CONTINENTAL DRIFT

Continental drift is the movement of plates in the Earth's crust. The Earth's crust is not a single unit rather is made of large rigid and mobile pieces of blocks called plates which carry;

(a) Continents
(b) Ocean basins.

The continental plate/ crust is made of light rocks rich in Silica and Alumina hence the term 'Sial' while the oceanic plate is made of heavier rocks rich in silica and magnesia hence the term 'Sima'. It is believed that both continents and oceans did not exist but came into existence after the breakup of a single Sialic landmass called Pangaea about 250 million years before the present. From then both continents and oceans moved / drifted to attain their current location and are still drifting. This led to the theory of continental drift to explain the origin of both continents and oceans and why they are drifting.

CAUSES OF CONTINENTAL DRIFT OR THEORIES CONTINENTAL DRIFT

There are five major theories put forward by different Geographers to explain the causes of continental drift. That is, Expanding Earth theory, F.B Taylor's theory, Alfred Wegener's theory, Sea- Floor Spreading theory and Plate Tectonism.

The Earth expansion theory

It is one of the earliest theories of continental drift. It states that:

- The Earth was originally a small planet covered with a thin continental crust on the surface.
- Gradually its interior started expanding forcing the outer crust to fracture or split into separate crustal blocks called continents.
- As the interior continued to expand, the cracks widened forming wide basins or gaps which were later occupied by water to create the present day oceans.
- This theory explains that the reason for the expansion of the earth's interior was that it grew older and its gravitational force became weak; making its materials spread outwards and expand hence continental drift.

F.B Taylor's theory of continental drift 1910

Taylor described continental drift as a huge landslide from Polar Regions to the equator.

- Taylor assumed that originally two super landmasses existed. Namely; Lauresia and Gondwanaland. Lauresia existed near the present day North Pole while Gondwanaland existed near the present day South Pole and was covered by huge ice sheets.
- Taylor argued that during the cretaceous period (about 146 million years before the present), the moon came close to the earth at the equator and exerted its gravitation force or pull that dragged Lauresia south wards to the equator and Gondwanaland North wards toward the Equator.
- In some cases, the crust would stretch and split behind forming troughs that became ocean basins and where the crust encountered resistance, it would experience uneven flow hence folded to produce mountains.
- Taylor suggested that the basins of Atlantic and Indian Oceans were left behind between the drifting continents.
- According to Taylor, when the two landmasses collided at the Equator, the sediments between them folded to the form the Fold Mountains of Alps in southern Europe and the Atlas range in North Africa.

Alfred Wegener's theory

He is the one who brought the concept of continental drift to lime light. His theory is one of the most famous theories of continental drift.

- **Wegener's** theory states that the present day continents came into existence after the disintegration of the huge super continent called Pangaea which existed about 280 million years before the present.
- Wegener believed that **Pangaea** existed near the present day South Pole and covered 40% of the earth's surface and was surrounded by a large ocean called **Panthalassa which** covered the remaining 60%**.**

- In the late pre-Cambrian (About 250 million years before the present), Pangaea began drifting northwards and in the process numerous fractures developed and split into two huge land masses called **Lauresia** and **Gondwanaland** separated by a narrow ocean known as **Tethys.**
- Lauresia lay across the equator and Gondwanaland land lay near the present day South Pole and was covered by a large ice sheet.
- About 135 million years before the present, Gondwanaland and Lauresia drifted northwards and in the process, numerous fractures/ cracks developed in both land masses and broke up completely to give rise to the present continents.
- Lauresia broke up first to form the present day North America, Europe, Asia and major islands such as Britain and Greenland in the Northern hemisphere.
- Gondwanaland broke up into Africa, South America, Australia, Antarctica, the sub-continent of India and major islands such as Madagascar in the southern hemisphere.
- The space in between them formed basins of major oceans such as Atlantic Ocean between Africa and South America.
- In the North, Eurasia drifted East wards while North America drifted westwards. In the south, Africa moved northwards to attain its present position astride the equator. India drifted north east wards and northwards towards the equator to join North America. Madagascar separated from Africa.
- Australia drifted eastwards away from Antarctica approximately 65 million years before the present.
- Wegener assumed continental drift was due to the centrifugal force and tidal attraction of the moon.

Sea- floor spreading theory by Henry Harris Hess

This is one of the modern theories of continental drift which did not focus on the geological similarity of coast lines but on the origin of the forces that drive continents. Professor Harris Hess discovered that the centrifugal force and tidal attraction suggested by Wegener are too weak to cause continental drift. His theory therefore focused on the forces that cause continental drift.

The theory assumes that;

- The interior of the Earth is in molten state (semi-fluid) because of the intense heat produced by radio-activity and geo- chemical reactions within the core &mantle.
- Molten rock (magma) is light hence rise inform of convective currents which flow horizontally/ laterally underneath the crust before sinking back into the mantle to complete the cycle. The lateral flow creates pressure in the crust inform of tension and compression forces which eventually lead to fracturing of the crust
- Hess proposed that the fracturing of the oceanic crust due to diverging convective currents creates a rift through which magma flows to the ocean floor where it cools into solid rock on contact with ocean water.
- According to Hess, the continuous upwelling magma and eventual solidification creates a new crust (young rock) at the mid ocean ridge which pushes the old crust (old rock) side- ways from the ridge and in the process, the ocean floor spreads or widens/ expands causing continental drift.
- This is the reason why mid-0cean ridges (chain of under water mountain range) encircle the entire globe for over 40, 000 miles
- The theory suggests that rate of sea-flow spreading of Atlantic ocean is at an average rate of 3- 5 cm (1-2 inches) per year while that of pacific ocean is 2-4 inches per year; although its East side edge is disappearing due to subduction underneath the continental plates of North &South America.

Plate tectonic theory

This is the most recent theory of continental drift. Plate tectonism refers to the movement of separate and rigid blocks of the earth called tectonic plates on which continents and ocean basins rest.

The theory assumes that;

- the earth crust is divided into six major plates and 12 small plates.

- The major plates include African plate, American plate (North and South), Eurasian plate (Europe and Asia) Austrian-Indian plate, Pacific plate, and Antarctic plate while the minor plates include Nazca (on the west edge of South America), Philippine plate, Caribbean plate e.t.c
- The theory assumes that a plate carries either an oceanic crust or continental crust and that plates are mobile floating on a layer of molten rock called the Asthenosphere like a tabular ice bergs on a frozen sea
- The theory also assumes that the Plates are driven by giant convective currents generated by intense heat produced by radio-activity and geo- chemical reactions within the core &mantle
- As plates move or drift, so do the continents which are carried on top as "passengers"
- The theory assumes that plates move along thee active plate margins or boundaries- areas of seismological activities created by convective currents namely;

(a) **Divergent (constructive) boundary**- formed when two plates move apart / away from each other. When this takes place underneath the oceanic plate, mid-ocean ridge is formed; pushing the old crust of the ocean floor away hence sea-floor spreading. The mid-ocean ridge is therefore an area where two tectonic plates are separating

For example mid-Atlantic ridge between South America and Africa, Indian –ocean ridge, mid-pacific ridge e.t.c

(b) **Convergent (destructive) boundary**- formed where two tectonic plates move towards each other and collide. When two oceanic plates meet, they collide head –on and the edge of one plate (oceanic which is heavier) slides underneath the other forming trenches in the ocean floor at the point of subduction for example Tonga, Mariana, Java e.t.c . The collision of two continental plates produces Fold Mountains for example Himalaya due to collision of Asian plate and Indian plate

(C) **Transform boundary**- plates go past each other without collision or diversion; creating faults on the surface for example **Andes fault** where North American plate rides against the pacific plate

1. Examine the causes of continental drift

- ❖ Define continental drift
- ❖ State and explain the theories of continental drift
- ❖ Give the weaknesses of each theory where applicable

Answer Guide

Continental drift refers to the large scale movement of sialic blocks relative to one another across the surface of the Earth to their present positions to create continents and ocean basins, for example North America, South America, Africa, Eurasia e.t.c. and Ocean basins such as Atlantic, Pacific and Indian Ocean.

There are five major theories put forward by different geographers to explain the causes of continental drift. That is, Expanding Earth theory, F.B Taylor's theory, Alfred Wegener's theory, Sea- Floor Spreading theory and Plate Tectonism.

The Earth expansion theory

It is one of the earliest theories of continental drift. It states that:

- The Earth was originally a small planet covered with a thin continental crust on the surface.
- Gradually its interior started expanding forcing the outer crust to fracture or split into separate crustal blocks called continents.
- As the interior continued to expand, the cracks widened forming wide basins or gaps which were later occupied by water to create the present day oceans.

This theory explains that the reason for the expansion of the earth's interior was that it grew older and its gravitational force became weak; making its materials spread outwards and expand hence continental drift

F.B Taylor's theory of continental drift 1910

Taylor described continental drift as a huge landslide from Polar Regions to the equator.

- Taylor assumed that originally two super landmasses existed. Namely; Lauresia and Gondwanaland. Lauresia existed near the present day North Pole while Gondwanaland existed near

the present day South Pole and was covered by huge ice sheets.

