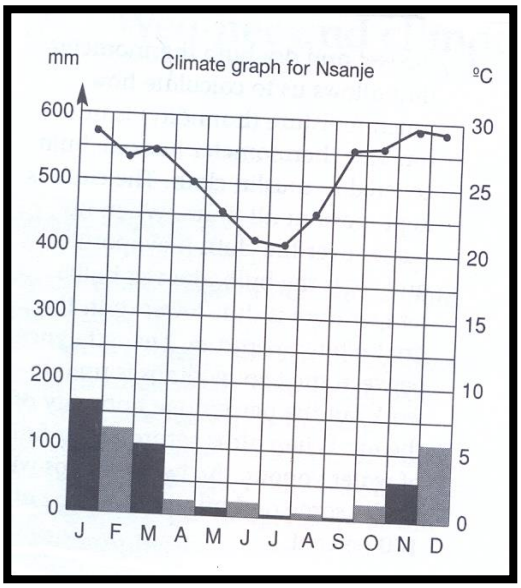
1. On the maps whereby **ISOHYTES** are used.
   ISOHYTES. These are lines drawn on a map showing or **joining places of the same amount of rainfall in millimetres.**
2. Use of **bar graphs** or histograms which show the months with higher rainfall and months with lower rainfall

RAINFALL GRAPHS

These are usually combined with temperature which is represented by a line graph. The temperature is represented on the top part of the rainfall graph.

month	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Temp (^{O}C)	23	22	20	18	17	16	16	18	20	26	26	23
Rainfall(mm)	200	250	160	20	20	19	0	19	18	18	75	150

AN EXAMPLE OF A RAINFALL GRAPH



TYPES OF RAINFALL

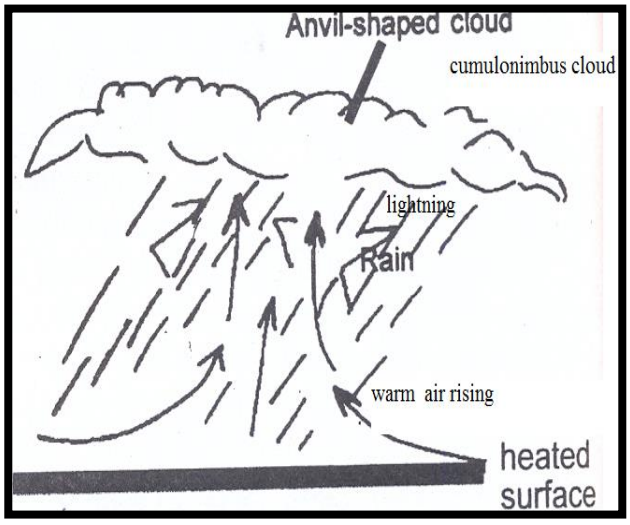
There are **three** types of rainfall.

1. Convectional rainfall
2. Relief rainfall
3. Frontal rainfall

1. CONVECTIONAL RAINFALL

This is formed when heated warm air is forced to rise in form of **convection currents**. The rising air carries moisture which then cools as it goes up until at last the vapour condenses to form clouds and rain comes.

DIAGRAM OF CONVECTIONAL RAINFALL



CHARACTERISTICS OF CONVECTIONAL RAINFALL

1. It is associated with anvil-shaped clouds called **cumulonimbus**
2. It is associated with **lightning**.
3. It is associated with **thunder** which is caused by the rapid expansion and contraction of air. This in turn produces positive and negative electrical charges.
4. This type of rainfall usually occurs in the **afternoon** when air has been heated and rises.

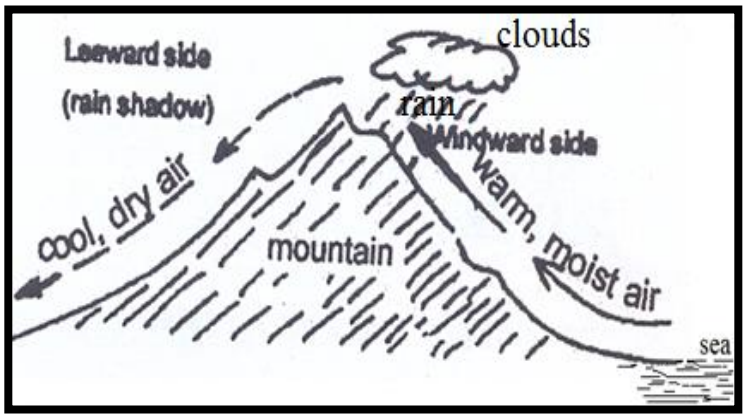
AREAS WHERE CONVECTIONAL RAINFALL USUALLY OCCURS

This type of rainfall occurs in the **equator or tropical regions** such as **Zaire** or **Democratic Republic of Congo**, **Amazon Basin, Ghana. This** type of rainfall takes place in these areas because **such places experience overhead sun with very high temperatures making** the earth to be greatly **heated.** This makes heated air to rise in form of convection currents with moisture.

2.RELIEF OR OROGRAPHIC RAINFALL

- This usually happens due to **the presence of physical features** such as **mountain**, **hills** and **lakes**.
- The rain occurs when air blows up against a high ground, **where it is forced to rise over it**. Air then cools, condensation takes place clouds are formed and rain falls. It is called Relief because it is influenced by physical features such as hill, mountains and lakes.

DIAGRAM OF RELIEF OR OROGRAPHIC RAINFALL



CHARACTERISTICS OF RELIEF OR OROGRAPHIC RAINFALL

1. It is most common where on shore winds rise over hilly regions lying at right angles to the direction of the wind.

2. Rain falls on **one side of the mountain which faces** the source of the moist air. This side that receives rainfall is called the **WIND WARD SIDE**

3. The other side of a mountain which receives **very little or no rainfall** at all is called the **LEEWARD SIDE**

- The leeward side receives very little or no rainfalls **because the descending winds are completely dry without moisture after losing moisture on the windward side.**
- Just because the leeward side receives little or no rainfall it is called a **RAINSHADOW AREA**

AREAS WHERE RELIEF RAINFALL USUALLY OCCURS

- This rainfall occurs in **all latitudes** provided there are physical features like mountain, lakes and winds. For example, the windward side of the Rockies in North America.

EXAMPLE OF AREAS THAT RECEIVE RELIEF RAIN IN MALAWI

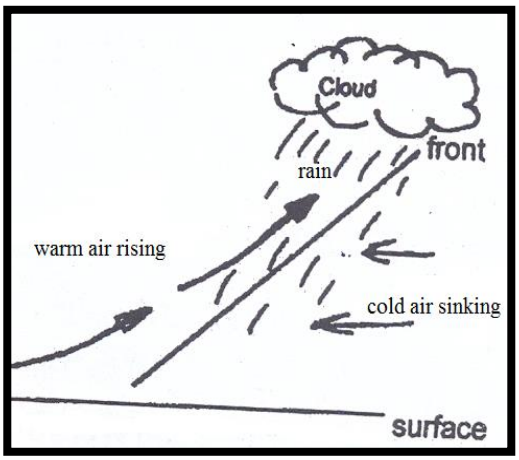
- ✓ Nkhata bay
- ✓ Karonga
- ✓ Zomba

NOTE: west Mzimba is a rain shadow area.

4.FRONTAL/DEPRESSION OR CYCLONIC RAINFALL

This type of rainfall occurs when large **masses of air of different temperatures meet**. When this happens, the **warm air which is less dense is forced up over the cooler air**. This happens because warm air is less dense than cold air. The rising of this warm air **rises together with moisture** which **cools** after reaching the **dew point**, forming **clouds**. These clouds when they become heavy they come down in form of **rainfall**. Between the warm air and cold air, a boundary called **FRONT** is formed hence **frontal rainfall**.

DIAGRAM OF FRONTAL RAINFALL



CHARACTERISTICS OF FRONTAL RAINFALL

1. Associated with **dark stratus** or **nimbostratus** sheet like clouds
2. The rainfall usually lasts for few hours but **heavy** followed by clear skies
3. Associated with low temperatures not as high as those in the tropics
4. It is very windy.

AREAS WHERE THIS TYPE OF RAINFALL OCCURS

Such type of rainfall occurs in the areas **where warm tropical air masses meet with the cold air masses** of temperate areas e.g. Britain, Canada and South Africa.

SIMILARITIES IN ALL TYPES OF RAINFALL

1**.** In all the three types, **warm moist** air rises.
2. In all the three types the rising air **must get cooled** at a certain height in the atmosphere.
3. In all the three types **clouds** must be formed for precipitation to take place.

DIFFERENCES IN THE THREE TYPES OF RAINFALL

1. In Convectional rainfall air rises because it is being **heated.**
2. In Orographic rainfall air is formed to rise **over a mountain barrier**
3. In frontal rainfall warm air is formed to **rise over cold air.**

Key words

Precipitation,rainfall,dewpoint,raingauge,isohytes,convection,relief,frontal,cumulonimbus,lightining,anvil ,windward,leeward,rainshadow,ororaphic,front

Sample questions

Give any two differences between a windward side and a leeward side in relief rainfall(2marks)
In relief rainfall why is it that the leeward side receives very little or no rainfall (2marks)
Define a front (2marks)
In relief rainfall what do you understand by the following terms: wind ward, leeward, rain shadow (2marks each)
With the aid of a diagram, explain convectional rainfall (6marks)
Explain any three similarities among all the three types of rainfall (6marks)
Define the term condensation nuclei (2marks)
What is the difference between precipitation and rainfall? (2marks)
Describe how precipitation is formed in relation to the hydrological cycle (6marks)
Apart from rain, give any other three forms of precipitation (3marks)
Why is convectional rainfall more of the tropical regions than other regions? (3marks)
State clearly three conditions necessary for precipitation to occur (3marks)
Define the term precipitation (2marks)
Describe how the following forms of precipitation are formed (i) Hail (ii) Sleet (iii)Frost (iv)Dew (3marks each)
State any two conditions that influence the formation of dew (2marks)
Distinguish between the following forms of precipitation (i) sleet and Hail (ii)snow and rain (2marks each)
With the aid of a well labelled diagram, explain how convectional rainfall is formed (6marks)
Explain any two differences between relief rainfall and cyclonic rainfall (4marks)
With the aid of a well labelled diagram, explain why the leeward side of a mountain receives little or no rainfall (6marks)
Explain why the mid latitude experience cyclonic rainfall (3marks)

THE ENVIRONMENT

This refers to **anything external surrounding of an organism**. Two things are important in the environment:

1. **ECOSYSTEM**: this is the **interaction** between **living things** and **non- living things** in the environment.
2. **ECOLOGY**: this is the **study of the relationships between living things and other parts** of the environment.

All living things depend on each other and materials of nature. For example, plants take materials from the air, soil and water and make food for themselves and other living things such as people and animals.

The sun provides heat and light for the food making process. This means that the sun's heat, light, soil, air and water are parts of the environment as they influence the survival of living things.

HUMAN ACTIVITIES THAT ENDANGER THE ENVIRONEMNT

1. **Poor agricultural practices** such as shifting cultivation, pastoral nomadism, making ridges along the slope. These often **leave the soil bare and increase the speed of running** water which erodes the soil.

2. **Deforestation**. This is the removal of forests from the environment **which does not only encourage greater runoff** and **large-scale erosion, but also increase the content of carbon dioxide content in the atmosphere.**

3. Misuse of **insecticides**. In controlling some pests, the environment is polluted as insectides are released into the air.

4. Poor **waste disposal.** Some waste is discharged into water bodies causing water pollution.

5. **Disruption of the food** chain by removing parts of it. For example, fire destroys vegetation which is used as food and shelter for animals. Killing some animals too disturb the food chain which bring imbalance in the environment. For example, removing herbivores make carnivores like lions to suffer.

6. **Poaching. This** is the illegal killing of animals in protected areas such as national parks and game reserves. It is bad as it contributes to disappearance of some animals e.g. elephants

ENVIRONMENTAL CONSERVATION

This covers the conservation of the ecosystem. Deterioration of the environment is associated with **destruction, reduction and decline of some species.** For example, the population of lions, elephants, hippopotamus and rhino in Malawi is on decline in national parks and game parks. Therefore, environment must be conserved because of the following reasons:

a. The animals that inhabit the environment are of **educational value.**
b. Animals and plants have as **much right to inhabit the environment** as human beings.
c. For preserving **natural beauty** whereby, the **genes of certain species** are combined and result into new birds once the genes of species are lost, they cannot be recreated.
d. **Environmental stability**, through the food chain as living things depend on each other for food and shelter.
e. Source of **food** and **medicine**.

HOW CAN WE MANAGE THE ENVIRONMENT?

Environmental management **refers to an attempt to harmonise and balance** the various **resources** that human beings have made use of**.** This can be done through the following ways**:**

a. By **establishing conservation** areas such as forest reserves, national parks and game reserves.

b. Catching game where they are either facing extinction or are populated and relocating them elsewhere

c. Protecting **rare** and **endangered** species

d. Civic educating people on conservation of the environment

e. Setting up laws that guard the environment with penalties against offenders.

ENVIRONMENTAL ISSUES

These are **concerns or problems** that have **arisen** because of the **human impact** on the **natural environment** which in turn affects human society at large.

EXAMPLES OF ENVIRONMENTAL ISSUES

- Deforestation
- Desertification
- Pollution
- Acid rain
- Climate Change
- Soil erosion

DESERTIFICATION

This is a **process that creates desert condition and by downgrading the land surface**. It is a **steady process** that turns good and fertile land into a **barren one**.

Thus, when human and climatic processes reduce biological activity, they change the once fertile farming land to desert-like conditions.

An area of the world seriously affected by desertification is the **SAHEL.**

The Sahel is a belt running west-east across Africa to south of the Sahara Desert.

The countries of the Sahel are Somalia, Ethiopia, Chad, Niger, Sudan, Mali, Burkina Faso, Mauritania, and Senegal.