- Taylor argued that during the cretaceous period (about 146 million years before the present), the moon came close to the earth at the equator and exerted its gravitation force or pull that dragged Lauresia south wards to the equator and Gondwanaland North wards toward the Equator.
- In some cases, the crust would stretch and split behind forming troughs that became ocean basins and where the crust encountered resistance, it would experience uneven flow hence folded to produce mountains.
- Taylor suggested that the basins of Atlantic and Indian Oceans were left behind between the drifting continents.
- According to Taylor, when the two landmasses collided at the Equator, the sediments between them folded to the form the Fold Mountains of Alps in southern Europe and the Atlas range in North Africa.

Weaknesses of Taylor's theory

- Although the moon came close to the earth, its force is too weak to pull the giant super continents from their polar locations.
- The concept does not apply to other fold mountains of Caledonian folding such as the uplands of north-western Ireland, Scotland and western Scandinavia and fold mountains of Hercynian folding
- The cause of continental drift is ought to come from within the interior of the earth and not out-side it.

Alfred Wegener's theory

He is the one who brought the concept of continental drift to lime light. **Wegener's** theory states that;

- The present day continents came into existence after the disintegration of the huge super continent called Pangaea which existed about 280 million years before the present.
- Wegener believed that **Pangaea** existed near the present day South Pole and covered 40% of the earth's surface and was surrounded by a large ocean called **Panthalassa which** covered the remaining 60%**.**
- In the late pre-Cambrian (About 250 million years before the present), Pangaea began drifting northwards and in the process numerous fractures developed and split into two huge land masses called **Lauresia** and **Gondwanaland** separated by a narrow ocean known as **Tethys.**
- Lauresia lay across the equator and Gondwanaland land lay near the present day South Pole and was covered by a large ice sheet.
- About 135 million years before the present, Gondwanaland and Lauresia drifted northwards and in the process, numerous fractures/ cracks developed in both land masses and broke up completely to give rise to the present continents.
- Lauresia broke up first to form the present day North America, Europe, Asia and major islands such as Britain and Greenland in the Northern hemisphere.
- Gondwanaland broke up into Africa, South America, Australia, Antarctica, the sub-continent of India and major islands such as Madagascar in the southern hemisphere.
- The space in between them formed basins of major oceans such as Atlantic Ocean between Africa and South America.
- In the North, Eurasia drifted East wards while North America drifted westwards. In the south, Africa moved northwards to attain its present position astride the equator. India drifted north east wards and northwards towards the equator to join North America. Madagascar separated from Africa.
- Australia drifted eastwards away from Antarctica approximately 65 million years before the present.
- Wegener assumed continental drift was due to the centrifugal force and tidal attraction of the moon.

Weaknesses of Wegener's theory

- Wegener is criticized for intruding into a field outside his profession because he was a meteorologist not a Geologist.
- Although centrifugal forces and tidal attraction of the moon exist they are too weak to pull the giant super continents from their polar location.
- He failed to explain the exact forces responsible for the drifting of the continents.
- Wegener also failed to understand that the forces that cause continental drift come from within the interior of the earth and not out of it.

Sea- floor spreading theory by Henry Harris Hess

This is one of the modern theories of continental drift put forward by Professor Henry Harris Hess to explain the origin of the forces that drive continents than the geological similarity of coast lines. Sea-floor spreading theory states that;

- The interior of the Earth is in molten state (semi-fluid) because of the intense heat produced by radio-activity and geo- chemical reactions within the core &mantle.
- Molten rock (magma) is light hence rise inform of convective currents which flow horizontally/ laterally underneath the crust before sinking back into the mantle to complete the cycle. The lateral flow creates pressure in the crust inform of tension and compression forces which eventually lead to fracturing of the crust
- Hess proposed that the fracturing of the oceanic crust due to diverging convective currents creates a rift through which magma flows to the ocean floor where it cools into solid rock on contact with ocean water.
- According to Hess, the continuous upwelling magma and eventual solidification creates a new crust (young rock) at the mid ocean ridge which pushes the old crust (old rock) side- ways from the ridge and in the process, the ocean floor spreads or widens/ expands causing continental drift.
- This is the reason why mid-0cean ridges (chain of underwater mountain range) encircle the entire globe for over 40, 000 miles
- The theory suggests that rate of sea-flow spreading of Atlantic ocean is at an average rate of 3- 5 cm (1-2 inches) per year while that of pacific ocean is 2-4 inches per year.

Plate tectonic theory

This is the most recent theory of continental drift. Plate tectonism refers to the movement of separate and rigid blocks of the earth called tectonic plates on which continents and ocean basins rest.

The theory assumes that;

- the earth crust is divided into six major plates and 12 small plates.
- The major plates include African plate, American plate (North and South), Eurasian plate (Europe and Asia) Austrian-Indian plate, Pacific plate, and Antarctic plate while the minor plates include Nazca (on the west edge of South America), Philippine plate, Caribbean plate e.t.c
- The theory assumes that a plate carries either an oceanic crust or continental crust and that plates are mobile floating on a layer of molten rock called the Asthenosphere like a tabular ice bergs on a frozen sea
- The theory also assumes that the Plates are driven by giant convective currents generated by intense heat produced by radio-activity and geo- chemical reactions within the core &mantle
- As plates move or drift, so do the continents which are carried on top as "passengers"
- Tectonic plates move along 3 major boundaries or margins caused by convective currents. Namely;

(a) **Constructive / divergent margins**-plates move away from each other to form a mid-ocean ridge
(b)**Destructive boundary/convergent margin**- the plates move towards each other hence collide and the dense oceanic plate sinks below at the subduction zone
(c)**Neutral / conservative or transform boundary**- Plates move past each other without adding or destroying the ocean floor example North American plate against the Pacific plate forming the San Andes fault causing off setting of land to the west.

2. (a) What is continental drift?

(b)Account for the occurrence of continental drift.

Approach

- Define continental drift
- State and explain the theories of continental drift
- Describe how each theory explains the origin of continents and oceans and why they are drifting

Answer guide.

(a) Continental drift refers to the large scale movement of sialic blocks relative to one another across the surface of the Earth to their present positions to create continents and ocean basins for example North America, South America, Africa, Eurasia e.t.c. and Ocean basins like Pacific and Indian Ocean.

Causes of Continental Drift/ Theories of Continental Drift

There are five major theories put forward by different Geographers to explain the causes of continental drift. That is, Expanding Earth theory, F.B Taylor's theory, Alfred Wegener's theory, Sea- Floor Spreading theory and Plate Tectonism.

Use the explanation given in the first question but don't state the weaknesses of each theory

3. Explain the factors responsible for the present day distribution of continents

Or

Account for the distribution of continents and oceans.

Approach

- Define continental drift
- Show the distribution of continents and oceans
- Explain the factors or theories of continental drift /continents and ocean basins.

The distribution of continents and oceans

- The earth's surface is divided into continents and water bodies.
- Today, the earth is divided into six independent landmasses called continents separated by water bodies such as pacific, Indian and Atlantic Ocean.
- Within the water bodies are small dry lands called islands
- It is believed that the current continents emanated from a single super land mass called Pangaea, which developed cracks before breaking up.
- The continents have drifted and still drifting from their original positions to the current ones.
- It is believed that Africa is the only continent that has not moved much but the rest have.
- South American block moved westwards creating the Atlantic Ocean in between North America which moved North east wards.
- Europe drifted North West wards creating the Mediterranean Sea in the middle.
- Asia moved to the East and Australia went to the east creating the Indian Ocean
- Africa, South America, Antarctica, Australia and the Indian sub continents are found in the southern hemisphere.
- North America, Europe and Asia exist in the northern hemisphere.

Several theories have been advanced to explain the present day distribution of continents and water bodies. **These include;**

Expanding earth theory,
F.B Taylor's theory,
Alfred Wegener's theory,
Sea- floor spreading theory
Plate tectonism

📖 Remember to explain these theories

4. (a)What is meant by the term plate tectonics?

(b)How does the theory of plate tectonics explain the present day distribution of continents?

Approach

- Define plate tectonism, outline the assumptions of the theory including ;

- ❖ The cause, major plates and the major plate boundaries.
- ❖ In part (b) describe the current distribution of continents, movements and other activities associated with plate margins

Answer guide

(a) **Plate tectonic theory** is the most recent theory of continental drift. Plate tectonism refers to the movement of separate and rigid blocks of the earth called tectonic plates on which continents and ocean basins rest.

The theory assumes that;

- the earth crust is divided into six major plates and 12 small plates.
- The major plates include African plate, American plate (North and South), Eurasian plate (Europe and Asia) Austrian-Indian plate, Pacific plate, and Antarctic plate while the minor plates include Nazca (on the west edge of South America), Philippine plate, Caribbean plate e.t.c
- The theory assumes that a plate carries either an oceanic crust or continental crust and that plates are mobile floating on a layer of molten rock called the Asthenosphere like a tabular ice bergs on a frozen sea
- The theory also assumes that the Plates are driven by giant convective currents generated by intense heat produced by radio-activity and geo- chemical reactions within the core &mantle
- As plates move or drift, so do the continents which are carried on top as "passengers"
- Tectonic plates move along 3 major boundaries or margins caused by convective currents. Namely;

-Constructive / divergent margins,
-Destructive boundary/convergent margin,
-Neutral / conservative or transform boundary.

(b). The theory shows that;

- the greatest part of the landmasses or continents is in the Northern hemisphere compared to the southern hemisphere.
- The theory presupposes that the plates generally move North ward others like the Americas move westward while Africa, Europe, Asia and Australia move North Eastward.
- Geo-chemical, radio-activity and geo-chemical reactions generate heat that melt the rocks in the mantle giving rise to convective currents which drive the plates to their direction of movement.
- There three types of movements caused by convective currents that affect the distribution of continents;

Divergent boundary or movements cause rifting of the crust and consequently outward movement of continents. In the process, ocean basins characterized by mid-ocean ridges and islands are formed. For example the mid-Atlantic ridge between South America and Africa.

Convergent boundary or movements push continents towards one another. For example;

- Continents may move towards each other. In the process, sediments are folded to form Fold Mountains for example when India moved towards Asia, sediments folded to form the Himalayas.
- A Continental plate may move towards the oceanic plate causing subduction of the denser simatic rocks and a trench forms at the point of subduction and Materials sink into the mantle where they are assimilated, forming trenches and volcanic mountains. For example the Nazca trench formed where the Nazca plate collides with South American plate and Andes Mountains are formed.
- Oceanic crust may move towards each other. This causes narrowing of the ocean basins and continents move nearer. In the process, trenches and volcanic arc form. For example Pacific and Eurasian plates have led to the formation of the Marina trench, Java, Peru, Tonga and Japan arc.

Transform boundary. Plates move past each other without causing any collision or diversion. In the process, they off set sections of the continents, ridges and trenches for example North American plate against the Pacific plate forming the San Andes fault causing off setting of land to the west.

5. Explain the relevance of Wegener's theory of continental drift to the understanding of the present day distribution of continents and ocean basins.

Approach

- ❖ Define continental drift
- ❖ Give the underlying assumptions in Wegener's theory of continental drift
- ❖ Show the current distribution of continents and ocean basins
- ❖ Show the relevance of the theory by explaining the evidences.
- ❖ Give the limitations of the theory.

Answer guide.

Continental drift is the movement of continental blocks relative to one another across the surface of the earth to their present position to create continents and ocean basins for example South America, Africa, Eurasia e.t.c. and ocean basins like pacific and Indian Ocean. **Wegener's** theory states that;

- The present day continents came into existence after the disintegration of the huge super continent called Pangaea which existed about 280 million years before the present.
- Wegener believed that **Pangaea** existed near the present day South Pole and covered 40% of the earth's surface and was surrounded by a large ocean called **Panthalassa which** covered the remaining 60%**.**
- In the late pre-Cambrian (About 250 million years before the present), Pangaea began drifting northwards and in the process numerous fractures developed and split into two huge land masses called **Lauresia** and **Gondwanaland** separated by a narrow ocean known as **Tethys.**
- Lauresia lay across the equator and Gondwanaland land lay near the present day South Pole and was covered by a large ice sheet.
- About 135 million years before the present, Gondwanaland and Lauresia drifted northwards and in the process, numerous fractures/ cracks developed in both land masses and broke up completely to give rise to the present continents.
- Lauresia broke up first to form the present day North America, Europe, Asia and major islands such as Britain and Greenland in the Northern hemisphere.
- Gondwanaland broke up into Africa, South America, Australia, Antarctica, the sub-continent of India and major islands such as Madagascar in the southern hemisphere.
- During drifting, the space between the continental blocks became wider forming the present day ocean basins such as Atlantic Ocean between Africa and South America.
- In the North, Eurasia drifted East wards while North America drifted westwards. In the south, Africa moved northwards to attain its present position astride the equator. India drifted north east wards and northwards towards the equator to join North America. Madagascar separated from Africa.
- Australia drifted eastwards away from Antarctica approximately 65 million years before the present.
- Africa, South America, Antarctica, Australia and the Indian sub continents are found in the southern hemisphere while North America, Europe and Asia exist in the Northern hemisphere.

EVIDENCES OF CONTINENTAL DRIFT

Relevance of the theory

Jig saw and visual fit. There is a close fitting of the continental coastlines across the Atlantic Ocean like a jig saw puzzle. That is, the East coast of South America and west coast of Africa (Guinea) have good visual fits not only at the surface but also at a depth of 2000 meters below the sea-level. Thus these continents must have been together before drifting.

Geometric fit. That is, the west coast line of Africa and eastern coastline of South America fit almost exactly in each other if rotated through an angle of 57^0 with rotational points at 40^0 North and 30^0 West.

Matching Geology. There is Similarity in rock alignment and minerals between the west coast line of Africa and eastern coastline of South America. For example the gold deposits of Guyana in South America appear to be a continuation of the gold deposits of Ghana in Africa. The Cretaceous oil

beds of Bahia in Eastern Brazil are similar to those in Angola; meaning that they were once joined together but separated due to continental drift. The coal bearing rocks of Eurasia and North America (Appalachian).

Existence of orogenic belts of Pre-Cambrian age and structure both in South America and Africa yet are sub-parallel to the coasts; proves that these continents were once joined together during their formation but separated due to continental drift. For example the cape ranges of South Africa appear to be a continuation of the fold mountain ranges of Falkland Island in South America.

Occurrence of carboniferous glacial deposits called Dwyka tillites in South Africa, South America, southern Australia and India proves that these continents emanated from the break up of Gondwanaland which had huge ice sheets due to its proximity to the South Pole.

Existence of Similar sedimentary basins along some parts of north eastern coast of Brazil, south eastern Nigeria and Cameroon means that these continents broke form Pangaea but separated due to continental drift.

Occurrence of Similar plant and animal species both in South America and Africa for example the tropical rain forests in Brazil, Congo and Gabon in Africa shows that these two continents were once together and experienced similar climatic conditions for a long period of time.

Palaeo magnetic evidence. When igneous rocks cool they are magnetized by the earth's magnetic field. In India, Australia and South America the magnetic properties in the magnetized rocks no longer point in the N-S direction as it should be. This suggests that during the course of drifting rocks were twisted and changed their true magnetic north direction.

Existence of laterites. Laterites only form under tropical climates. The occurrence of laterites in cold continental climatic regions like North America (Kentucky and Ohio), Ayrshire in Britain, Germany and Russia shows that these continents drifted from the tropics with laterites to their present positions.

Existence of coral reefs- in Green land, Britain and North America shows that these areas drifted from the tropics where conditions for coral reef formation exist for example warm temperatures of tropical climate, clear, salty and well oxygenated water.

The occurrence of salt evaporites in cold parts of southern states of Britain, U.S.A., Germany and Russia yet salt evaporites occur in tropics shows that these regions once existed in the tropics before attaining their current position.

Proximity of the continental blocks to the North Pole than the South Pole justifies the north ward drift of Gondwanaland and Lauresia.

Deposition of new rocks at the mid-ocean ridge, trenches in ocean floor, expansion of Atlantic Ocean and the widening of the rift valley floor at an average of 2cms per year proves that continental drift took place and is still taking place.

Weakness or limitations of Wegener's theory

- Wegener is criticized for intruding into a field outside his profession because he was a meteorologist not a Geologist.
- Although centrifugal forces and tidal attraction of the moon exist they are too weak to pull the giant super continents from their polar location.
- He failed to explain the exact forces responsible for the drifting of the continents.
- Wegener also failed to understand that the forces that cause continental drift come from within the interior of the earth and not out of it.

6. Justify Wegener's theory of continental drift using evidence from the southern hemisphere.

Or

Justify the continental drifting theory using specific evidence from southern continents.

Approach

- define continental drift
- Give the underlying assumptions in Wegener's theory of continental drift
- Show the current distribution of continents and ocean basins

❖ Identify and explain the evidences strictly from the southern hemisphere

Answer guide

Refer to question **5** above for the introduction.

Evidences of continental drift from the southern continents/ hemisphere

▪Jig saw and visual fit ▪Geometric fit ▪Matching Geology
▪Existence of orogenic belts of Pre-Cambrian age and structure both in South America and Africa
▪Occurrence of carboniferous glacial deposits ▪Palaeo magnetic evidence
▪Existence of similar sedimentary basins along some parts of north eastern coast of Brazil
▪Occurrence of similar plant and animal species both in South America and Africa
▪Deposition of new rocks at the mid-ocean ridge
▪Proximity of the continental blocks to the North Pole than the South Pole
▪The widening of the rift valley floor at an average of 2cms per year is a proof that continental drift took place and is still taking place.

🕮 **Remember to explain these points**

CONTINETAL DRIFT AND LAND FORM DEVELOPMENT IN EAST AFRICA

7. (a)What is meant by plate tectonic movements?

(b)Explain the influence of plate tectonic movements on the development of relief land forms in East Africa.

Approach

❖ Define plate tectonic movements, outline the assumptions of the theory including ;
❖ The cause, major plates and the major plate boundaries.
❖ In part (b) Show how plate tectonism generates tensional; compression forces and vertical movements which led to the occurrence of faulting, vulcanicity, warping and folding.
❖ Explain the formation of landforms produced by these tectonic processes.

Answer guide

(a) Plate tectonic movement refers to the movement of separate and rigid parts of the earth called tectonic plates on which continents and ocean basins rest.