The natural vegetation of the Sahel is the **Savanna.**

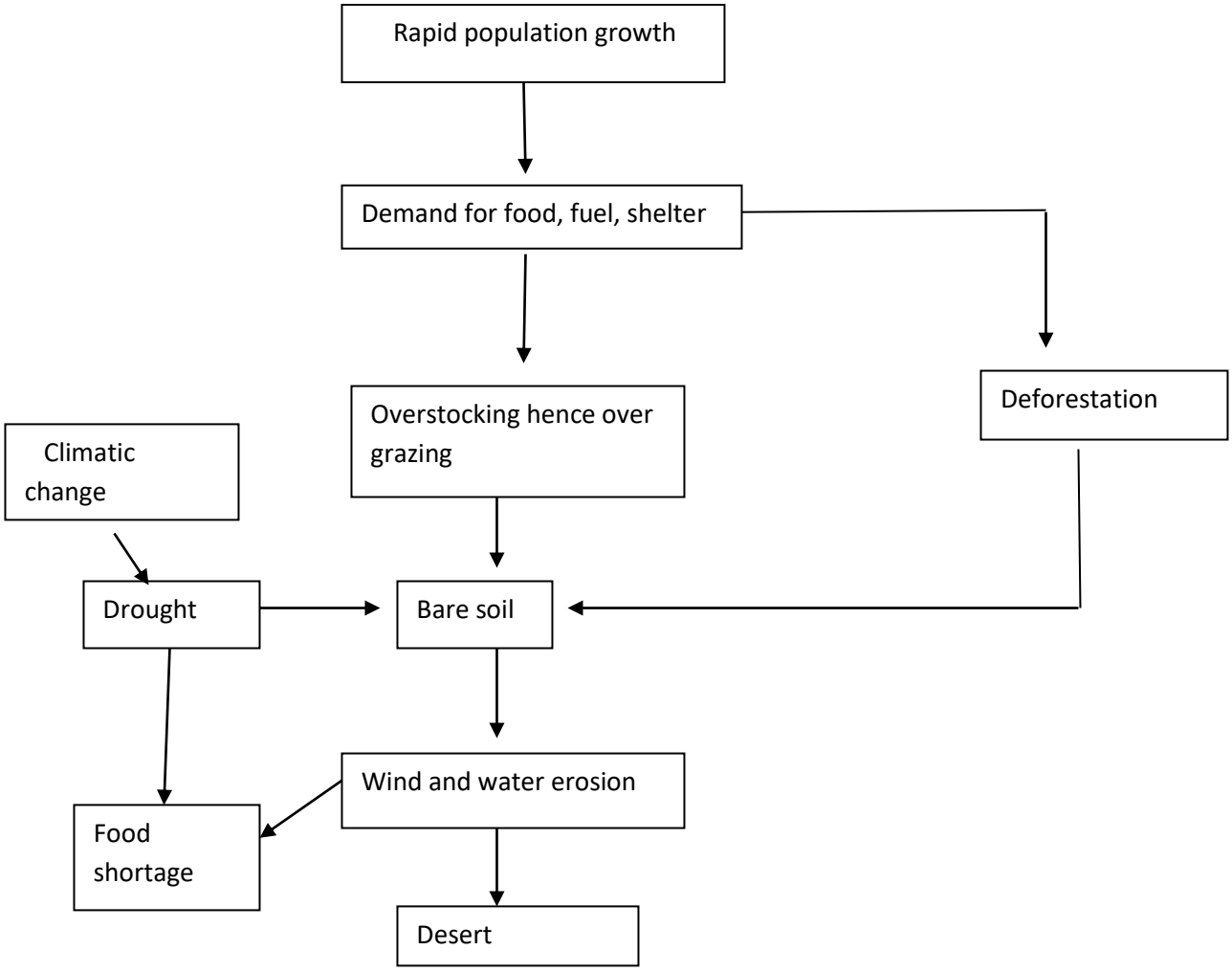
CAUSES OF DESERTIFICATION

1. Having **large numbers** of livestock **gathering in watering holes** which leads to **overgrazing** and degradation of the vegetation e.g. nomadic pastoralism.
2. The **demand for wood** for fire especially in developing countries. Trees and shrubs are removed making soil to become **vulnerable to erosion** by wind and water.
3. **Over-cultivation** because of rapid population growth which results into increased pressure on farmland. This makes people to cultivate in **marginal areas** such as catchment areas, river banks which are more vulnerable to erosion and makes rivers to dry up easily.
4. Climatic change especially in the years of **drought**
5. **Deforestation** which is the felling and clearance of forest land.

THE PROCESS OF DESERTIFICATION

The process of desertification starts with the **increase in human population**. As the human numbers multiply, forests are cleared for farming, fuel and shelter.

This results into d**eforestation**, **soil erosion**, **climatic change**, **drought** and eventually **desert**. The process of desertification is summarised below.



LEVELS OF DESERTIFICATION

SLIGHT= desert already exist e.g. Kalahari

MODERATE: significant fall in plant cover

SEVERE: top soil eroded, and productive grasslands replaced by useless shrubs

VERY SEVERE: the land is destroyed by deep gullies and the desertification process is **irreversible**

EFFECTS OF DESERTIFICATION

1. **Soil degradation**: as the top soil is removed, the sub soil becomes **infertile unsuitable for cultivation**
2. **Poor crop yield:** as the soil becomes degraded, that is, infertile, crop yields are reduced
3. **Flooding:** since the ground is **not protected, marginal areas such as river banks are cultivated, floods** occur frequently destroying buildings and life
4. **Climatic change:** this is in terms of drought, **destruction of the ozone layer,** acid rain and global warming
5. **Soil erosion**: as the soil is left bare due to the removal of vegetation, it is exposed to erosion agents such as water and wind which removes it.
6. **Depletion of water resources:** in trying to **improve the fertility** of the soil as a result of desertification a lot of chemical fertilisers are applied on the land. These are then washed into the water bodies which become harmful to water resources such as fish.

WAYS OF CONTROLLING DESERTIFICATION

i. **Afforestation:** the planting of trees in places where there were no trees before.
ii. **Reafforestation:** the planting of new trees after removing the old ones.
iii. **Proper land husbandry,** that is following good farming practices such as constructing ridges across the slope which slows down the speed of running water, not using bush fires when clearing the land.
iv. **Carrying out civic education** campaigns addressing to people the importance of the environment and bad results misusing it.
v. **Controlling rapid population growth** through good health measures. This will reduce the pressure of alternative source of energy such as electricity which reduces the pressure on firewood.
vi. **Using clean sources of energy such as solar.** This will stop people from depending on fuel wood.

ENVIRONMENTAL POLLUTION

Pollution refers to **all ways by which people dirtens or contaminates their surroundings** creating harmful conditions to living things. It is the most serious problem to the environment.

Air, water and **soil** which form important part of the environment and are necessary for the survival of living things are badly polluted.

TYPES OF POLLUTION

There are mainly three:

1. Air pollution
2. Water pollution
3. Land pollution

CAUSES AND EFFECTS OF POLLUTION

A. AIR POLLUTION

- Removal of **vegetation** covers making the air not to be purified, thereby adding a lot of carbon dioxide into the atmosphere which results into global warming
- **Emission of fumes** from vehicles and factories into the air
- **Noise and out gassing.** Out gassing is the emanation or issuing of gases from the lithosphere
- **Burning of bushes** which add a lot of **carbon dioxide** into the atmosphere.

EFFECTS OF AIR POLLUTION

i. Produces very bad and **irritating smell**
ii. Results into **poor visibility** e.g. smoke
iii. Harmful on **human health** as it results into **respiratory problems** which contribute to diseases such as asthma, bronchitis and pneumonia
iv.Results into **global warming**
v.Destroys the **ozone layer** resulting into high temperatures on the earth.

B. WATER POLLUTION

CAUSES OF WATER POLLUTION

1. The industries dump huge **amount of wastes** and **effluent** into water bodies.
2. Discharging of **wastes** from sewage into the water.
3. Application of **chemicals** such as deldrin and DDT on water apart from excessive use of chemical fertilizers.
4. Oil spills because of **the discovery** of off-shore oil wells and movement of ships on water.

EFFECTS OF WATER POLLUTION

i. Scarcity of **good water** for drinking and home use.
ii. **Eutrophication** which leads to **loss** of aquatic life and biodiversity.
iii. **Water borne diseases** such as diarrhoea, cholera and dysentery
iv. Oil spilling affects **fishing grounds** killing many species of fish and other aquatic life

C. LAND POLLUTION

CAUSES OF LAND POLLUTION

- Poor waste disposal which is the throwing away or **heaping of solid waste** (garbage) such as remains of food, tins, automobiles, tyres, cans on the land
- **Nuclear** testing pollutes the land
- **Mining** especially open cast, scar the land.
- **Deforestation** which leaves the land bare and **unattractive.**

EFFECTS OF LAND POLLUTION

- Loss of some **living things** as some of the dumped materials **are poisonous**
- Make the land not to look **beautiful**
- The spreading of **diseases as some litter attract pests**

CONTROLLING ENVIRONMENTAL POLLUTION

a. **By recycling**: this is the reprocessing of waste products for reuse. This avoids polluting the land, air and water. Examples include:
    - Cans can be **smelted down** and used to make new cans, instead of throwing them away.
    - Old newspapers can be turned into **new pulp and reused** instead of throwing away or burning them
    - Ground-up glass can serve as an **ingredient in road-building** materials
    - Glass bottles like empty Coca-Cola can be **refilled**
b. **Registration and reinforcement of laws** that protect the environment e.g. restriction in the use of chemicals like DDT.
c. **Conservatio**n of the environment like forests
d. **Proper waste disposal** through the use of landfills.
e. **Use of clean sources of energy** such as hydro-electricity or solar energy which pollutes less to the environment and at the same time protects vegetation from being cleared for firewood.
f. **Civic education campaigns** on the importance of conservation of the environment.

WILDLIFE

This includes the species of **plants** and **animals** which are found in the natural environment.

TYPES OF WILDLIFE IN MALAWI

1. Animals e.g. Buffaloes
2. Birds e.g. Eagle
3. Insects e.g. Bees
4. Snakes e.g. Black cobra
5. Trees e.g. Mulanje cedar

CLASSIFICATION OF WILDLIFE IN MALAWI

This is in terms of their eating or food habits: -

a. Predators

- These feed on other animals e.g. Lions, leopards

b. Decomposers

- These are micro-organisms that make things rot or decay such as bacteria and fungi

c. Herbivores

- These are animals that feed on plants only e.g. Elephants, zebra and buffaloes

d. Insectivores

- These are animals that feed on insects only e.g. Chameleons, frogs, lizards

HABITAT FOR WILDLIFE IN MALAWI

1. Forests

- These act as areas where wildlife gets food and shelter.
- For example, the forests of Viphya plantation

2. Nature Sanctuaries

- These are set aside for conservation of specific species of wildlife e.g. Lilongwe Nature Sanctuary

3. Game Reserves

- These are controlled areas under Ministry of Tourism.
- They do not have tourist facilities for accommodation e.g. Vwaza marsh game reserve.
- These are areas where wildlife is protected.

4. National Parks

- These are protected areas strictly controlled by the Government.
- These are more developed with good tourist accommodation facilities e.g. Camps at Liwonde National Park and Nyika National Park.

5. Lakes and Rivers

- These keep fish and some water plants e.g. Lake Malawi and Shire River.

SIGNIFICANCE OF WILDLIFE

- **Tourist attraction** which brings money to the nation
- Development **of infrastructure** such as roads, markets and airports.
- Improves **international relationships** through tourism
- **Employment opportunities** in game reserves national parks and forest reserves
- **Medicinal** purposes
- **Timber** for furniture

ENDANGERED WILD AQUATIC SPECIES

Endangered species are those animals which are **prone to extinction** due to **their value** to human beings. Wild animals that are endangered include:

a. **Black rhinos** for their horns
b. **Elephants** for ivory (tusks)
c. **Lions** and **Leopards** for their skins
d. **Buffaloes** for meat and hides

e. Colourful birds
f. Aquatic species mostly endangered include fish such as **chambo**

ACTIVITIES THAT ENDANGER WILD AND AQUATIC LIFE

- **Pollution** on land water, and sea making such species to die.
- **Overfishing** due to high or fast growth of human population raising the demand.
- **Poaching** in protected areas such as game reserves and national parks.
- **Deforestation** for settlement, firewood and urbanisation.
- **Drainage of marshes** and swamps which are richest ecosystems in the environment

THE WETLANDS

Wetland is an area of land covered with a shallow layer of water during some or all of the year.

Wetlands are **transitional zones between land and sea where the soil is frequently waterlogged, and the water table is at or near surface.**

TYPES OF WETLANDS

1. Marshes. These are generally grassy areas covered by a shallow layer of water.

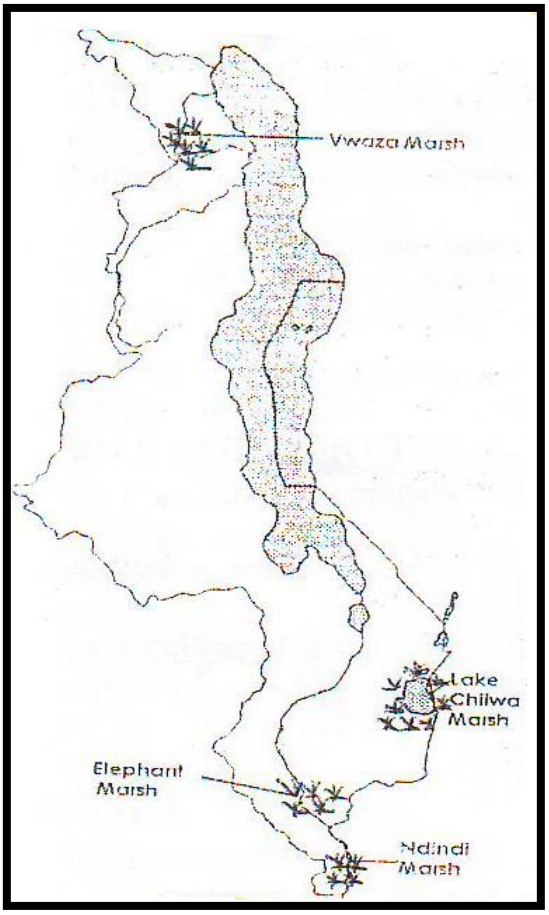
2. Swamps.These are flooded forests with trees and shrubs growing in the water.

3. **Bogs.These** contain some water which is acidic without a lot of vegetation

EXAMPLES OF WETLANDS IN MALAWI

- Elephant marsh
- Ndindi marsh
- Vwaza marsh
- Lake chilwa marsh
- Lake Chiuta marsh

MAP OF MALAWI SHOWING IMPORTANT WETLANDS



IMPORTANCE OF WETLANDS

1. They are **producers of life for they provide feeding**, spawning and nursery of fish
2. They **lock up plenty of carbon** in form of **peat** thus preventing it from entering the atmosphere as carbon dioxide, the main gas in **global warming**.
3. These are **habitat for birds and endangered** and threatened plant and animal species
4. They **absorb and filter pollutant** that would degrade rivers and lakes thus providing clean water.
5. At the coast they **buffer the impact of tides and inland** wetlands absorb runoff thereby reducing **flood waves** downstream
6. They **stabilise shorelines and river banks beauty**, the environment, providing grounds where biological studies and recreations can take place.
7. These are centres of **tourism**.

EFFECTS OF DRAINING WETLANDS

1. **On quality of water**: when solids are carried in suspension, the **low speed of water** through a wetland makes the solids to be deposited, that is, making the water clean.

2. On flood control: swamps hold **back water or run off** and thus controlling floods. Removal of wetlands speeds up storm flow or run off downstream.

3. Ecological effects: there is a delicate balance between wetlands and marsh plants, wildlife and other adapted species. Once drained, this balance is upset, leading to the extinction of some plant and animal species.

4. Decline **in tourism industry**

HUMAN ACTIVITIES THAT THREATEN WETLANDS

Because of the fast-human population growth, wetlands are facing the following problems:

- ✓ **Draining them** away for using the land **for cultivation**
- ✓ Constructing **settlement**s in such places
- ✓ **Planting** rice in marshes
- ✓ **Catching fish** in these marshy places.

MANAGEMENT OF WETLANDS

1. **Civic educating** individuals and communities living near and around them on the importance of these habitats.
2. The **government passing stringiest laws** to protect such wetlands e.g. Heavy punishments attached to encroachment and poaching.
3. Allowing people around such places to **catch fish** once in a year. This would make them to be responsible people towards wetlands

OTHER ENVIRONMENTAL PROBLEMS

1) ACID RAIN

Nitrogen oxide and sulphur dioxide are released into the air by factory chimneys and vehicle exhaust.

When these gases dissolve in rain water they form solutions of nitrous and nitric acids which form **acid rain.**

EFFECTS OF ACID RAIN

- ✓ Erodes statues and buildings
- ✓ Destroy **plants**

- ✓ Affects the **PH levels** in the soil and water leading to death of lakes resources and forest in addition to damaging soil fertility.

2) EUTROPHICATION

This is the process **whereby nutrients that people add such as nitrates from agricultural fertilisers and phosphates from detergents in sewage are washed finding their way into water bodies.**

The nutrients **speed up the growth** of **algae** in water bodies such as lakes. As larger amounts of algae grow, larger amounts also **die**. The **dead algae** become wastes and during **decaying process** they use up the waters **oxygen** supply. Therefore, no plant and fish life remain due to the depletion of oxygen in water.

3) OZONE LAYER

This is the **protective layer that protects the earth's surface from the ultraviolet rays of the sun**.

It is formed from the combination of **oxygen atoms**.

Air pollution because of the emission of chemicals called **chlorofluorocarbons** (CFCs) used in **insulation material**, **aerosols** and **refrigerators** attack and destroy the ozone.

A lot of holes form in the ozone which results into the **penetration of ultraviolet rays from the sun on to the earth surface.** This kills plant and animal species. It can only be conserved if people stop using materials that emit a lot of **CFCs** into the earth. Otherwise it is irreversible- a non-renewable resource.

4) GREEN HOUSE EFFECT

This is the process whereby gases such as carbon dioxide and methane in the atmosphere absorb and re-emit infrared radiation emitted by the earth's surface, hence trapping warmth. This raises temperature on the earth's surface causing **global warming**.

Examples of such green house gases are:

CARBON DIOXIDE: produced by **burning fuels** and **industrial wastes** in addition to **deforestation**

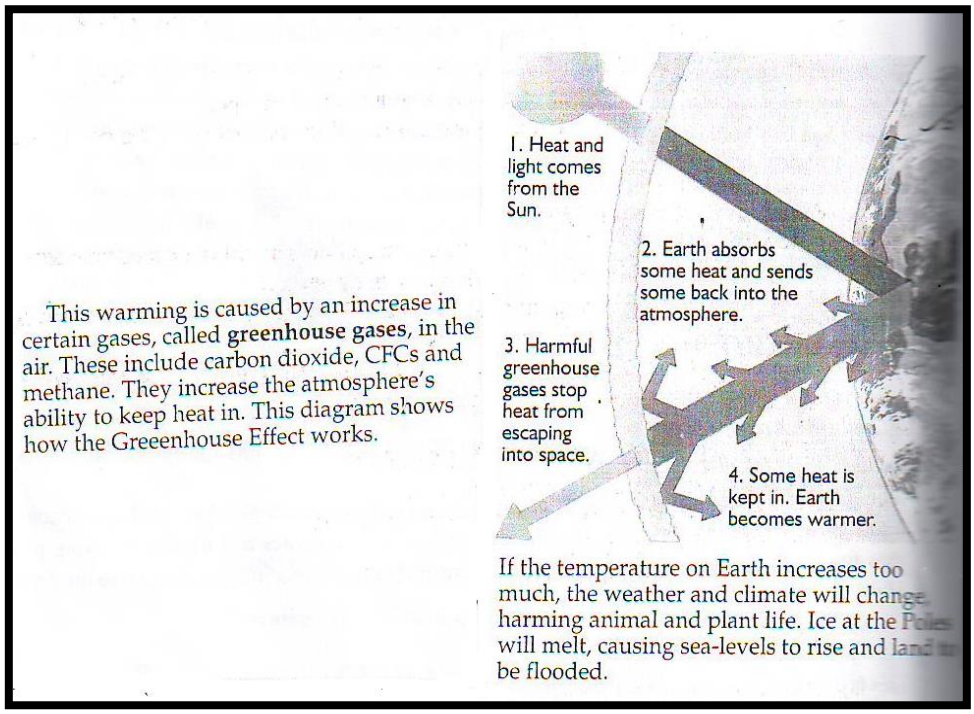
METHANE: produced through some kinds of warming such as **cattle rearing** and **rice growing**, and from **rotting wastes**.

CHLORINE, FLOURINE which are part of chlorofluorocarbons.

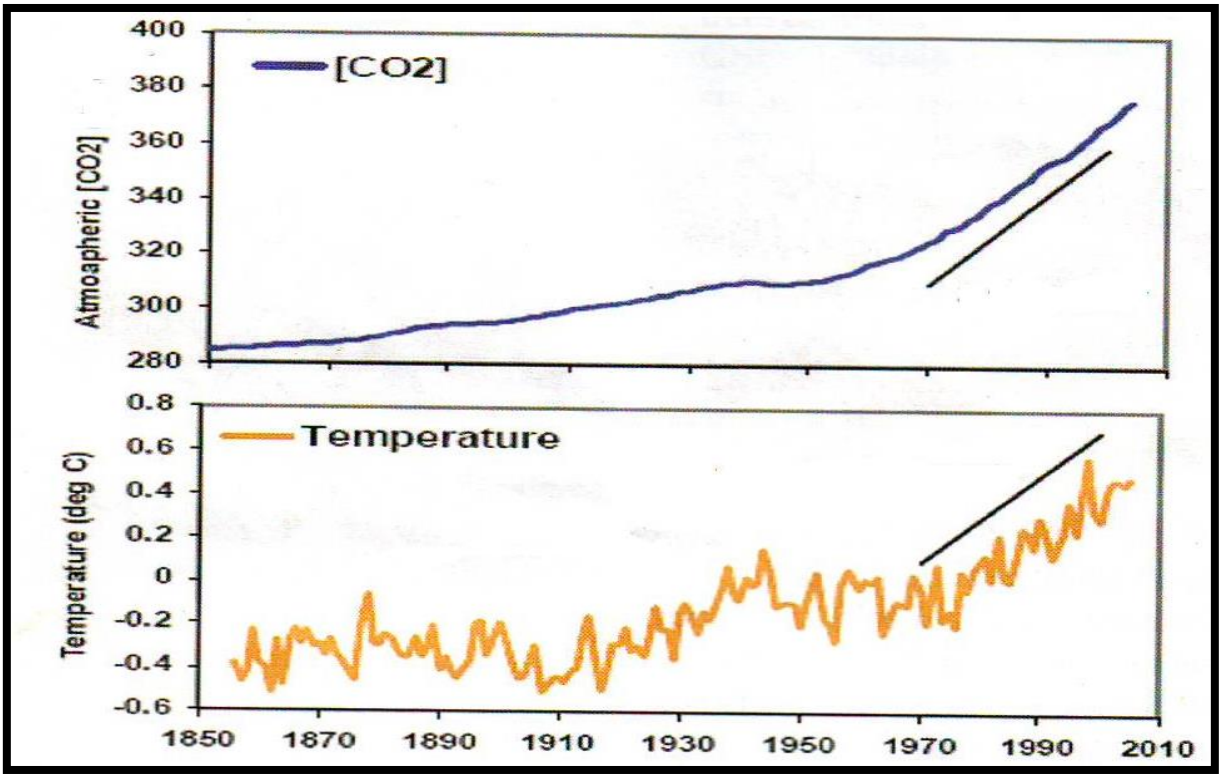
These gases increase the atmosphere's ability to keep in heat. They **trap the reflected rays** and send **them back** to the earth. This makes **temperatures to be extremely high in the earth**- a situation called **GLOBAL WARMING**.

GLOBAL WARMING

This is **the gradual increase** in temperature on the earth's surface **because of human activities** which **emit a lot of greenhouse gases** in the atmosphere**.** According to **United Nations Report** (1992), the increase in greenhouse gases enhances the **natural greenhouse effect**, resulting in additional **warming of the earth's atmosphere.** The figure below illustrates the occurrence of global warming.



The graphs below shows the increase **in emissions such as CO_2 has** contributed **to the rise in global temperature** from 1850 to 2010



EFFECTS OF GLOBAL WARMING

a. Alter **ecological** balance as ecosystems change in nature.
b. **Shifts rainfall patterns** resulting in unusually **heavy rains** and **floods** or serious **droughts**.
c. **Hot areas** becoming hotter which spreads **desertification**

d. **Shifting climatic belts** and vegetation types and in the process some plants and animals being lost
e. **Spreading** tropical **diseases** to the temperate regions.
f. Melting of the **ice in the Polar Regions**. This increase **water levels in oceans** bringing floods low-lying regions and increased erosion along the coastal areas. It also makes some **islands** to be at risk of submerging in water.
g. **Climate change** as a major effect

CHECKING GLOBAL WARMING

1. Reducing the use of **carbon producing fuels e.g. coal.**
2. Preventing **wild fires** which add great amounts of carbon dioxide into the atmosphere
3. Reduce **changing the surface properties** of lands, wetlands and oceans that affect the interaction between the atmosphere and these surfaces.
4. **Holding international meetings** under organisations such as the United Nations trying to put up measures by international agreement to **combat the problem**.

CLIMATE CHANGE

This refers to **long term changes in weather patterns because of human activities** on the environment.

HUMAN ACTIVITIES THAT CONTRIBUTE TO CLIMATE CHANGE

1. **Industrial activities** which emit a lot of greenhouse gases such as carbon dioxide.
2. **Damping waste products** carelessly which results into the **release of methane**, a greenhouse gas.
3. **Deforestation** for settlement, farming and road construction with **urbanisation**. This increases the rate of CO_2 in the atmosphere as the vegetation help to remove the CO_2
4. **Burning of fossil fuels** such as oil to produce electricity emits carbon dioxide and nitrous oxide which are greenhouse gases.

HOW DOES GREENHOUSE GASES CAUSE CLIMATE CHANGE?

The greenhouse gases form a **blanket** or a layer which **traps** the suns radiation and **warms the earth**.

EFFECTS OF CLIMATE CHANGE

1. **Low crop** yield due to poor germination, wilting and damaged leaves.
2. **Drought conditions** due to the **altering of the hydrological cycle** affecting crops and animals
3. **Shortage of water** in the environment. This is because the **water table goes far below**, water levels in water bodies become **very low affecting the supply of water** in town, cities and communities.
4. Change in the direction of the **flow of ocean currents** due to increase in temperature in Polar Regions.
5. **Floods** which destroy life and property as the **water cycle is greatly changed**
6. Melting of **ice caps** in the Polar Regions contributing to a **rise in sea levels** posing a threat to coastal areas and islands.
7. **Desertification** as some areas becomes barren for crops and animals to survive.
8. **Increase in storms** or **cyclones** due to creation of low pressure systems of air. These are very **destructive.**

MITIGATION MEASURES FOR REDUCING THE IMPACT OF CLIMATE CHANGE

Mitigation. These are **measures put forward** to **reduce the impact** and **occurrence** of climate change. The following are some examples of mitigation measures against climate change:

1. **Afforestation and reforestation**. Vegetation helps to remove a lot of CO_2 in the atmosphere.
2. **Minimising burning bushes, grass, and crop residues**. This will make CO_2 not to be released into the atmosphere.
3. **Recycling the products**. This will reduce the waste to be damped in the environment.
4**. Use of clean, renewable source of energy such as solar**. Apart from protecting vegetation, this will reduce the emission of greenhouse gases.
5. **Efficient use of energy** to **reduce the amount of energy required** e.g. use of energy solar bulbs.
6. **Holding international** meetings such as those under the United Nations which such issues are discussed and nations jointly look for solutions.
7. **Civic educating the communities** about the dangers of climate change and suggested ways of reducing the impact of climate change.

ADAPTATION INITIATIVE MEASURES TO CLIMATE CHANGE

These are measures which people are **required to do to live** and **withstand the impact** of climate change. These are to be followed in communities in Malawi to withstand the effects of climate change which come through heavy storms, drought, floods, and shortage of water in the environment among others.

EXAMPLES OF ADAPTATION INITIATIVES

1. **Rain water harvesting** from roof tops at school and at home for different uses such as washing and watering plants.
2. Planting **early maturing varieties** of crops to catch up with the rains.
3. **Planting drought tolerant** crops such as cassava, sweet potatoes and sorghum in drought hit areas such as Karonga and Salima.
4. Use **renewable resources** such as water and wind.
5. Use of energy **saver stoves** which people can make. These will not require use of a lot of wood.
6. Construction of **storm barriers** such as **dykes** and **water ways** to withstand the impact of **floods**.

BARRIERS AGAINST THE IMPLEMENTATION OF ADAPTATION ACTIONS

1. Lack of **financial resources** to assist communities in some of the measures which require some funds.
2. Lack of **advanced technology** as well as challenges in using it. For example, the use of solar.
3. Lack of **strong and well-established institutions** to provide and distribute the needed materials, for example, use of energy **saver stoves**.
4. **Some cultural practices** hinder the adaptation measures, for example, considering maize only as a staple food.

BENEFITS OF THE ADAPTATION PRACTICES

1. Contribute to **economic development** as some of these measures tend to increase production.
2. **Alleviates poverty** among the people as some act source of jobs e.g. irrigation
3. Reduces the **risks of disasters** in areas thereby saving people e.g. from floods
4. Some help to **conserve water** and **soil.**

RESPONSE TO CLIMATE CHANGE

This is done through several **policy actions** and **responses** both nationally and internationally that aim at supporting climate change mitigation.

INTERNATIONAL RESPONSE TO CLIMATE CHANGE

This involves **international agreements** in which nations meet and agree on some ways of mitigating climate change. Member countries then ratify such agreements.

EXAMPLES OF INTERNATIONAL AGREEMENTS ON CLIMATE CHANGE

1. **The United Nations Framework Convention on Climate Change (UNFCCC)**

Took place in 1992 in which some nations met under the United Nations. Malawi ratified it in 1994

The objective of this treaty was **to ask nations to stabilise greenhouse gas concentrations in the atmosphere to a level which cannot be dangerous.**

Countries were also reminded **to share information** about emission of **greenhouse gases,** come up with **national strategies** and **cooperate in addressing issues of climate change.**

2. **The Kyoto Protocol in 2001.**

This aimed at **further reducing the Greenhouse gases by industrialised nations** with developing countries contributing on a voluntary basis.

BENEFITS OF THESE INTERNATIONAL TREATIES AND INTERVENTIONS

1. Countries managed to **reduce the release of the greenhouse gases** in the atmosphere from both developed and developing nations.
2. Managed to strengthen **international cooperation** through fighting against climate change which seems to be a common enemy.