The theory assumes that;

- the earth crust is divided into six major plates and 12 small plates.
- The major plates include African plate, American plate (North and South), Eurasian plate (Europe and Asia) Austrian-Indian plate, Pacific plate, and Antarctic plate while the minor plates include Nazca (on the west edge of South America), Philippine plate, Caribbean plate e.t.c
- The theory assumes that a plate carries either an oceanic crust or continental crust and that plates are mobile floating on a layer of molten rock called the Asthenosphere like a tabular ice bergs on a frozen sea
- The theory also assumes that the Plates are driven by giant convective currents generated by intense heat produced by radio-activity and geo- chemical reactions within the core &mantle
- As plates move or drift, so do the continents which are carried on top as "passengers"
- Tectonic plates move along 3 major boundaries or margins caused by convective currents. Namely;

Constructive / divergent margin- plates move away from each other to form a mid-ocean ridge
Destructive boundary/convergent margin- the plates move towards each other hence collide and the dense oceanic plate sinks below at a subduction zone
Neutral / conservative or transform boundary- Plates move past each other without adding or destroying the ocean floor example North American plate against the Pacific plate forming the San Andes fault causing off setting of land to the west.

(b). These movements generate tensional force, compression force and vertical movements which led to the occurrence of tectonic processes of faulting, vulcanicity, warping and folding responsible for the formation of various relief landforms. For example;

Faulting-led to formation of;

The East African rift valley, Block Mountains, Escarpments, Grabens, Tilt block landscapes, Fault guided valleys

Vulcanicity-occurs at the margins of the faulted areas leading to;

(a) Extrusive volcanicity responsible for the formation of volcanic cones such as;

Ash and cinder cones, Composite cones, Basaltic cones, lava plateaus, Cumulo domes, Calderas, explosion craters e.t.c

(b) Intrusive volcanicity responsible for the formation of;

Batholiths, sills, dykes, e.t.c exposed by denudation forces to form Inselburgs, ridges, arenas/trenches e.t.c

Warping- occurred in form of up and down warping and formed depressions occupied by Lake Victoria and Kyoga. The shoulders of the rift valleys of western Kenya and Uganda uplifted before faulting leading to the formation of ridges / watersheds.

Folding- led to formation of synclines and anticlines.

📖 Remember to explain the formation of these landforms with clear diagrams and examples.

8. Examine the relevance of Wegener's theory of continental drifting to landform development in East Africa.

Approach

- ❖ Define continental drifting
- ❖ Give the assumptions of Wegener's theory
- ❖ Explain the origin of the forces that that cause continental drift
- ❖ Show how tectonic processes are generated and the resultant landform

Answer guide

Continental drift is the movement of continental blocks relative to one another across the surface of the earth to their present position to create continents and ocean basins for example South America, Africa, Eurasia e.t.c. and ocean basins like pacific and Indian Ocean. **Wegener's** theory states that;

- The present day continents came into existence after the disintegration of the huge super continent called Pangaea which existed about 280 million years before the present.
- Wegener believed that **Pangaea** existed near the present day South Pole and covered 40% of the earth's surface and was surrounded by a large ocean called **Panthalassa which** covered the remaining 60%**.**
- In the late pre-Cambrian (About 250 million years before the present), Pangaea began drifting northwards and in the process numerous fractures developed and split into two huge land masses called **Lauresia** and **Gondwanaland** separated by a narrow ocean known as **Tethys.**
- Lauresia lay across the equator and Gondwanaland land lay near the present day South Pole and was covered by a large ice sheet.
- About 135 million years before the present, Gondwanaland and Lauresia drifted northwards and in the process, numerous fractures/ cracks developed in both land masses and broke up completely to give rise to the present continents.
- Lauresia broke up first to form the present day North America, Europe, Asia and major islands such as Britain and Greenland in the Northern hemisphere.
- Gondwanaland broke up into Africa, South America, Australia, Antarctica, the sub-continent of India and major islands such as Madagascar in the southern hemisphere.
- During drifting, the space between the continental blocks became wider forming the present day ocean basins such as Atlantic Ocean between Africa and South America.
- In the North, Eurasia drifted East wards while North America drifted westwards. In the south, Africa moved northwards to attain its present position astride the equator. India drifted north east

wards and northwards towards the equator to join North America. Madagascar separated from Africa.

- Australia drifted eastwards away from Antarctica approximately 65 million years before the present.
- Africa, South America, Antarctica, Australia and the Indian sub continents are found in the southern hemisphere while North America, Europe and Asia exist in the Northern hemisphere.
- Wegener's theory assumes that the interior of the Earth is in a molten state (semi-fluid) because of the intense heat produced by radio-activity and geo- chemical reactions within the interior of the Earth (core &mantle)
- Molten rock (magma) is light hence rises inform of giant convective currents from the mantle and flow laterally or horizontally underneath the crust hence dragging it in the direction to which they are flowing/ moving before sinking back into the mantle to complete the cycle.
- The rise or vertical and lateral flow of convective currents generate tensional force; compression force and vertical movements which led to the occurrence of tectonic processes of faulting, vulcanicity, warping and folding responsible for the formation of various relief landforms. For example;

Faulting-led to formation of;
The East African rift valley, Block Mountains, Escarpments, Grabens, Tilt block landscapes, Fault guided valleys
Vulcanicity-occurs at the margins of the faulted areas leading to;
(a) Extrusive volcanicity responsible for the formation of volcanic cones such as;
Ash and cinder cones, Composite cones, Basaltic cones, lava plateaus, Cumulo domes, Calderas, explosion craters e.t.c
(b) Intrusive volcanicity responsible for the formation of;
Batholiths, sills, dykes, e.t.c exposed by denudation forces to form Inselburgs, ridges, arenas/trenches e.t.c
Warping- occurred in form of up and down warping and formed depressions occupied by Lake Victoria and Kyoga. The shoulders of the rift valleys of western Kenya and Uganda uplifted before faulting leading to the formation of ridges / watersheds.
Folding- led to formation of synclines and anticlines.
🕮 Remember to explain the formation of these landforms with clear diagrams and examples.

9. To what extent can the theory of plate tectonism explain the present landforms in East Africa?

Approach

- ❖ Define plate tectonism, outline the assumptions of the theory including ;
- ❖ The cause, major plates and the major plate boundaries.
- ❖ Explain how plate tectonism generates tensional; compression forces and vertical movements which led to the tectonic processes.
- ❖ Give the 1St evaluation (to a larger extent) and describe the land forms produced tectonic processes of faulting, vulcanicity, warping and folding.
- ❖ Give the 2rd evaluation (to a large extent) and explain other processes responsible for landform development in East Africa for example
- ❖ Glaciation, river and wave through erosion and deposition
- ❖ Briefly explain at least three land forms produced by each process.

10. Justify the theory of sea-floor spreading to landform development in East Africa.

Approach

- ❖ Define sea-floor spreading; outline the assumptions of the theory
- ❖ Give the evidences to justify the theory
- ❖ Explain the resultant land forms.

Answer guide.

Sea floor spreading is a theory put forward by an American geologist called Henry Hess to explain the movement and distribution of present day continents and ocean basins and the resultant landforms.

The theory assumes that;

- The interior of the Earth is in molten state (semi-fluid) because of the intense heat produced by radio-activity and geo- chemical reactions within the core &mantle.
- Molten rock (magma) is light hence rise inform of convective currents which flow horizontally/ laterally underneath the crust before sinking back into the mantle to complete the cycle. The lateral flow creates pressure in the crust inform of tension and compression forces which eventually lead to fracturing of the crust
- Hess proposed that the fracturing of the oceanic crust due to diverging convective currents creates a rift through which magma flows to the ocean floor where it cools into solid rock on contact with ocean water.
- According to Hess, the continuous upwelling magma and eventual solidification creates a new crust (young rock) at the mid ocean ridge which pushes the old crust (old rock) side- ways from the ridge and in the process, the ocean floor spreads or widens/ expands causing continental drift.
- This is the reason why mid-0cean ridges (chain of underwater mountain range) encircle the entire globe for over 40, 000 miles
- The theory suggests that rate of sea-flow spreading of Atlantic ocean is at an average rate of 3- 5 cm (1-2 inches) per year while that of pacific ocean is 2-4 inches per year.

Evidences of sea-floor spreading

- Existence of mid-ocean ridges for example mid Atlantic ridge, pacific ridge, Indian Ocean ridge e.t.c
- Existence of long volcanic mountain ridges for example the Andes on the edge of South American plate and Nazca plate, coastal ranges on the edge of North America.
- Existence of trench systems at the edge of colliding plates such as Java trench Pacific Ocean, Peru, Tonga and Marianas
- The drifting apart of Somalia and Arabia at a rate of 2 cm per year indicates that the floor of red sea is spreading or widening
- Rock samples drilled from ocean floor near the ridge by Glamour challenger revealed that the rocks are young compared to the rocks on the continents.
- Differences in the magnetic alignment of old rocks and the young rocks confirmed by Palaeo-magnetic studies indicate that the sea-floor is spreading at an average rate of about 2-4 inches per year.