CHALLENGES FACED IN THESE TREATIES AND INTERVENTIONS

1. Some were based **on voluntary basis by countries** in the agreements made. Some countries withdrew at will, for example Canada withdrew from the Kyoto Protocol.
2. Some big influential nations **were not willing** to take part because of their level of the industries which would be greatly affected. For example, The United States of America refused to ratify the contents of the Kyoto Protocol.
3. Failure to set **binding** greenhouse **gas emissions reduction targets**. The treaties and conventions just encouraged nations without giving the nations targets to reduce the emissions, especially the **UNFCCC**
4. The targets of reducing greenhouse gases by 5% in Kyoto Protocol exempted **China** and **India** which are major world polluters due to huge populations and growing manufacturing industries.
5. There were **disagreements** between developing nations which most of them did not want to reduce the greenhouse gases and developed nations which most of them depend on industrial production that contribute to greenhouse gas emission.
6. **Inadequate funding** to developing nations to be used in climate change mitigation measures.

NATIONAL RESPONSE TO CLIMATE CHANGE

Malawi as a country has taken some steps in trying to combat climate change effects. The following are some of the roles which the government has taken so far:

1. The Country **ratified** the international agreements which aim at limiting the greenhouse gas emissions. For example, the Government ratified the **UNFCCC in 1994** and **Kyoto Protocol** in **2001.**
2. The country has done some **measures** such as;

(i)Developed the National Environmental Action Plan which recognised climate changes as one of the issues.

(ii)Enacted the Environment Management Act in 1996 which encourages afforestation programmes.
(iii)Takes climate change as one of its priority areas, promoting and adoption of renewable energy sources such as solar and wind.
(iv)Managed to come up with a Ministry of Environment and Climate Change
3. The Malawi government has also managed to come up with some policy measures such as:
(i)Supporting **Organisations** or **individuals** that invest in Climate change
(ii)Introducing **soft loans** for investing in Climate friendly industries.
(iii) Integrated climate change issues into the **education system** to raise awareness of the country's vulnerability to climate change.
(iv) Coming up with **Green Belt irrigation** iniatives to ensure food security in the country.
(v)Managed to come up with **Family Planning sensitization** and programmes in order to ease population pressure on resources in the environment.

SAMPLE QUESTIONS

Mention three gases in the atmosphere which contribute to global warming (3marks)
Describe any two sources of greenhouse gases (4marks)
Explain any two human activities that contribute to the increase of greenhouse gases in the atmosphere. (4marks)
Explain how greenhouse gases contribute to climate change (3marks)
Mention any two examples of greenhouse gases (2marks)
Explain how the effects of climate change can be reduced at (i) National level (2marks) (ii) International level (2marks) (iii) Individual level (2marks)
Describe any two effects of climate change that can be noticed in Malawi (4marks)
Explain any two mitigation measures to climate change (4marks)
Explain any two signs of climate change (4 marks)
Describe how volcanic eruptions can contribute to climate change (3marks)
What is the meaning of the term adaptation as regards to climate change? (2marks)
Explain the difference between climate change mitigation and climate change adaptation (2marks)
Explain any two mitigation measures that can be carried out to reduce the impact of climate change (4 marks)
Identify any two policies that support climate change mitigation at (i) National level (ii) International level (4marks)
State any three benefits that arise from adapting to climate change(3marks)
Mention any two constraints that hinder the implementation of adaptation actions to climate change (2 marks)

GEOGRAPHICAL INFORMATION SYSTEM (GIS)

This is a system designed to **capture, store**, **manipulate**, **analyse, manage** and **present spatial** or **geographical data**. It is a computerized system that facilitates the phases of data entry, data analysis and data presentation.

SPATIAL DATA

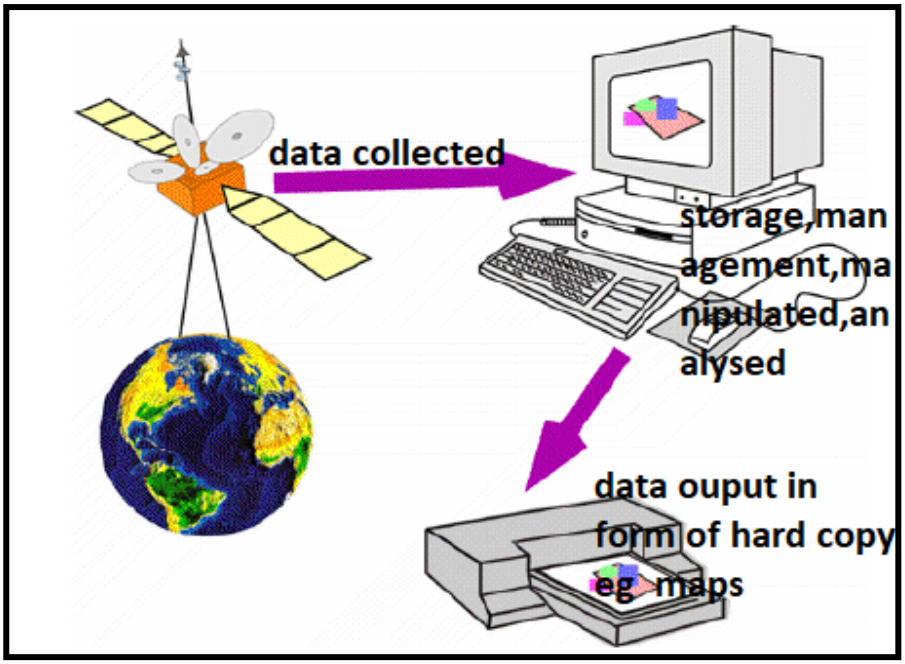
This is the data with **location**, containing information about the **location**, **shape** and relationship among geographical features.

TYPES OF SPATIAL DATA

1. **Vector data.** This is made up of points, lines or polygons
2. **Raster data.** Made up of grid cells with each cell having a value to represent what lies where the box is.

COMPONENTS OF GIS

1. **Hard ware and software data input**. This is the **computer** on which GIS operates with programmes. This allows the **collection of data** in form of digital or computer readable form to be used and analysed for some purpose.
2. **Data storage**: These are **facts and statistics** collected together for reference or analysis. There is **data management** and **analysis** that is displayed on the **computer monitor**.
3. Data **manipulation functions** that allow data from **disparate** sources, that is, from many sources and parts to be used simultaneously.
4. **Data output by People**: People operate the **system** and decide on the methods of capturing, manipulating and analysing the data required from the input. It deals with **an output system** that generates **hard copy**, **images** and other types of output



HOW GIS OPERATES

1. There is assembly of data **inform of typing** directly into the computer, using GPS or digital scanning.
2. There is **data storage** using the data base in the computer.
3. There is **analysing,** and **manipulation** of the data stored.
4. There is data **output** which is inform of **tables** and **maps.**

THE GIS PROCESSES

It involves **six steps** that are common to what is referred to as the end to end map making process

1. Defining the **spatial problem** or question
2. Defining the GIS **criteria**
3. Importing or **creating** the **data sets**
4. **Performing** the GIS analysis.
5. Creating output
6. Deciding whether the output solves or answers the spatial question. If not, then refine the problem and start the process again

GIS APPLICATION

Use of GIS is important in many areas such as

1. **Cartography** which deals with production of maps
2. **Land** use planning
3. Mapping **archaeological** sites to identify features
4. Environmental studies
5. Power line inspection
6. Surveillance e.g. diseases in health sector
7. Commercial advertising
8. Urban and regional planning
9. Population studies

Note that GIS use **remote sensing**, **satellite images** and **aerial photographs**.

REMOTE SENSING

This is the collection of information relating to objects without being in **physical contact** with **them**. The **sensors** collect data information of images which are integrated within a GIS.

Remotely sensed data come from **cameras** on board satellites, airplanes, shuttles, and balloons.

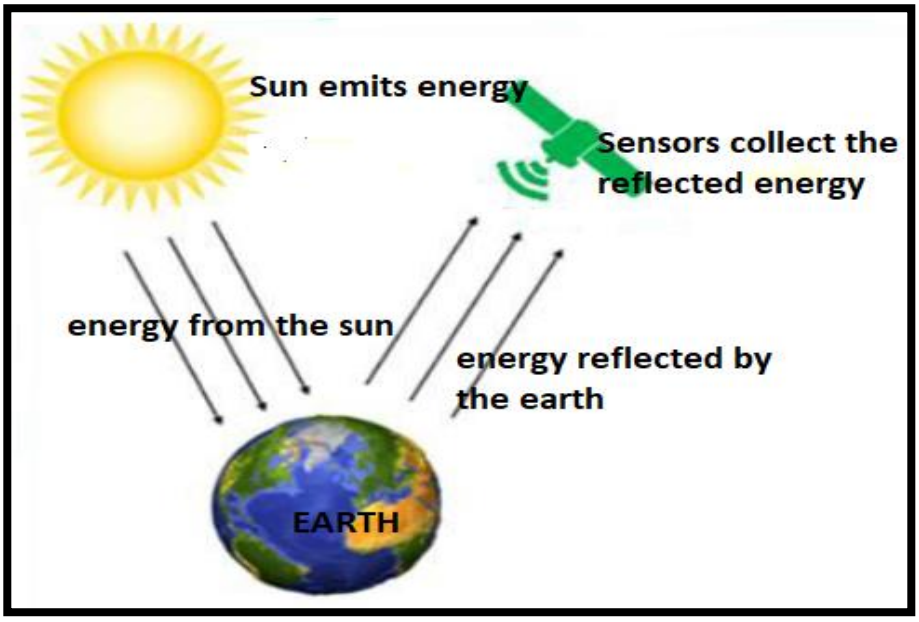
Aerial photographs and **satellite images** are common examples where remote sensing is used, which work like **eyes** and **ears** in human beings.

FEATURES AND PROCESSES OF REMOTE SENSING

1. **The Sun**. This provides **solar radiation** inform of **shortwaves**. These waves are absorbed by **features on the earth's surface reflected** into the atmosphere as **thermal infrared waves**.
2. **The land features.** These include soil, water bodies, forests, mountains, building and anything found on the earth's surface. These are **a target** in remote sensing as they **reflect waves** from the sun which are **captured by the sensors** mounted on platforms or aero planes or balloons.
3. **Sensors.** These are **special cameras** mounted on airplanes or satellites. These **collect the images of features** on the earth. There are **two** types of sensors or remote sensing:

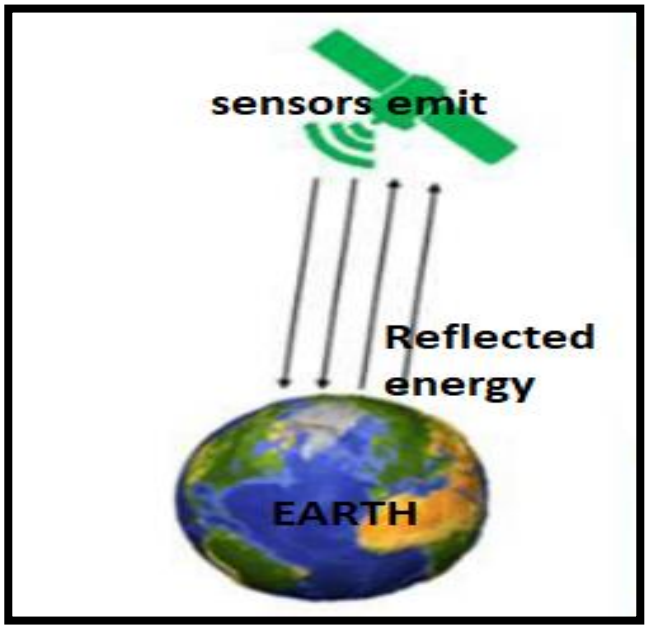
(i)**Passive Remote Sensors**.

These use the energy from the **sun that is reflected or emitted** from the **observed object**. These greatly **depend on the reflected rays** from the earth's crust. For example, Cameras



(ii)**Active Remote Sensors**

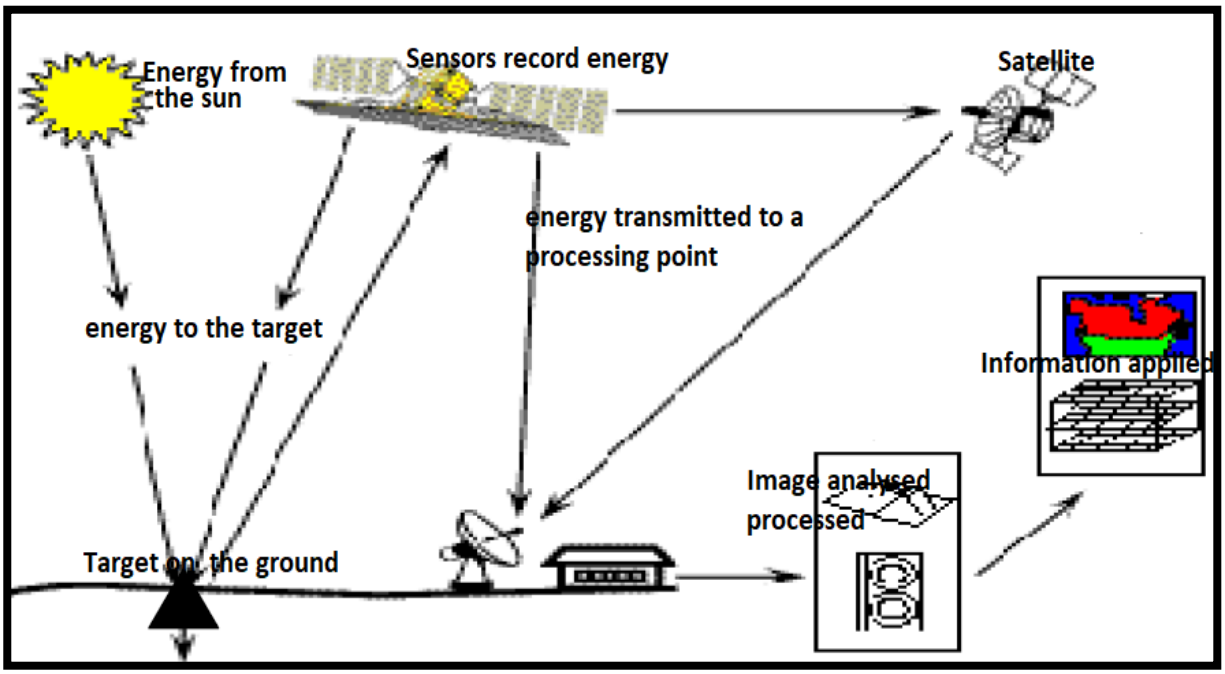
These beam **their own energy** to a target or a feature and **record the reflected** component. These emit their **own energy to an object and receives** the reflected energy at the same time. Examples of these include **RADAR** (Radio Detection and Ranging) and Sonar.



4. **Data processing**

The collected data is transferred from the **remote sensors** down to the **control station** where **computers** are used to process and analyse it. Using GIS, the information is then processed.

PROCESSES INVOLVED IN REMOTE SENSING



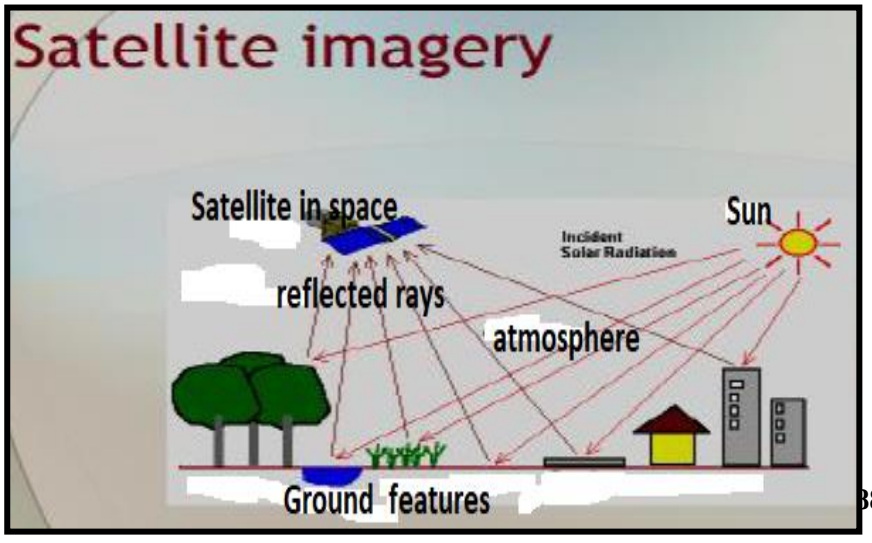
APPLICATIONS OF REMOTE SENSING

Remote sensing makes it possible to collect data on dangerous or in accessible areas.

1. Help to monitor **risks areas** making people to take **relevant measures** of environmental management e.g. desertification, deforestation, climate change.
2. Used in mapping large **scale fires**
3. Helping to explore **mineral deposits** under the ground.
4. **Mapping the oceanic** bottom thereby exploring the topography of the ocean floor and marine features.
5. Checking clouds thereby helping in **weather prediction** especially in meteorology
6. Monitoring **geological processes** and **disasters** such as volcanic eruptions and earthquakes.

SATELLITE IMAGES

These are taken in space with cameras mounted on satellites and aircraft or space crafts.



GOOGLE EARTH

This is a computer software programme used to view satellite images.

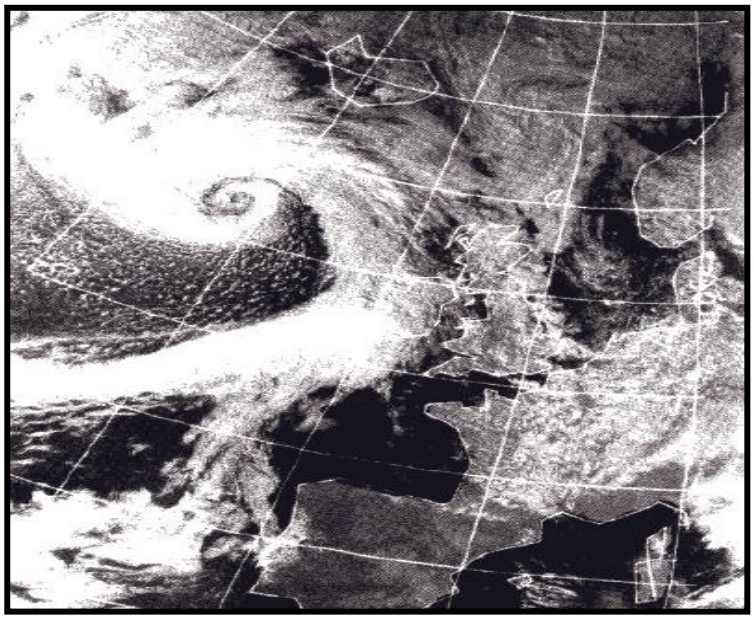
ADVANTAGES OF SATELLITE IMAGES

1. **Large amount of data** is collected within a short time.
2. Information collected does not recognize **international boundaries** hence there are **no delays** in collecting data.
3. The data can be taken from areas where it is **difficult to reach** e.g. deep seas
4. Promote **human security** as it is used by the army.
5. Forms a basis for **research.**

DIASDVANTAGES OF SATELLITE IMAGES

1. Since are taken from space, they are **disturbed** by weather changes such as clouds.
2. There are **low quality** of pictures since they are taken from very far from the ground.

AN EXAMPLE OF A SATELLITE IMAGE SHOWING THE DEPRESSION IN BRITAIN



AERIAL PHOTOGRAPHS

These are pictures taken from the **air using aeroplanes**, balloons, drones or rockets. Aerial photography is another form of remotely sensed data.

Aerial photographs are of two types.

(1) Vertical aerial photographs
(2) Oblique aerial photographs

1. VERTICAL AERIAL PHOTOGRAPHS

These are taken at **right angles** to the ground with an aeroplane flying straight.

2. OBLIQUE AERIAL PHOTOGRAPHS

These are taken **with cameras tilted** at an angle less than a right angle.

Oblique photographs are of two types.

A) **High oblique** – In which the photographs **show horizon**.

B) **Low oblique-** In which the photographs **do not show the horizon**.

DIFFERENCES BETWEEN AMAP AND PHOTOGRAPHS

1. Aerial photographs **show more details of the actual surface** as maps show what the map **makers have decided are important**.
2. On the map all features **are drawn as if seen directly from above** anywhere where as in photographs **all features are seen from an angle**.
3. Maps are **drawn to scale** while as in aerial photographs there **is no uniform scale** used.
4. Maps take a **very long time to be produced** while aerial photographs take a **very short period** to be produced.
5. In maps **symbols are used** to show features and land uses of an area while as in aerial photographs **real images of features** in details of size, shape, and quality are clearly shown.

DIFFERENCES BETWEEN AERIAL PHOTOGRAPHS AND SATELLITE IMAGES

1. Aerial photographs have **better resolution** while satellite images have **poor resolution** as they are taken **very far and disturbed by weather** conditions.

2. Aerial photographs are taken at a **lower altitude** within the atmosphere while satellite images are taken from **above the atmosphere in space** by satellites orbiting the earth.

3. Aerial photographs are taken by **cameras in aeroplanes**, drones or balloons while as satellite images are taken and recorded **by electronic scanners** mounted on satellites in space.

APPLICATIONS OF AERIAL PHOTOGRAPHS AND SATELLITE IMAGES

1. Used by map makers in **cartography** to make maps, providing details about the landscape of an area.
2. In **archaeology**, these are used for locating minerals under the ground.
3. Town planners use them in **urban studies** to develop and locate infrastructure, roads and new facilities.
4. In **climate,** these are used for detecting climatic hazards such as droughts, floods.

GLOBAL POSITIONING SYSTEM

This is a **satellite-based** system for determining accurate position on or near earth's surface.

Key words

GeographicalInformationSystem(GIS),Remotesensing,data,analysing,manipulating,spatial,satellites,passive sensing, active sensing,oblique,vertical.

Sample Questions

Define the term remote sensing (2marks)

Mention any two areas where remote sensing is important (2marks)

What do you understand by the term Geographical Information System (GIS)? (2marks)

Mention any two differences between aerial photographs and satellite images (2marks)

Explain any two differences between maps and aerial photographs (4marks)

Describe the role of the following in remote sensing (i)Land features (ii)Sensors (iii)The sun (2marks each)

Explain the difference between Active remote sensing and Passive remote sensing (2marks)
Describe how the GIS operates (4marks)

CLIMATE AND VEGETATION

CLIMATE. This refers to average weather conditions of a place **for a long time** and it covers **a large** area.
WEATHER. This refers to the condition of the atmosphere of an **area for a short period** of time and it **covers a small** area.
CLIMATIC REGION. An area in the world with **similar climatic** conditions.

MAJOR CLIMATIC REGIONS OF THE WORLD

1. Hot climates such as the **equatorial, tropical desert, tropical continental and tropical monsoon**
2. **Warm climates** such as the **Mediterranean climate**.
3. **Cool climates** such as the **Siberian climate**
4. **Cold climates** such as **Tundra climate**

MAIN CLIMATES

1. Equatorial climate
2. Tropical continental or Tropical Sudan
3. Tropical desert
4. Tropical Monsoon
5. The Warm Temperate Western Margin or the Mediterranean
6. The Siberian
7. The Tundra

CRITERIA USED FOR CLASSIFYING WORLD CLIMATES

1. **Temperature. This** refers to the degree of hotness or coldness of an area. Different parts of the world receive different amount of temperatures which tend to control the activities different areas.
2**. Precipitation. The** falling of solid and liquid forms of water from the atmosphere on the earth's surface tend to bring different conditions hence controlling people's activities.
3. **Latitude. This** refers to the **distance from the equator**. Areas which are close to the equator experience higher temperatures than far from the equator hence different climates.
4. **Distance from the sea**. Some areas are greatly influence by the sea through the winds blowing towards them carrying moisture from oceans.

IMPORTANCE OF CLIMATE

1. Determines the **type of crops** to be grown in a certain region
2. Control **peoples activities** such as housing and clothing.

3. Determines the **type of vegetation** found in an area.

THINGS TO TAKE NOTE OF WHEN DEALING WITH CLIMATES GIVEN A TABLE OR GRAPH

1. **Identifying** the type of climate

This can be done by checking the **distribution of rainfall** and **temperature**. For example, the **Equatorial climate** will show **heavy rainfall** well distributed **throughout** the year with a **very small temperature range**. Desert climate has very **low total amounts of rainfall** with some months **not registering any amount** at all,

while as the **Mediterranean** climate will receive **higher amounts of rainfall** in **winter,** that is, when temperatures are very **low. Tropical Sudan** receives heavy rainfall in **summer** only with **winters** very dry.

2. Finding the **annual temperature range**

This is done by **subtracting** the **lowest** temperature from the **highest** temperature in a year.

3. Calculating the **average temperature** for the station.

This is done by **adding** the **temperatures** for the whole year and **dividing** the result by **12.**

4. Calculating the **total amount of rainfall** for the station.

This is found by **adding all rainfall amounts** for all months for the station.

5. Stating whether the Station is in the **northern** or **southern** hemisphere

This is done by **observing** the **temperature**. When the temperatures are higher in **June** and **July** it means the Station is in the **Northern Hemisphere** because it experiences **summer** during these months due to **overhead sun** along the tropic of cancer. When the temperatures are **higher** in **November, December** to **January** it means the Station is in the **southern hemisphere** as it experiences **summer** during these months due to **overhead** sun along the **tropic of Capricorn**.

6. **Characteristics** of the climate

This is done by observing **rainfall** amounts and **temperature**. Some climates receive rainfall in winter while others receive heavy rainfall well distributed throughout the year, others very dry while others receive heavy rainfall in summer only. In terms of temperature, others have a small temperature range, others higher temperature range, while other climates have temperatures that go below the freezing point.

7. Type of **vegetation** associated with the climate

For example, desert vegetation, tropical evergreen, tropical savannah, coniferous

8. **Adaptation** of the vegetation to the climate

This is because of **temperature** experienced and **rainfall amounts** received. For example, long roots, thick stems or trunks, loss of leaves, climbing other trees, buttress roots, conical shape, thorns or spikes, succulent stems, and umbrella shaped.

9. Examples of **trees** found

Mahogany, Ironwood, Ebony, Cypress, Spruce, Baobab, Acacia, Eucalyptus, Cactus, Teak

10. **Problems** experienced in the climates

These mainly come because of **temperatures** experienced and **amount of rainfall** which affects **agriculture** and **human beings**. For example, drought conditions, floods, pests and diseases, frozen soils, leaching and erosion, excessive heat and sand dunes.

11. **Economic** activities

The conditions experienced in each climate determines the economic activities such as, Plantation farming, nomadic pastoralism, fruit canning, cereal cultivation, lumbering, shifting cultivation,tourism,wine production, saw milling and paper and pulp making.

12. Plotting a **bar graph** if given a table.

This is done using either **temperature** or **rainfall amounts**. Care should be taken if the question requires either a **bar graph** or a **histogram**. Remember a bar graph there are spaces between the bars while as a histogram has joined bars. Observe the scale given e.g. **2cm** to represent **50mm** of rain and any other instructions such as the space between the bars and the width of the bars.

13. Examples of **countries** with the given climate

It is important to know examples of such countries in the **Northern** hemisphere and in the **Southern** hemisphere. For example, in the Mediterranean climate, Cape Town, South Africa is in the Southern hemisphere while California in the United States of America is in the northern hemisphere.

1. EQUATORIAL CLIMATE

LOCATION. Between **0^0 and 5^0 North or South** of the equator.

CHARACTERISTICS OF THIS CLIMATE

1. **Heavy convectional rainfall** well distributed all the year round with double maxima. Total rainfall is between **1500** to over **2000mm**
2. **High temperatures** all the year round of up to **26 ^{0} C** with every day being like summer.
3. It has a **small temperature range** of between **1 and 3^0C**
4. It has **no distinct seasons** due to **heavy rainfall** all year round and **high temperatures**. High rainfall is as a result of the convergence of the **trade winds** along the doldrums

CLIMATIC DATA FOR EQUATORIAL

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Temp ^{o}C	25	25	25	25	25	24	23	25	25	25	25	25
Rainfall (mm)	138	144	194	190	83	24	13	58	117	173	225	223

Total rainfall: 1582 mm

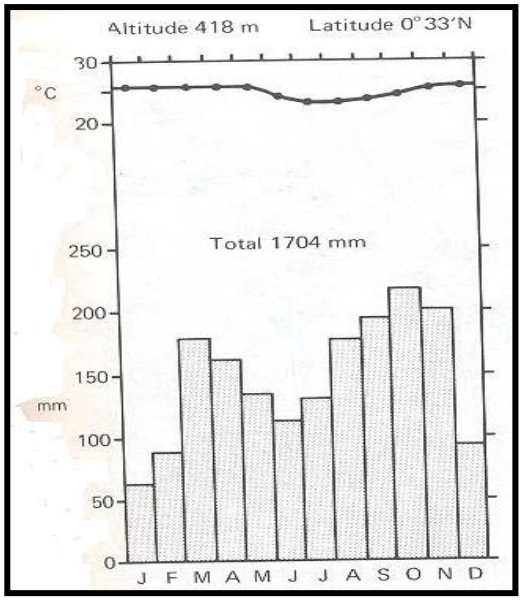
Annual temperature range: 2°C

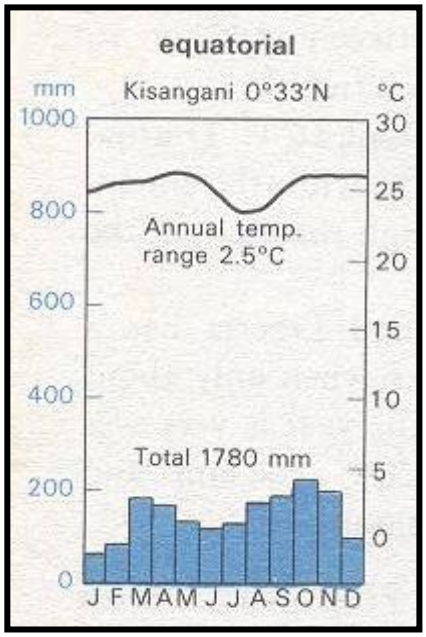
TOTAL RAINFALL = 1582mm

Annual temperature range **25^0C-23^0C =2^0C**

The station is in the **Southern hemisphere** as temperatures are higher from **November to December** which is **summer** in the Southern hemisphere