The rise or vertical and lateral flow of convective currents generate tensional force; compression force and vertical movements which led to the occurrence of tectonic processes of faulting, vulcanicity, warping and folding responsible for the formation of various relief landforms. For example;

Faulting-led to formation of;

The East African rift valley, Block Mountains, Escarpments, Grabens, Tilt block landscapes, Fault guided valleys

Vulcanicity-occurs at the margins of the faulted areas leading to;

(a) Extrusive volcanicity responsible for the formation of volcanic cones such as;

Ash and cinder cones, Composite cones, Basaltic cones, lava plateaus, Cumulo domes, Calderas, explosion craters e.t.c

(b) Intrusive volcanicity responsible for the formation of;

Batholiths, sills, dykes, e.t.c exposed by denudation forces to form Inselburgs, ridges, arenas/trenches e.t.c

Warping- occurred in form of up and down warping and formed depressions occupied by Lake Victoria and Kyoga. The shoulders of the rift valleys of western Kenya and Uganda uplifted before faulting leading to the formation of ridges / watersheds.

Folding- led to formation of synclines and anticlines.

📖 Remember to explain the formation of these landforms with clear diagrams and examples.

11. Examine the relevance of sea-floor spreading and plate tectonic theories to landform development in East Africa.

Approach

- Define both theories and outline the assumptions,
- Show how both theories explain the origin of tension, compression forces and vertical movements which lead to tectonic processes of faulting, vulcanicity, warping and folding.
- Explain the resultant landforms clear diagrams and examples where applicable

Answer guide

Sea -floor spreading and plate tectonics are recent theories of continental drift- the movement and distribution of present day continents and ocean basins and the resultant landforms.

The theory of plate tectonics assumes that the earth's crust is divided into a series of rigid and light blocks called tectonic plates which float on partially molten material (Asthenosphere) in the upper mantle.

The major tectonic plates include; the African plate, American plate (North and South), Eurasian plate (Europe and Asia) Austrian-Indian plate, Pacific plate, Antarctic plate while minor plates include Nazca (on the west edge of South America), Philippine plate, Caribbean plate e.t.c.

A plate carries either an oceanic crust or continental crust

Both theories assume that;

The interior of the Earth is in a molten state (semi-fluid) because of the intense heat produced by radio-activity and geo- chemical reactions within the interior of the Earth (core &mantle)

Molten rock (magma) is light hence rises inform of giant convective currents and flow horizontally/ laterally underneath the tectonic plates before sinking back into the mantle to complete the cycle.

The lateral flow of convective currents drags the tectonic plates to their direction of flow/ movement like a tabular ice bergs on a frozen sea

When this movement takes place underneath the oceanic plate, exerts tension and compression forces leading to fracturing of the oceanic crust inform of a rift through which magma from deep within the crust up-wells and turns into solid rock as it cools on contact with ocean water hence creating a new crust (young rock) at the mid ocean ridge; pushing the old crust (old rock) side ways from the ridge.

In the process the floor of the ocean spreads or widens pushing the tectonic plates away from each other hence continental drift.

The tectonic plates move along three major boundaries created by convective currents. That is;

Constructive / divergent margins-plates move away from each other to form a mid-ocean ridge

Destructive boundary/convergent margin- the plates move towards each other hence collide and the dense oceanic plate sinks below at a subduction zone

Neutral / conservative or transform boundary- Plates move past each other without adding or destroying the ocean floor example North American plate against the Pacific plate forming the San Andes fault causing off setting of land to the west.

- The movement of plates along boundaries generates vertical (uplifting), tensional and compressional forces and tectonic processes of faulting, vulcanicity, warping and folding responsible for the formation of various relief landforms. For example;

Faulting-led to formation of;

The East African rift valley, Block Mountains, Escarpments, Grabens, Tilt block landscapes, Fault guided valleys

Vulcanicity-occurs at the margins of the faulted areas leading to;

(a) Extrusive volcanicity responsible for the formation of volcanic cones such as;
Ash and cinder cones, Composite cones, Basaltic cones, lava plateaus, Cumulo domes, Calderas, explosion craters e.t.c
(b) Intrusive volcanicity responsible for the formation of;
Batholiths, sills, dykes, e.t.c exposed by denudation forces to form Inselburgs, ridges, arenas/trenches e.t.c

Warping- occurred in form of up and down warping and formed depressions occupied by Lake Victoria and Kyoga. The shoulders of the rift valleys of western Kenya and Uganda uplifted before faulting leading to the formation of ridges / watersheds.

Folding- led to formation of synclines and anticlines.

📖 Remember to explain the formation of these landforms with clear diagrams and examples.

EARTH QUAKES

12. (a)Explain the cause of earth quakes
(b)Explain the effects of earthquakes on the people of East Africa.

Approach

- Define earth quakes
- Give the types/ classification of earth quakes
- Explain the causes and give the areas affected by earth quakes
- Bring out the effects and relate them to specific areas in East Africa.

Answer guide

An Earth quake is a rapid and detectable tremor or movement and adjustment within the rocks in the earth's crust, causing series of elastic shock waves outwards in all directions or vibration of the earth/ sudden violent movement of the earth's surface.
Earth quakes may be classified as primary (longitudinal, push or "p" waves), secondary (transverse, shake or "s" waves), surface (love waves "L").

Causes of earth quakes

The origin/ causes of earth quakes are attributed to plate tectonism. The collision of plates causes an impact that triggers off vibrations within the crust.
Plates are light and float on partially molten rocks in the upper mantle. Plates are also rigid and mobile, moving vertically or horizontally.
The plates are driven by convective currents generated from the intense heat due to radio-activity and geo-chemical reactions in the mantle.
Convergence of currents cause plate collision at the convergent boundary, resulting into deformation of the crust on either edge/ fault line or within the mantle.

Process of development

As the plates are dragged, the rocks become plastic and elastic; storing energy (like bent wooden stick)
Frictional resistance holding the rocks together is over come along the faults/ edges due to compression. Because of too much heat at the edge, the friction is reduced making the edges slippery.
Further displacement exerts pressure and stress along the fault line/ edges
Additional friction increases in slippage storing a lot of energy.
Rapid release of the edge makes the energy radiated in all directions from the focus in form of waves (explosive energy)
Slippage allows the deformed rocks to snap back (reversed movement) or readjustment thereby vibration as earth quakes.
Rock elasticity reforms to its original shape (elastic rebound). Major earth quakes may generate smaller ones after a few days or years.
The waves travel from the centre of the disturbance as one wave shock.
Earth quakes may also occur due to;

Transform plate movement; isostatic movements and where there is excessive vulcanicity (tectonic in nature)

The point in the earth's crust from which the vibrations or shock waves originate is called the focus/ hypo centre

While the epicenter is the point on the surface of the earth above the origin of the earth quake (vertical point above the origin/ focus)

Shock waves are transmitted quickly through the earth's crust to the surface where the earth quake occurs.

N.b the shock waves decrease in strengths as they travel away from the focus.

The magnitude of the earth quake is measured by the seismography, equipped with a Richter scale to indicate the intensity of the quake.

Major earth quakes occur in places like;

California, china, Japan, India, Mexico, Peru, Uganda (, Bundyibugyo, Toro, Kabarole)

Marking Format

Definition, origin of earth quakes, processes of development, areas of occurrence of earth quake globally... 15 marks

b) Effects of earth quakes.

- Loss of lives for example 1966 earth quake killed 150 people in Toro. 1996 earth quake measuring 7.0 killed 157 and injured more than 1300 in Semliki valley in western Uganda. In Dec 2005, a quake measuring 6.0 killed six people in Rwenzori and injured many.
- Triggers off landslides/ mass wasting in highland areas, blocking roads and destroying other communication infrastructures for example in Kigezi, Kabarole e.t.c
- Promotes famine as crops/ farms are destroyed by land slides.
- Destruction of social services / structures such as schools, hospitals, cathedral e.t.c. for example 1994 where Virika hospital in Toro was destroyed.
- Some people are left homeless (displaced) for example 1994 in Toro.
- Increases government expenditure in form of emergence funding for disaster preparedness, developing infrastructures in affected areas e.t.c or High costs of replacing the destroyed property for example buildings
- Flooding and some times drowning of the coastal areas due to Tsunamis
- Earth quakes whose epicenter was at kisomoro about 25km off fort portal town caused broke out of fire
- Earth quakes accelerate research development.

FAULTING IN EAST AFRICA

EFFECTS OF FAULTING ON LANDFORM DEVELOPMENT IN EAST AFRICA

13. Examine the influence of faulting on the development of relief/ land forms in East Africa.

14. Examine the effect of faulting on the development of relief land forms in East Africa.

Approach

- ❖ Define faulting
- ❖ Explain the origin/ causes of faulting
- ❖ Describe the land forms produced by faulting
- ❖ Draw diagrams and give examples.

Answer guide

Faulting is an endogenetic process involving the fracturing and relative dislocation and displacement of hard rocks of the earth crust due to strain and stress caused by tension and compression forces operating in the earth crust.

Origin of faulting

Faulting is originates from Radio-activity and Geo-chemical reactions within the interior of the earth (mantle and core); generating intense heat that keeps the weak rock in the upper mantle (Asthenoshere) in molten state/ form.

Molten rock is light therefore tends to rise in form of convective currents which flow horizontally underneath the crust; creating tension, compression and vertical forces responsible for fracturing, dislocation and displacement of hard rocks

Regions affected by faulting in East Africa

Faulting affected areas of western Uganda, western and central Kenya, central and southern Tanzania.