SOME CLIMATIC GRAPHS FOR THE EQUATORIAL CLIMATE





NOTE : both graphs have heavy rainfall well distributed all year round with a double maxima

EXAMPLES OF COUNTRIES WITH THIS CLIMATE

- Guinea Coast
- Malaysia
- Indonesia
- Amazon Basin
- Congo Basin or DRC
- Philippine

VEGETATION

It has the **equatorial evergreen** forest with the following characteristics:

1. Evergreen with broad leaves and **luxurious growth**
2. Contains a **variety of plants** which are close together
3. Forms **complete canopy**
4. Trees occur **in layers with tallest** trees having buttresses
5. **Climbing plants** such as lianas

ADAPTATIONS OF THE VEGETATION

1. **Large flat leaves** facing the sun for transpiration
2. **Leathery** leaves to prevent wilting
3. **Shiny slippery** surface of leaves to shed water
4. **Long buttress roots** for support
5. **Climbing** plants for sunlight

EXAMPLES OF TREES IN THIS VEGETATION

- Mahogany
- Ebony
- Rosewood
- Ironwood
- Greenheart
- Chengal

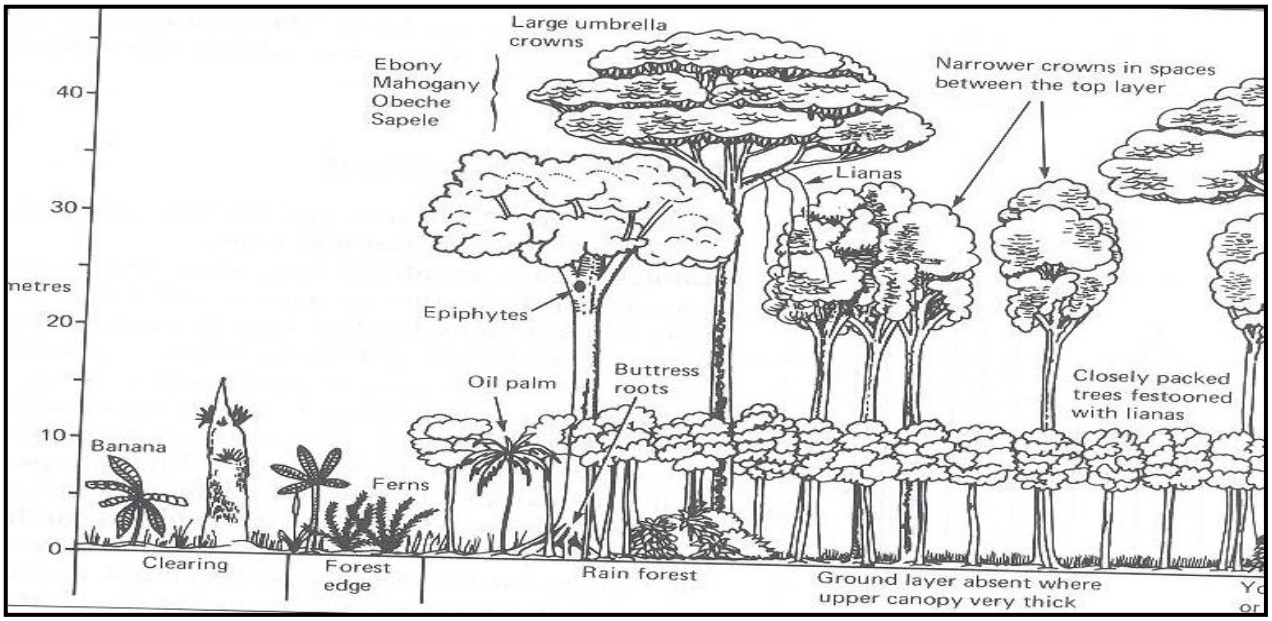
POTENTIAL ECONOMIC DEVELOPMENTS IN EQUATORIAL CLIMATE

1. **Lumbering** due to the presence of trees such as **mahogany** which are used in **timber for furniture**
2. **Shifting cultivation** by certain tribes in the Congo Basin, Malaysia and Indonesia
3. **Plantation farming** with crops such as rubber, oil palm, cocoa, sugarcane
4. **Hunting** and collecting fruits by some tribes

PROBLEMS HINDERING DEVELOPMENT IN THE EQUATORIAL

1. Outbreak of **pests and diseases** which attack plants and animals including people
2. **Rapid deterioration of soil** due to leaching and erosion
3. difficult in constructing **roads** due to thick forest full of dangerous animals
4. **High temperatures** affect the health of the people when working

SOME PICTURES OF THE EVERGREEN EQUATORIAL VEGETATION



NOTICE: Trees are close and occur in layers

2. THE TROPICAL CONTINENTAL OR SUDAN CLIMATE

LOCATION: Between **5^0 and 15^0 North and South** of the Equator

Best developed in Africa and South America with the following as examples of countries with this climate include Malawi, Zimbabwe, Tanzania, Kenya, Parts of Brazil, Australia

CHARACTERISTICS OF THIS CLIMATE

1. **Heavy convectional rainfall which falls in summer** only while winters are **dry without rainfall**.
2. Annual rainfall of around **760** and **800mm**
3. Summers are very **hot with temperatures up to 32^0C**
4. Annual temperature range of between **8^0C and 11^0C**

CLIMATIC DATA FOR TROPICAL SUDAN

This station is in the **Southern hemisphere** as the **highest temperatures** are from November to January which is summer in the Southern hemisphere.

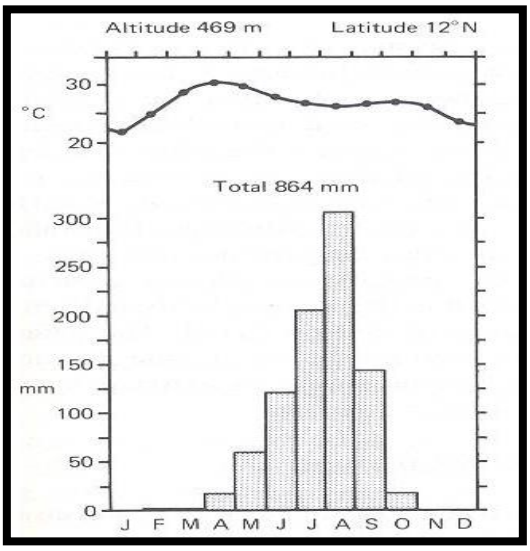
Tropical continental climate for Lilongwe (altitude 918m, 13°49'S).

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Temp °C	22	21	21	19	16	14	15	16	20	22	23	22
Rainfall (mm)	205	220	154	36	8	0	0	4	5	9	85	131

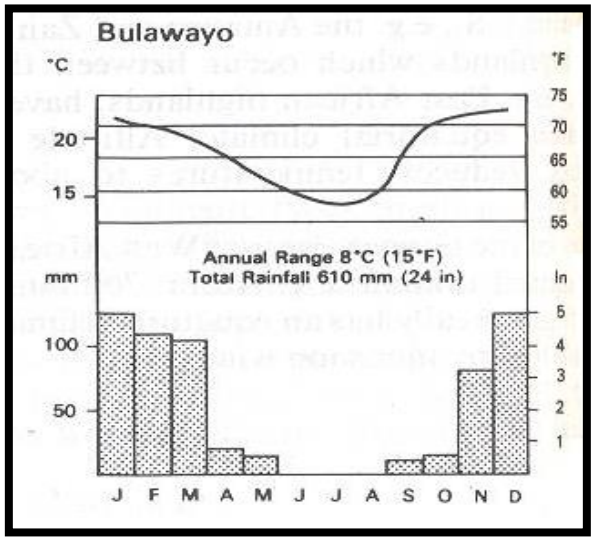
Total rainfall: 857mm

Annual temperature range: 8°C.

SOME GRAPHS FOR TROPICAL SUDAN CLIMATE



This is a Station in the **Northern hemisphere** as it has higher temperatures in **June to July** which is **summer** in the **Northern hemisphere**.



This is a station in the **southern hemisphere** as has **higher temperatures** from November to January which is **summer** in the Southern hemisphere.

THE VEGETATION

It is associated with the **Tropical Savannah** which is characterised by tall grass of **2metres** with **scattered trees**. This name Savannah applies to **Africa** and **Australia** while in **Guiana** in South America is called **Llanos** and Brazilian highlands are called **Campos.**

ADAPTATIONS OF THE VEGETATION TO THE TROPICAL CONDITIONS

1. Trees are **deciduous**, that is, they **lose or shed leaves in dry months in order to reduce transpiration**.
2. Develop **swollen or thick trunks** for **water storage** to be used in drier months e.g. **Baobab**.
3. Grasses **wilt or turn brown** and remain **dormant during the dry months**.
4. Have **long roots** to get water from deep **down** the ground.
5. **Umbrella** shaped which **conserves moisture by covering the radius of roots.**

EXAMPLES OF TREES

Baobab, Acacia**,** Bottled trees

ECONOMIC DEVELOPMENTS IN THE TROPICAL SUDAN

1. It is a home of **wild animals** and is called **a big game country**. Examples of animals are antelopes, zebras, elephants, buffaloes, giraffes, lions, leopards.
2. **Plantation farming** is practiced with sugarcane, tea, coffee, cotton as some crops
3. Livestock is kept by the **nomadists.**

PROBLEMS THAT HINDER ECONOMIC DEVELOPMENT

1. **Unreliability** of rainfall with **drought** conditions with affect the **growth of crops**
2. **Loss of soil fertility** through erosion due to **torrential downpours** in summer
3. **Excessive heat** in summer which affects people
4. Tropical **diseases** and **pests** affecting **crops and animals**

PICTURES OF VEGETATION OF SAVANA

NOTE. This **baobab** is adapted to the conditions in that it has **lost its leaves**, it has a **thick trunk, and umbrella** shaped and **long roots.** The vegetation is known for game.

3. TROPICAL DESERT CLIMATE

These are regions where **aridity is the most outstanding feature because precipitation is both scarce and unreliable.**

LOCATION: Between Western sides of continents between **15^0 and 30^0 North and South** of the equator.

REASONS FOR THE EXISTENCE OF DESERTS IN THESE AREAS

1. Influence of the **horse latitudes** in which winds moves out of the areas making such areas to be dry. The descending **winds that come from the atmosphere are completely dry.**
2. The existence of the **cold ocean currents** which **do not bring rainfall** to the adjacent landmasses as are **not able to pick up moisture**.
3. Some of such areas **lie in the rain shadow areas** with mountains acting as **barriers to rain bearing winds.**

EXAMPLES OF HOT DESERTS

DESERT	**COUNTRY**	**HEMISPHERE**
Great Australian	Australia	Southern
Arabian	Saudi Arabia	Northern
Iran	Iran	Northern
Thar	India	Northern

Great Sahara	Morocco,Algeria,Mali,Libya,Chad	Northern
Kalahari	Botswana	Southern
Namib	Namibia	Southern
Atacama	Chile	Southern
California	United states of America	Northern

CHARACTERISTICS OF HOT DESERT CLIMATE

1. Get less than **250mm** of rainfall annually.
2. **Great diurnal** temperature range as temperatures are very **high during the day** due to absence of clouds and very **low at night due to absence** of clouds that can form a blanket.
3. **High temperatures** and **low humidity**.
4. **Poor** sand **soils** of sand dunes

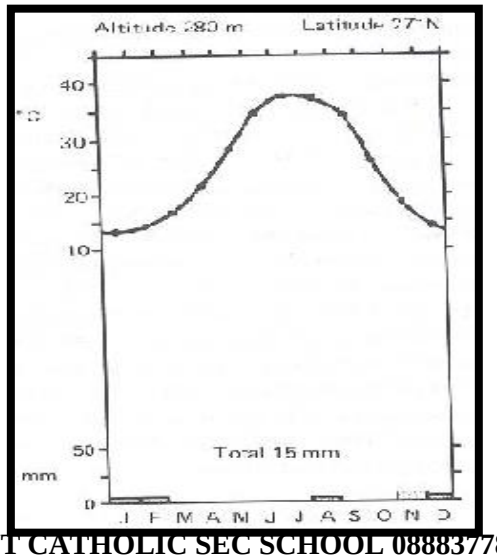
CLIMATIC DATA FOR DESERT CLIMATE

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Temp ^{O}C	20	22	25	30	32	33	31	30	30	30	30	30
Rainfall (mm)	0	0	0	2	3	25	77	83	37	0	0	0

Total rainfall: 227mm
Annual temperature range: 13°C

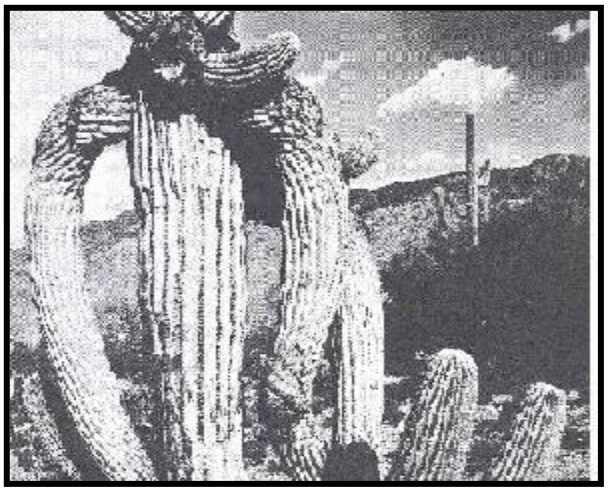
The station is in the **Northern hemisphere** as it has **higher temperatures in June and July** which is **summer** in the northern hemisphere. The graph below is for a place in the **Northern hemisphere** based on the same reason.

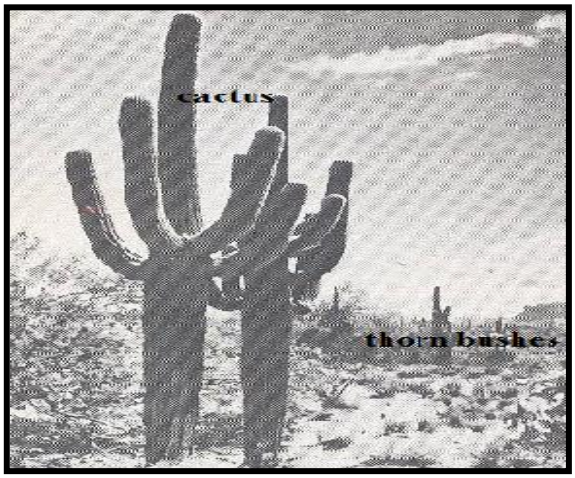
GRAPH ABOUT DESERT CLIMATE



NATURAL VEGETATION

Xerophytic plants which are **drought resistant** e.g. cactus, mulga, dwarf scattered acacia, porcupine grasses and thorn bushes.