Faulting formed a wide range of relief features in East Africa like rift valley, Block Mountains, fault scarps, grabens, tilt block landscape and fault guided valleys.

The Rift valley

A rift valley is an elongated trough or depression between more or less parallel faults or in-facing fault scarps. The formation of the rift valley is not clear thus various theories have been put forward by different Geographers to explain its formation. Namely: tensional theory, compression, differential up-lift theory e.t.c

Use at least two theories stated above to explain the formation of the rift valley

Tension theory

This theory was advanced by J.W Gregory to explain the formation of the Eastern section of the rift valley.

According to Gregory, radio-activity and Geo-chemical reactions generated intense heat that produced convective currents in the mantle.

When convective currents reached the earth crust, diverged leading to development of tensional forces within the crust of East Africa.

Tensional forces pulled the crust in opposite direction from the central point within the earth crust forming **normal faults** and displacement of the rock strata.

Consequently, the Side blocks were pulled apart or away from each other while the middle/ central block sunk down under its own weight; displacing the rocks below to form **a rift valley with gentle slopes**.

Denudation forces such as weathering, erosion and mass wasting modified the side slopes.

Clear Diagram

Compression theory

This theory was advanced by E.J Wayland to explain the formation of the western section of the East African rift valley. (Lake Albert region).

According to wayland, intense heating in the interior of the earth by radioactivity and geo-chemical reactions resulted into convective currents

When convective currents reached the earth crust, tended to converge; creating compressional forces that pushed the crust of East Africa in the same direction, resulted into **reversed faulting**.

Continued compression forced sideway fault blocks to override the central/ middle block that remained stable at a relatively lower level, formed a rift valley with steep slopes or sharp edges.

After a long period of time, the sharp edges of up-thrusted fault blocks, hanging above the middle block were modified denudation forces such as weathering, erosion and mass wasting to produce smooth escarpments of today.

Clear Diagram

Block Mountains or Horsts

A block mountain is a **raised fault block** bordered by faults on one or more sides and stands above the surrounding land, for example mountain Rwenzori in south western Uganda, Uluguru, Usambara, Mahange, Pare in Tanzania, Nyiru and Ndoto in Kenya.

The formation of the horsts is not clear, leading to different theories to try explaining its formation. Namely; differential up-lift theory, relative subsidence theory e.t.c

Use the two theories stated above to explain the development of the block mountain.

The differential up-lift theory

According to this theory, compression forces produced by convective currents moving in opposite direction below the crust, produced numerous fault lines in the crust. Compression was followed by vertical moving forces created by raising convective current, which raised/ up-lifted the faulted crust.
The middle/ central fault block was however up-lifted faster and higher than the side-way blocks to form a horst.

Diagram

Relative Sinking /Subsidence Theory

According to this theory, compressional forces produced several fault lines in the crust.
Sinking convective currents (back into the mantle), pulled the faulted crust downwards to the mantle at different rate/ speed.
Side-way fault blocks sunk faster than the middle fault block which lagged behind and remained standing above the surrounding land formed a horst/ block mountain.

Diagram

Fault scarps \fault escarpments

A fault scarp is a steep slope **along a single fault line**. A fault scarp is formed when vertical forces produced by rising convective currents in the interior of the earth; acted on a single fault and caused one block **to slide down** relative to another to form a steep slope. For example Butiaba fault scarp near Lake Albert and Kicwamba in fort portal, western Uganda. Mau and Elgeyo fault scarp in Kenya and Manyara fault scarps in Tanzania.

Diagram

Grabens or hollows

A graben is a narrow trough between parallel faults formed within the rift valley due to secondary faulting on the floor of the rift valley. Later the grabens were filled with rain water, streams and rivers to form rift valley lakes for example grabens occupied by Lake Albert, Edward in Uganda, Turkana, Baringo, Nakuru and Magadi in Kenya, Tanganyika and Eyasi in Tanzania.
Graben lakes are deep, have steep banks, elongated with regular shore line.

Diagram

Tilted block landscape

This is a landscape of made of angular ridges and narrow depressions formed when tensional and compressional forces were accompanied/ followed by vertical operating forces which raised/ up-lifted and tilted the faulted blocks on one side, for example Aberdare region in Kenya.

Diagram

Fault guided river valley

A fault guided river valley formed where a single fault developed in the crust. Faulting created a single fault line where rocks were displaced and shattered, therefore easily deepened by running water and widened by denudation forces such as weathering and wasting to form a fault guided valley.
Later, the river abandoned its original course and started flowing following the fault line hence the name fault guided river valley, For example river Aswa valley in Northern Uganda, Kerio valley between Elgeyo escarpment and Kamasiya ridge in Kenya.

Diagram

15. With the aid of specific examples, examine the influence of faulting on the development of landforms in any one country of East Africa.

Approach

- Define faulting
- Explain the origin/ causes of faulting
- Describe the land forms produced by faulting
- Draw diagrams and give examples strictly from the country selected /chosen

THEORIES FOR THE FORMATION OF THE GREAT RIFT VALLEY

Account for the formation of the East African rift valley.
Justify the validity of the theories put forward to explain the formation of the Great Rift Valley in East Africa.
Examine the theories put forward to explain the formation of the Great Rift Valley in East Africa.

Approach

- Define a rift valley.
- Locate the Great Rift Valley descriptively or by drawing a sketch map.
- Explain the origin of the rift valley and describe the theories advanced to explain its formation.
- Point out the evidences where possible to justify the theories and with clear diagrams

Answer guide.

A rift valley rift valley is an elongated trough or depression between more or less parallel faults or in-facing fault scarps.

The Great Rift Valley in East Africa consists of two branches namely; the western branch that runs from Lake Malawi in the south through Lake Tanganyika and gradually fades out north of Lake Albert.

The Eastern branch passes trough Kenya down to Tanzania and into Lake Malawi in the south.

The rift valley contains numerous graben lakes produced by secondary faulting for example Lake Albert, Tanganyika and Turkana.

Origin of the Rift valley

The origin of the rift valley is not clear thus various theories which are related to two processes of Radio- activity and Geo-chemical reactions within the interior of the earth (core and mantle); generating intense heat that keeps the weak rock in the upper mantle (Asthenoshere) in molten state/ form.

Molten rock is light therefore tends to rise in form of convective currents which flow horizontally underneath the crust; creating tension, compression and vertical forces responsible for fracturing, dislocation and displacement of hard rocks in the crust along fault lines to create a rift valley.

Theories put forward include: tensional theory, compressional, differential up-lift theory, Up-arching theory, sea floor spreading and plate tectonics

Tension theory

This theory was advanced by J.W Gregory to explain the formation of the Eastern section of the rift valley.

According to Gregory, radio-activity and Geo-chemical reactions generated intense heat that produced convective currents in the mantle.

When convective currents reached the earth crust, diverged leading to development of tensional forces within the crust of East Africa.

Tensional forces pulled the crust in opposite direction from the central point within the earth crust forming **normal faults** and displacement of the rock strata.

Consequently, the Side blocks were pulled apart or away from each other while the middle/ central block sunk down under its own weight; displacing the rocks below to form **a rift valley with gentle slopes**.

Denudation forces such as weathering, erosion and mass wasting modified the side slopes.

Clear Diagram

- The volcanic activity associated with the rift valley indicates that the central block sunk and forced magma underneath to rise up along fault line to form volcanic features along the rift valley

Compression theory

This theory was advanced by E.J Wayland to explain the formation of the western section of the East African rift valley. (Lake Albert region).

According to wayland, intense heating in the interior of the earth by radioactivity and geo-chemical reactions resulted into convective currents

When convective currents reached the earth crust, tended to converge; creating compressional forces that pushed the crust of East Africa in the same direction, resulted into **reversed faulting**.
Continued compression forced sideway fault blocks to override the central/ middle block that remained stable at a relatively lower level, formed a rift valley with steep slopes or sharp edges.
After a long period of time, the sharp edges of up-thrusted fault blocks, hanging above the middle block were modified denudation forces such as weathering, erosion and mass wasting to produce smooth escarpments of today.

Clear Diagram

This theory is justified by the presence of folded sedimentary strata in this region produced by compressional forces.

Differential uplift theory or subsidence theory

The theory was advanced by Dixey and Troup to explain the step faulted part of the rift valley near Nairobi.
The theory assumes that there was a period of general uplift/ up warping of East Africa probably due rising convective currents generated from intense heat produced by radio activity and geo-chemical reactions in the interior of the earth.
The general uplift of the region resulted into normal faulting; creating numerous parallel faults in the crust, raised at different rates.
The theory assumes that side way fault blocks were raised faster than the central / middle fault block that rose slowly hence lagged behind in stages to form the rift valley.
Alternatively, compressional forces produced several fault lines in the crust. Compression was accompanied by sinking convective currents (back into the mantle) pulled the faulted crust downwards in stages or different rates.
The theory assumes that the middle/ central fault block sunk faster than the side way fault blocks which sunk slowly hence lagged behind in stages to form a rift valley.
At each stage of either uplift or subsidence, the mass of land formed a terrace hence formation of kedong fault scarp near Nairobi, appearing as a series of terrace rising from the rift valley floor up to the escarpments.
The gaps in the middle of the terraces formed the rift valley.

Clear Diagram

Up-arching theory by Lester .C. King

According to this theory, rising convective currents in the mantle caused a general up-bending or up-arching of the East African region. According to Lester King, tension forces caused the crest or summit of the up-bent area to crack and opened to form a rift valley. This theory is justified by the fact that the rift valley is on a raised plateau.

Sea floor spreading and plate tectonic theory by Harris Hess

The theory assumes that diverging convective currents underneath the African plate are creating deep faults in the plate causing the faulted region to sink slowly into the mantle hence a rift valley on the surface.
The continuous flow of convective currents underneath the African plate is increasing tensional forces causing the rift valley to widen at an estimated rate of 1.2cm each year.

In conclusion, the formation of the Great Rift Valley is a product of convective currents in the interior of the earth generating tension, compression and vertical endogenetic responsible for fracturing the earth crust to form a rift valley as explained above.
Emphasis should be on major theories of tension and compression.

Assess the effects of faulting on the land form evolution of East Africa.

16. To what extent has the process of faulting been responsible for land form development in East Africa?

Approach

- Define faulting

- Explain the origin/ causes of faulting
- Give the 1St evaluation (large) and describe the land forms produced by faulting; drawing diagrams and giving examples.
- Give the 2rd evaluation (larger) and explain other processes responsible for landform development in East Africa
- Explain at least three land forms produced by each process. That is;
- Vulcanicity, warping, glaciation e.t.c

Research question

Examine the effects of faulting on the drainage of East Africa

VULCANISM IN EAST AFRICA

Vulcanicity is the total process by which gases and molten rock/ magma are injected into the crust and or ejected onto the surface of the earth crust through vent/ fissures/ fault lines to form intrusive and extrusive volcanic features respectively.

Vulcanicity therefore combines both intrusive and extrusive volcanic activities.

INTRUSIVE VOLCANIC LAND FORMS IN EAST AFRICA

17. Examine the effect of intrusive volcanicity on land form development in East Africa.

18. Examine the influence of intrusive volcanicity on the development of relief landforms in East Africa.

Approach

- Define intrusive volcanicity
- Explain the process or origin/causes of intrusive volcanity
- Describe the land forms produced by intrusive volcanicity
- Draw diagrams and give examples.

Answer guide

Intrusive volcanicity is the process by which molten rock/ magma is injected or pushed into the earth crust from the interior of the earth to form intrusive volcanic landforms.

Origin

•Intrusive Volcanicity is brought about by radio activity and geo-chemical reactions in the interior of the earth generating intense/ great heat and pressure; melting mantle rock into molten rock/ magma.

•Some times magma forms as a result of Friction between moving rocks during plate movement and faulting.

•High pressure pushes out the molten rock/ magma into the crust; rising towards the surface through lines of weakness such as faults created by tectonic forces/ movements such as faulting.

•The injected materials solidify within the earth's crust at different levels due to;

– reduction in pressure,

–the chemical composition of magma,

– the nature of the surrounding rocks in terms of jointing and hardness.

•The conditions stated above also determine significantly the size and shape of the resulting landforms such as sills, dykes, laccoliths, lapolith and batholiths and are associated with various reliefs in East Africa.

•Intrusive volcanic landforms remain invisible until they are exposed on the surface by denudation processes like weathering, wasting and erosion that remove the overlying less resistant rocks or strata.

LAND FORMS CREATED BY INTRUSIVE VOLCANICITY

Sills- these are horizontal sheets of igneous rock structure lying between the bedding planes of sedimentary rocks.

They are formed when a sheet of basic magma rises and solidifies horizontally in the bedding planes of sedimentary rocks near the surface.

Sills vary in thickness and may extend for a wide area for example in Mubende, Tororo and Thika in Kenya.

Where sills are harder than the soft surrounding rocks, they were exposed and formed flat-topped hills, escarpments or cliffs as relief landforms after prolonged weathering and erosion for example Sukuru hills in Tororo and Kakinzi in Luwero

In addition, the escarpments and impermeable rocks associated with sills along river course created waterfalls for example Sipi falls in Kapchorwa, Kisiizi falls in Rukungiri and Thika falls in Kenya.

Dykes - are vertical or steeply inclined sheet of igneous rock structures cutting across rock strata. They were formed when magma solidified vertically in fissures before reaching the surface to form a wall like feature in the crust.

Dykes vary from few centimeters to hundreds of meters and are always discordant to the bedding planes of the rock strata for example Sukuru hills and dykes in southern parts of Lake Turkana.

In areas where dykes are harder than the surrounding rocks, they formed elongated hills or ridges and volcanic plugs as the surrounding rocks were destroyed by weathering and erosion for example ridges in Busia, Sukuru, Isingiro, Rungwe complex in Kenya and Tororo rock.

In areas where soft dykes alternate with hard country rocks , they were worn away to form long narrow ditch like depressions on the surface called trenches for example linear trenches near lake Turkana in Kenya

Batholiths- are very large dome-shaped intrusions made of large crystalline granite rock. They are formed when acidic magma cools down very deep in the crust, usually at the root of major volcanic mountains.

These hard batholiths were later exposed by prolonged denudation force of weathering and erosion, forming uplands/ highlands/ hill rock out crops which stand out as inselburgs or residual hills surrounded by soft low laying relief / plain for example Singo hills in Mubende, Sukuru hills in Tororo, Labwor and Parabong batholiths in Northern Uganda. Maragoli and Sangalo hills in western Kenya

In areas where soft batholiths alternate with hard country rocks, they were worn away to form arenas or wide depressions on the surface for example Rubarola arena in Kabale.

Laccoliths- are mash room or dome shaped intrusive igneous rock structures with a flat base. They are formed from injection of viscous /acidic magma into the layers, unable to spread far; accumulated in large mass.

The viscous magma forced the overlying rock strata to bend upwards hence dome shaped as it solidified.

When exposed by denudational forces, laccoliths have formed uplands when harder than the surrounding rocks for example Kitui and Voi areas in Kenya.

Candidates are expected to clearly explain and illustrate the intrusive volcanic relief landforms with relevant diagrams and examples…….25mks

EXTRUSIVE VOLCANICITY

19. Examine the influence of volcanicity on the development of relief land forms in East Africa.

20. Examine the effect of extrusive volcanicity on the development of relief land forms in East Africa.

Approach

- Define volcanicity
- Explain the origin/ causes
- Describe the land forms produced by volcanicity
- Draw diagrams and give examples.

Answer guide

Volcanicity is the process through which gases and molten rock are extruded onto the earth's surface through the vent or fissures to form various volcanic landforms.

Origin of extrusive volcanic landforms

Volcanicity is brought about by radio activity and geo-chemical reactions in the interior of the earth generating intense/ great heat and pressure; melting mantle rock into molten rock/ magma.
Some times molten magma forms as a result of Friction between moving rocks during plate movement and faulting.
High pressure pushes out the magma into the crust; rising to the surface through vent and lines of weakness such as faults created by tectonic forces/ movements such as faulting.
The shape and the size of the volcanic landforms are determined by the chemical composition/viscosity of magma and the nature of volcanic eruption. That is acidic (high silica content), intermediate and basic magma(less silica)

LANDFORMS PRODUCED BY VOLCANICITY

Ash and cinder cones, composite cones, shield and lava plateaus, explosion craters, caldera, Cumulo domes, volcanic plugs and neck e.t.c

Ash and cinder cones- are cones formed when acidic lava is ejected in violent eruption; breaking down into volcanic dust **(ash)** and small rock fragments **(cinder**).
These materials/ rock fragments fall back and build up a concave shaped cone around the vent due to the spreading out of materials near the base.
Ash is laid first followed by cinder and each layer represents a phase of eruption.

Characteristics of ash and cinder cones

- have steep slopes,
- small in size, not exceeding 300 meters (1000 ft) and
- often form parasitic cones on or near larger volcanoes.
- occur frequently in groups for example Sarabwe and Sabiniyo in Kisoro district, Teleki in Kenya and on the Eastern side of mountain Elgon.

Composite cones / strato volcanoes-these are larger cones made of alternate layers of ash and lava ejected through the vent over a long period of time.
The first eruption is violent and breaks down into volcanic dust called ash laid down around the vent to form the first layer. As pressure reduces, lava pours out on top of the ash to form the second layer. Successive eruptions build up a composite cone which can rise thousand of meters high above the surrounding surface.

Characteristics of ash and lava cones

- they are usually larger cones with steep slopes and broad bases,
- have smaller parasitic cones on the sides as exists for lava when the vent is sealed during the gentle eruption,
- have large craters at the top; created by secondary eruption which blows off the top of the cone,
- take long to erupt because lava hardens and seals the vent.

Examples include mountain Kilimanjaro, Kenya, Oldoinyo Lengai in Tanzania and Muhavura in south western Uganda.

Both ash and cinder cones and composite volcanoes are associated with high relief in East Africa

Shield volcanoes / Basalt volcanoes. They are elongated volcanoes formed when basic lava flows for a long distance and over a wide area before cooling and solidifying on the surface. The consequent solidification leads to formation of a much stretched lava cone.