GIANT CACTUS which is adapted to desert conditions as it has **spines to reduce water loss**, **thick succulent stems** to keep water, **long searching roots** to get the scarce water, **no leaves to reduce water loss**

ADAPTATION

1. Some like cactus **store water** in their **succulent** stems, develop **long roots** to search ground water, have **spines** instead of leaves to reduce transpiration, **tough waxy layer** to reduce water loss
2. Many plants produce seeds which **lie dormant** for years until a little rain comes.
3. Many plants are **thorny to protect from desert animals** and **reduce transpiration**.

ECONOMIC DEVELOPMENT

1. Crops are grown in **Oases** e.g. date palms, wheat, vegetables
2. **Nomadic pastoralism** takes place with tribes such as the Fulani.
3. Have **minerals** such as **oil, gold** which are mined.

PROBLEMS THAT HINDER ECONOMIC DEVELOPMENT

1. **Scarcity of rainfall** and **very high temperatures** hinder **crop growing**.
2. Areas are full of **sand dunes**, which are **not fertile.**
3. **Scarcity of water** for plants and animals.
4. **Strong winds** that blow dust, not good for **eyes and the body**.
5. **Very low temperatures** at night requiring **clothes for warmth**.

4. TROPICAL MONSOON CLIMATE

This climate depends on the **Monsoon winds which change direction according to seasons**

Best developed in South East Asia-India, China, Japan, Philippines and Manila. It also develops in Northern Australia and some parts of East coast of Africa.

CHARACTERISTICS OF MONSOON CLIMATE

1. A **Seasonal reversal** of the **winds** is the main feature.
2. **Heavy summer** rainfall which varies greatly between **620mm** to over **2000mm** annually.

3. **Three seasons** are experienced namely hot, dry season, cool dry season and hot wet season
4. Temperatures range from about **32^{0}C in hot season to 15^{0}C in cool season**.

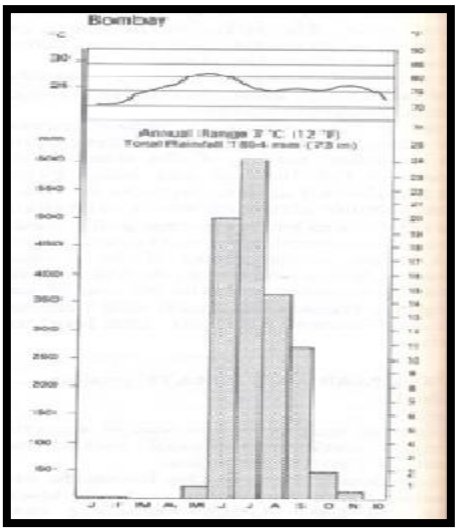
CLIMATIC DATA FOR MONSOON

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Temp ^{o}C	25	25	27	30	28	27	27	27	27	26	25	25
Rainfall (mm)	4	6	6	50	308	480	582	528	393	176	75	8

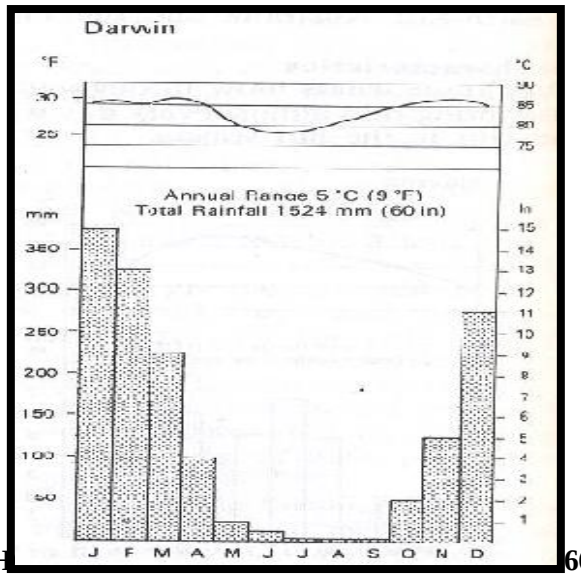
Total rainfall: 2616mm
Annual temperature range: 5^{o}C

Note that the difference with **tropical monsoon and Sudan if given a table is that Monsoon has higher rainfall with no months without rain completely. This Station is in the Northern hemisphere. This is because** higher temperatures are experienced in **June and July** which is summer in the northern hemisphere.

SOME GRAPHS



This graph is in the **Northern hemisphere**. They **experience high temperatures** in June, July to August



This is in the **Southern hemisphere. It has higher temperatures from November to January which is summer in the Southern hemisphere**

NATURAL VEGERTATION

Monsoon forest with the following characteristics

1. Smaller number of **species than the tropical evergreen** of the equatorial climate.
2. Most **trees are deciduous losing leaves** in hot dry seasons just **like in the Tropical Sudan**.
3. **Tall trees but not as close together** as in the **tropical evergreen equatorial** forest.
4. The **undergrowth is dense due to the penetration of light** to the ground which is unlike the **tropical evergreen** in which **there is no undergrowth** as trees form complete canopy which makes it hard for light to reach the ground.

COMMON TREES

- Bamboo thickets
- Teak
- Sandalwood
- Acacia

- Eucalyptus

NOTE: Trees are **not arranged in layers as is the case with the tropical evergreen vegetation**. There is **dense undergrowth which is unlike the evergreen vegetation**. However; trees are close together just like in the evergreen vegetation.

Explain any two differences that can be noticed between monsoon forests and equatorial rain forests

PROBLEMS HINDERING ECONOMIC DEVELOPMENT

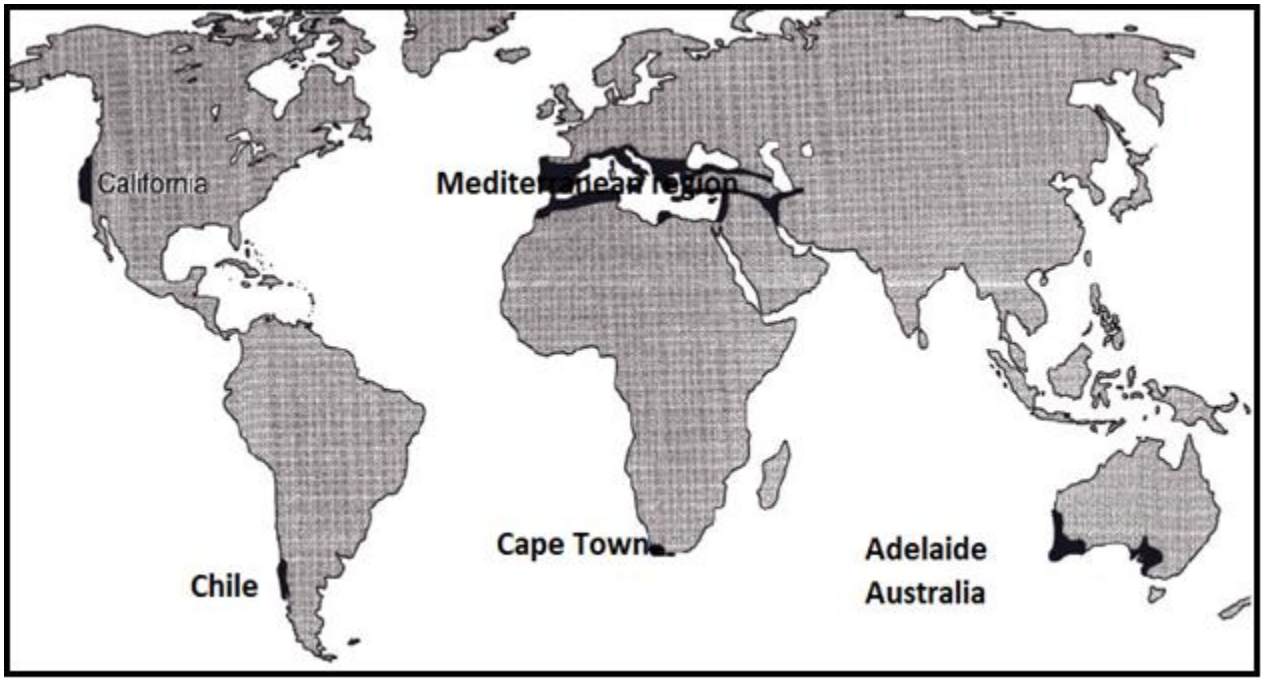
1. **Long drought conditions** before the Monsoon winds **bring rainfall affect crop growing**.
2. **Severe monsoon rains** results into **floods** which wash away crops and infrastructure.
3. **High population** which brings shortage of land for cultivation.
4. **Difficult to maintain soil fertility** due to fragmentation of the land.

5. THE MEDITERRANEAN CLIMATE

This climate takes its name from the coastlands of the **Mediterranean Sea**. It is confined to the **western areas** continents between **30^0 and 45^0 north or south** of the equator.

EXAMPLES OF AREAS WITH THE MEDITERRANEAN CLIMATE

1. Shores of the **Mediterranean Sea** (France, Italy, Spain, Israel) in the Northern hemisphere.
2. **Central Chile** in South America in the Southern hemisphere.
3. **Central California** in the United States of America in the Northern Hemisphere
4. South-Western tip of South Africa around **Cape Town** in the Southern Hemisphere
5. Southern Australia **(Adelaide) in the** Southern hemisphere.



CHARACTERISTICS OF THE MEDITERRANEAN CLIMATE

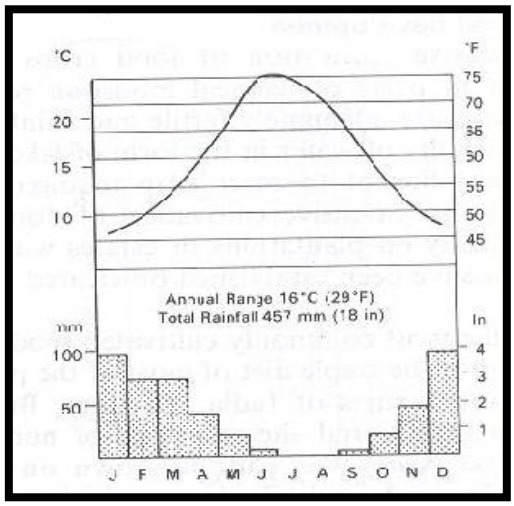
1. **Dry warm summer** as the trade winds are **off shore** there by **not bringing rainfall** with very low humidity.
2. Experience rainfall in **winter** because **of the on shore westerly winds**. This makes the climate to be called **winter rain climate** making **it a distinct climate as all climates receive rainfall in summer**.
3. The annual amounts of rainfall are between **500mm and 700mm**.It rarely reaches **840mm**.
4. Temperature range from **21^0C in summer to 10^0C** or below in winter.
5. Experience both **hot and cold local winds** with the **Sirocco, Mistral, and Bora** as examples.

CLIMATIC DATA FOR THE MEDITERRANEAN CLIMATE

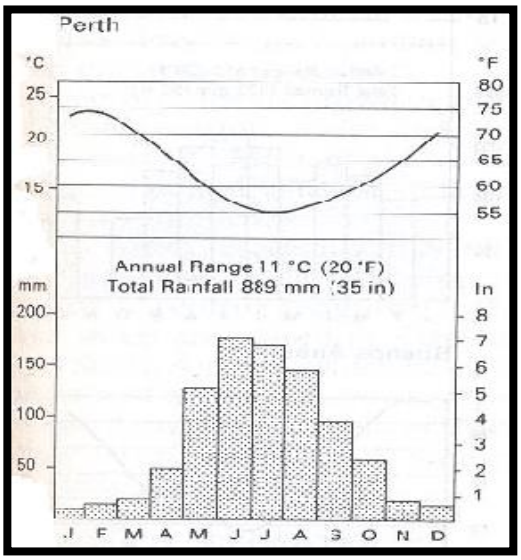
Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Temp ^{O}C	11	11	14	16	20	22	24	24	22	20	15	11
Rainfall (mm)	115	84	74	40	48	13	8	8	38	75	126	133

Total rainfall: 762mm
Annual temperature range: 13°C

This table is in the **Northern hemisphere** as it has higher temperatures in **June** and **July**.
Note that the Station receives **higher amounts of rainfall** from November to January where temperatures are **lower** which is a characteristic of this climate.



The graph above shows the Mediterranean climate in the **Northern hemisphere** as the temperature are higher in June and July.
Note that the station receives **higher amounts of rainfall** from **November to January** where temperatures are **low** which is a characteristic of this climate.



The graph above is the Mediterranean climate in the **Southern Hemisphere** as temperatures are higher from **November to January**.
Note that the station receives **higher amounts of rainfall** in **June and July** where temperatures are **low** which is a characteristic of this Mediterranean climate.

VEGETATION IN THE MEDITERRANEAN CLIMATE

It has the **Mediterranean vegetation** which is a transitional between hot deserts and temperate forests. This vegetation exists in form of:

1. Evergreen coniferous forests-pines
2. Mediterranean evergreen forest-open woodlands with oaks
3. Mediterranean bush and shrubs.

EXAMPLES OF TREES FROM THIS CLIMATE

Pines, Firs, Eucalyptus, Cypresses, Oaks

ADAPTATION OF THE VEGETATION

1. **Thick barks** for water storage.
2. **Conically** shaped trees to cut the surface area for transpiration.
3. **Needle shaped** leaves to cut off transpiration.
4. **Long tap roots** to get water from the ground.

ECONOMIC DEVELOPMENTS IN THE MEDITERRANEAN REGION

1The region is known for **fruit farming** e.g. oranges, lemons.
2. The **region produces cereals** such as wheat and barley.
3. The **mountain pastures support** animals such as goats, sheep and cattle.
4. **Wine production** is speciality of this climate.
5. **Favourable for tourism** since summers are warm and bright.

PROBLEMS WHICH HINDER DEVELOPMENT

1. **Drought** conditions which affects **crop production**
2. **Land shortage** due to population increase, which is solved by **terracing upland areas**.

PHOTOGRAPH OF THE MEDITERRANEAN VEGETATION

6. SIBERIAN CLIMATE

Mainly located in the **Northern hemisphere** from Alaska to Hudson Bay and Sweden 60^0N
Examples of some countries with this climate are **Canada** and **USSR** with Tundra climate to its north.

CHARACTERISTICS OF THIS CLIMATE

1. **Bitterly cold and long winters**, with temperatures from -34^0 to -50^0C.
2. It has a **large annual temperature range** of more than 30^0C.
3. **Cool brief summer** with temperatures of 21^0C.S
4. Total annual rainfall is between **380mm and 635mm** but well distributed throughout the year.

CLIMATIC DATA FOR SIBERIAN CLIMATE

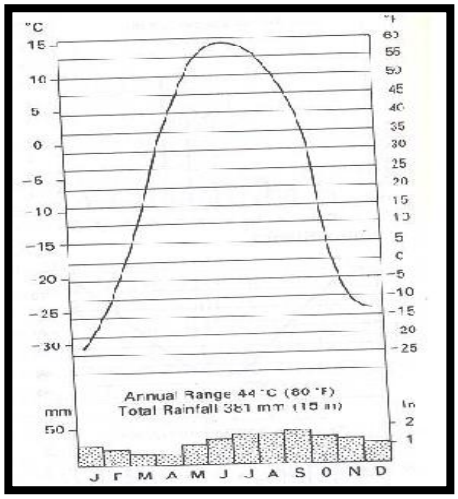
The cool temperate continental climate for Winnipeg (Altitude 240m, 49°50'N)

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Temp °C	-19	-18	-10	0	13	17	20	17	12	0	-8	-17
Rainfall (mm)	25	25	32	36	57	76	75	62	61	37	27	25

Total rainfall: 538mm

Annual Temperature range=20^0C- -19^0c=39^0C

GRAPH FOR SIBERIAN CLIMATE



NOTE: This climate can be differentiated from Tundra in that it has a **higher maximum temperature** than Tundra.

VEGETATION OF SIBERIAN CLIMATE

It is associated with the **Coniferous forests or Conifers** with trees such as firs, pine, spruce and larch which provide **softwood**. Such trees are conically shaped, have small leaves, there is little undergrowth.

POTENTIAL DEVELOPMENTS IN THIS CLIMATE

1. **Lumbering** which is the most important activity. The following industries depend on lumbering:

(i)Saw milling for plywood, planks and hardboards

(ii)Paper and pulp

(iii)Fuel industry where the soft wood is burnt.

2. **Trapping animals** such as beavers, muskrat, ermine, silver fox which are hunted **for fur**.

3. Grain producing e.g. wheat

7. TUNDRA CLIMATE

Occurs north of **60^0 in the polar region**, best developed in **Northern Canada and North Asia**, as most of the **Southern pole is covered by water**.

CHARACTERISTICS OF THIS TUNDRA CLIMATE

1. Precipitation is less than **250mm** falling in summer but well distributed all the year round.
2. Winters are **severely cold with no day light**, whereas summers are short and brief.
3. The average temperature of the **warmest month is less than 10^0C** but **above 0^0C**.The coldest month records more than **-40^0C**
4. Very large annual temperature range **up to 50^0c**.
5. **Glei soils** with poor drainage.

s CLIMATIC DATA FOR TUNDRA CLIMATE

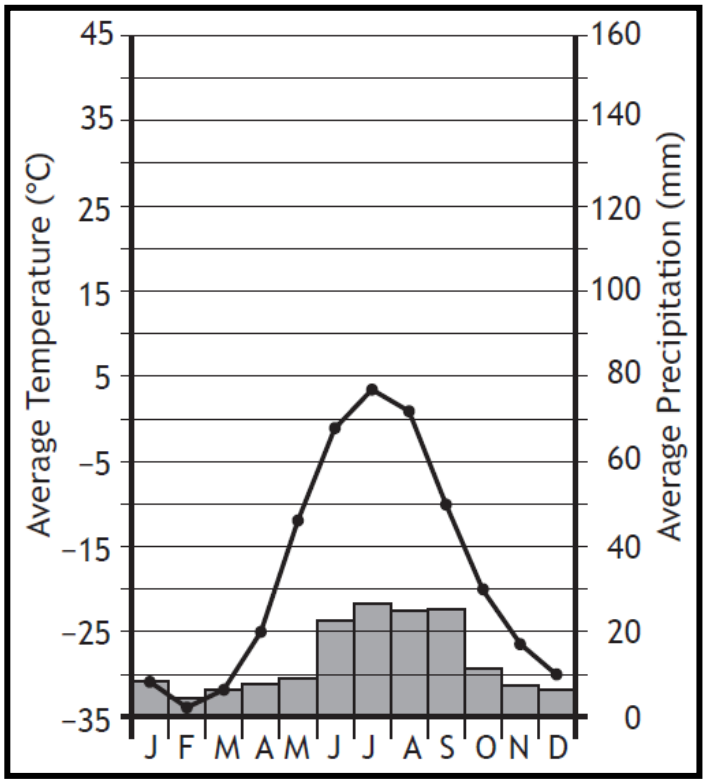
Tundra climate for Upernivik (Altitude 20m, 73°N)

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Temp °C	-20	-23	-20	-15	-4	2	5	5	0	-5	-10	-18
Rainfall (mm)	10	10	15	15	15	15	25	28	25	28	28	13
Daylight hours	0	6	12	16	24	24	24	20	13	8	3	0

Total rainfall: 227mm

Annual temperature range =5^0C- -23^0C=28^0c

GRAPH FOR TUNDRA CLIMATE



Note that the highest temperature is less than 5^0C

VEGETATION IN TUNDRA

The area is **treeless** and dominated by **mosses, linches**, **bilberry**, and **small woody shrubs**. The **reindeer** is the best-known **animal**.

ECONOMIC OR POTENTIAL DEVELOPMENTS

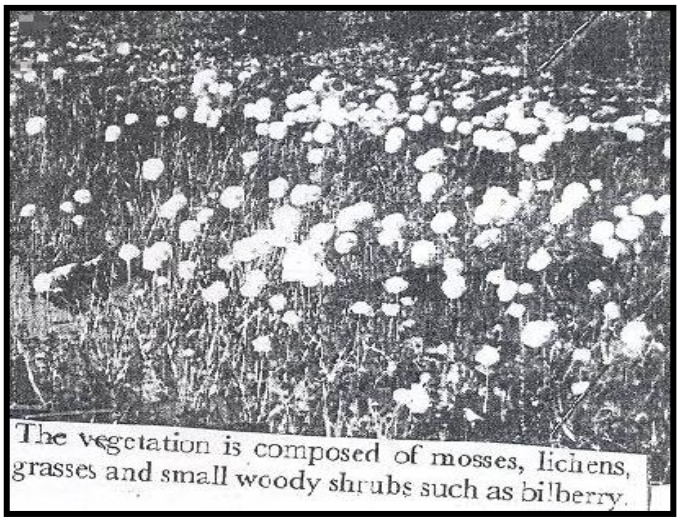
There is **no agricultural** development because of the following reasons:

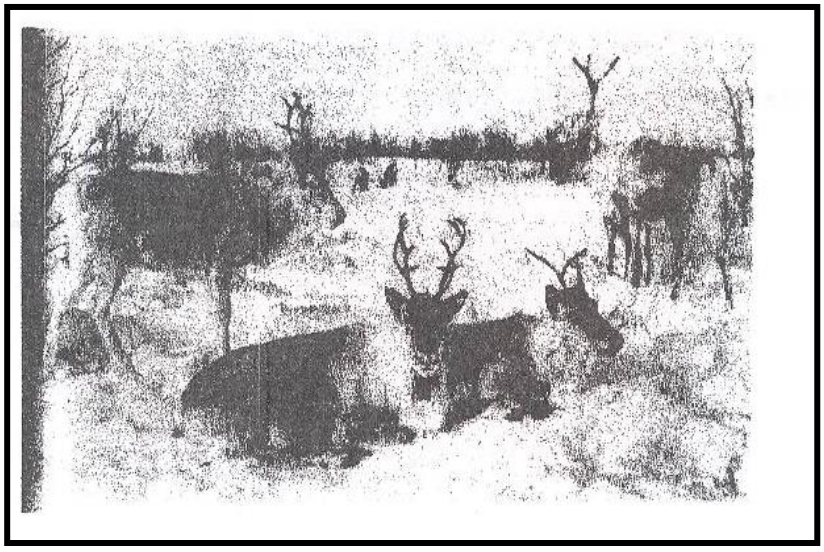
1. Soils are **permanently** frozen
2. **Poor drainage** soils

3. Strong and cold **winters**

SOLIFLUCTION: The process through which thick mud flow down the slopes creating bulges without breaking on the surface in cold polar regions

VEGETATION PICTURES





1. Identify the type of climate shown above
2. Name any **two** examples of countries that experience this climate
3. Explain any **two** factors that affect development in this climate

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The Tables A and **B** below represent the climatic data for the **two** climates. Study them and use them to answer the questions that follow.

Place A

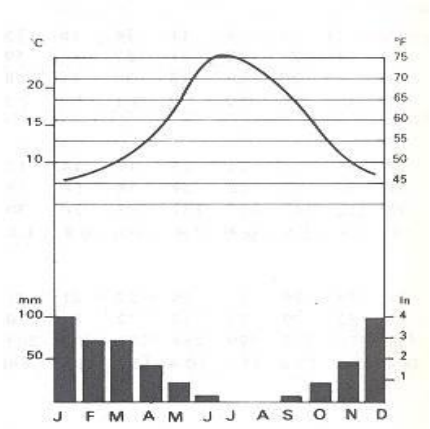
	J	F	M	A	M	J	J	A	S	O	N	D
Temperature °C	24	24	22	19	16	14	13	14	15	16	19	22
Rainfall mm	8	11	20	46	125	185	175	138	81	55	21	14

Place B

Temperature °C	26	26	27	27	28	27	27	27	27	27	26	26
Rainfall mm	218	155	165	175	183	170	173	218	180	208	254	264

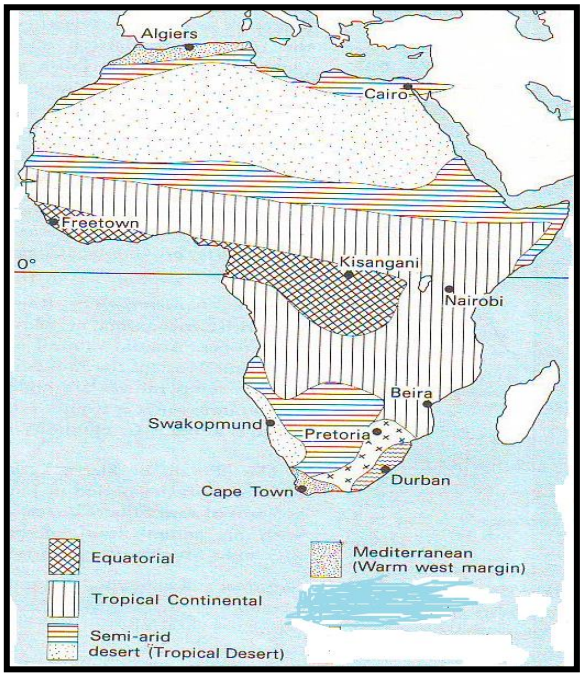
1. Identify the **two** climates indicated above **(2marks)**
2. To which hemisphere is climate **A** located. Give a reason for your answer **(3marks)**
3. Suggest **two** economic developments which take place in climate **B. (2marks)**
4. Suggest **two** problems that hinder economic development in climate **B. (2marks)**
5. Explain any **two** ways in which the vegetation found in climate **B** is adopted to the conditions found in the climate**. (4marks)**

The graph below represents the climate of a particular place. Use it to answer the questions that follow

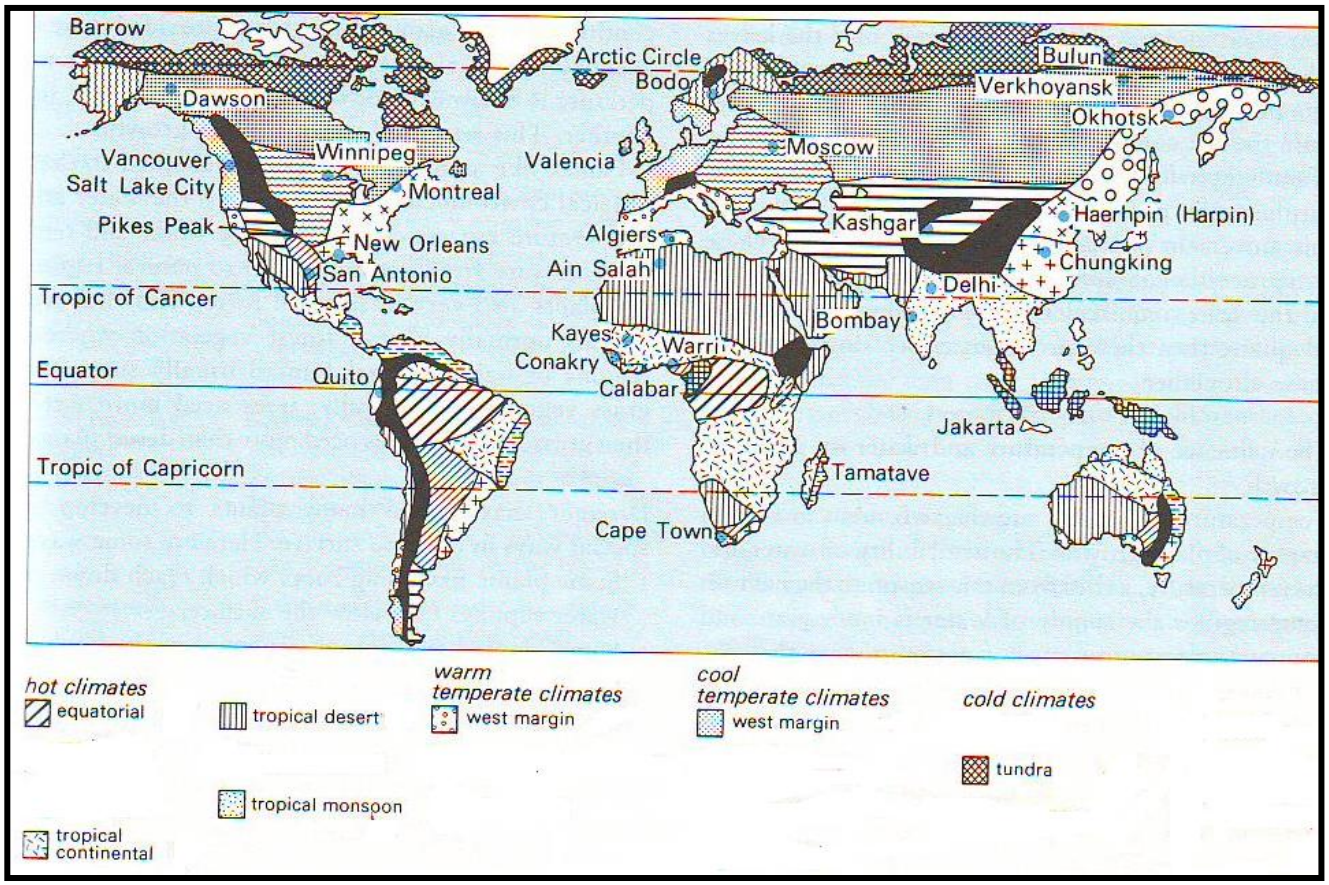


1. Identify the type of climate presented by the graph above **(1mark)**
2. In which hemisphere is the station located. Give a reason for your answer **(3marks)**
3. Describe the relationship between rainfall and temperature as shown by the graph **(3marks)**
4. Mention any **two** ways in which the vegetation in this climate is adapted to the conditions in this climate **(2marks)**

IMPORTANT CLIMATES EXPERIENCED IN AFRICAN CONTINENT



THE WORLD MAPS BELOW SHOWS MAIN CLIMATES



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