▪The magma forming such a volcano comes out through several fissures or openings in the crust.
▪Rapid loss of gases occurs and because lava is less viscous, it flows for a while before solidifying.

Characteristic of shield volcanoes

- Shield volcanoes are of low height but with broad bases and extensive gently sloping sides,
- Some basalt volcanoes have large shallow and steep-sided small craters formed due to the subsidence of the summit of the volcano,

Example is Nyamlangira in Eastern Congo within the Virunga/ mufumbira ranges.

Lava plateaus. They are stretched / elongated uplands with generally leveled summit made of successive layers of basaltic lava.

▪Lava plateaus are formed when basic lava slowly pushes to the surface from several fissures in the earth crust and spreads out over the surrounding country side before solidifying as a sheet of basalt.

▪Repeated fissure eruptions build a thick and high plateau which may reach 6000 ft. high

▪Examples include laikipian on the eastern slopes of Aberdare range and Yatta plateau in Kenya, lava plateaus in Kisoro and Ntungamo.

Characteristic of Lava plateaus

- Have stretched/ elongated tops
- Have gentle to steep slopes

Lava plateaus and shield volcanoes are usually associated with areas of moderate relief

Explosion craters. These are Shallow and wide circular depressions on the surface of the earth crust formed by violent gaseous explosion that removes the over lying crystalline rocks. Rock fragments fall back and pile up to form a low rim round of the crater.

Characteristic of Explosion craters

- They are normally flat floored and may be as wide as 500 meters in diameter but usually less than 50 meters high
- Since the depression extends toward the water table; they are filled with water to form explosive crater lakes which usually
- occur in groups for Example Lake Katwe, Nyungu, Nyamunuka in south western Uganda and Lake Basoti North East of Singida in Tanzania.

Volcanic craters (Mountain Craters)- these are funnel shaped or circular low depressions in the tops of volcanic mountain /cones. They are usually less than a kilometer in diameter

▪Mountain Craters are formed when the top of a volcano is blown off during second violent eruption.

▪Most Mountain craters are filled with rain and glacier water to form crater lakes found in the top/ summit of dormant and extinct volcanoes.

▪example of Mountain crater lakes include Menengai crater in Kenya's rift valley, Lake Simbi in south- Nyanza district (Kenya), Lake Katungi in Bushenyi, Gisozi in Kisoro, crater lakes on Mount Elgon, Kenya, Kilimanjaro and Muhavura and Paradise on the summit of mount Marsabit.

Calderas. A caldera is a large circular depression in top of a volcanic mountain, usually 1km in diameter.

Most calderas are formed when the summit/ top of a volcano either;

- collapses/ subsides into the magma chamber below under its own weight because of the movement of supporting magma. The caldera formed by this process is called Cauldron or subsidence caldera, for example Napak in Karamoja Uganda, Menengai and Suswa calderas in the Eastern Rift valley in Kenya

Or

- when the upper part of the dormant volcano is blown off in a violent explosive secondary eruption, for example Longonot caldera on mount Longonot in Kenya and Ngorongoro crater in Tanzania.

Diagram

Cumulo dome- A Cumulo dome is a steep sided convex dome formed when acidic lava is pushed slowly out of the crust under low pressure and swells on the surface. Lava being acidic, piles up around the vent where the outer layers solidify quickly on exposure to air while the magma inside remains in semi liquid state. As more lava pushes out, the outer layers bulge/ swell into dome shape or a ball like structure with steep slopes, for example the Cumulo dome at Ntumbi near Mbeya in southern Tanzania

Tholoid- this is a Cumulo dome formed inside a crater or caldera of a larger volcanic mountain, for example the tholoid in the caldera on mount Rungwe in Tanzania.

Volcanic plug. A volcanic plug is a mass of hard rock/lava standing out vertically on the surface of the earth.

It is formed due to a sudden reduction in pressure during volcanicity; causing acidic lava to solidify in the vent and becomes resistant to denudation forces such as weathering and erosion that remove the surrounding weak/ soft rock layers. For example Tororo rock, in Eastern Uganda and Alekitek near Napak caldera in southern Karamoja.

21. Examine the relationship between the nature of material ejected and the resultant extrusive land forms in East Africa.

Approach

- Define volcanicity
- Explain the origin/ causes
- Identify the types of magma/lava and
- Describe the land forms associated with each type
- Draw diagrams and give examples.

Answer guide

Refer to the question above for the introduction

The shape and the size of the volcanic landform are determined by the nature of volcanic eruption and the viscosity of the out pouring lava. That is;

Acidic lava contains a high silica content of about 66% hence viscous and cools rapidly around the vent. It is associated with violent eruption and forms features with steep slope for example,

Ash and cinder cones, composite cones, Cumulo domes, tholoids and volcanic plugs

🕮 **Remember to explain the formation of these landforms.**

Basic or basaltic lava Contains less silica and therefore very fluid and flows for a long distance before solidifying. It is associated with gentle or quiet eruption producing features with gentle slopes and low relief land forms for example.

Shield volcanoes and lava plateaus

🕮 **Remember to explain the formation of these landforms.**

Gaseous lava. Magma contains very reactive gases and water and cause violent eruption. It is associated with **explosion craters, mountain craters and calderas.**

🕮 **Remember to explain the formation of these landforms.**

22. With reference to any one country in East Africa, account for the formation of volcanic landforms on its landscape.

Approach

- Define volcanicity
- Explain the origin/ causes
- Describe the land forms produced by volcanicity
- Draw diagrams and give examples strictly from the country selected /chosen

Refer to question above for answers

INFLUENCE OF VOLCANICITY ON DRAINAGE IN EAST AFRICA

23. Examine the influence of vulcanicity on drainage in East Africa.

Approach

- Define vulcanicity
- Explain the origin/ causes
- Identify forms of drainage
- Identify land forms resulting from vulcanicity associated with drainage with specific examples from East Africa.

Answer Guide

Volcanicity is the process through which gases and molten rocks are extruded onto the earth's surface through a central vent or fissures.

Volcanicity is brought about by radio activity and geo-chemical reactions in the interior generating intense/ great heat and pressure; melting mantle rock into molten rock/ magma.
Some times molten magma forms as a result of Friction between moving rocks during plate movement and faulting.
High pressure pushes out the magma into the crust; rising towards the surface through vent and lines of weakness such as faults created by tectonic forces/ movements such as faulting.
The shape and the size of the volcanic landforms are determined by the chemical composition/viscosity of magma and the nature of volcanic eruption. That is acidic (high silica content), basic magma(less silica) and intermediate
The effects of extrusive volcanicity on drainage features depend on the nature of eruption and the magma ejected. That is;
Violent gaseous explosion removes overlying crystalline rocks to form wide circular depressions that are filled with water to form **explosion crater lakes** for example Lake Katwe, Nyamunuka, Kasenyi, Kikorongo, e.t.c in south western Uganda.
Violent eruption may blow off the top / summit of a volcano or the summit of a volcanic mountain may collapse into the chasm to form a smaller circular depression filled with water to form mountain crater lake for example Lake Katungi in Bushenyi, Gisozi in Kisoro, crater lakes on Mount Elgon, Kenya, Kilimanjaro and Muhavura, Menengai crater in Kenya's rift valley and Lake Simbi in south-Nyanza district (Kenya) and Lake Paradise on the summit of mount Marsabit. Crater lakes are usually very small.
Some times violent eruption or subsidence of the summit forms a large, wide and circular depression on the volcanic mountain filled with water to form **caldera lakes** for example Lake Ngozi, Embagai and Ngorongoro in Tanzania.
Lava dammed lakes are formed as a result of deposition of basic lava across the existing river valleys causing damming and back ponding of the river for example lake Bunyonyi, Mutanda, Kyahifi, Kayumbo and Murehe in Kigezi south western Uganda, Lake Saka in Fort Portal.
Violent eruption of acidic lava builds Volcanic cones or mountains which form **divides/water shed** for numerous rivers forming **radial drainage** whose subsequent streams develop dendritic pattern for example Manafwa, Sironko, Malaba and Nzoia on mount Elgon and those on mountain Kenya, Kilimanjaro and Muhavura.
Volcanic materials that are porous in nature do **limit surface drainage** for example the basalts in Kisoro area and Bunyaruguru lack flowing rivers/surface drainage.
Intrusive volcanicity influences drainage especially where formerly existing dykes and seals are exposed by continuous erosion for example
Waterfalls and rapids develop where rivers cross resistant intrusive land forms such as dykes and sills. For example Sipi falls in Kapchorwa and Kisiizi falls in Rukungiri.
Presence of waterfalls and rapids lead to formation of other related features for example **gorges, plunge pools** e.t.c formed by falling water on soft rocks. Murchison gorge
Hot springs- mass of hot underground water flowing to the surface of the earth through fissures
Geysers- mass of underground steam and hot water gushing out to the surface through fissures.
Hot springs and geysers partly owe their origin to vulcanicity. Due to the existence of hot rocks or molten rock beneath the surface of the earth, when it rains water sinks into the ground and comes in to contact with super heated rocks and is therefore heated. Pressure builds up and steam and hot water expand in the fissures, rising to the surface. Hot springs are evident in Bundyibugyo district like Sempaya, Kitagata in Bushenyi and Kisiizi in Rukungiri.

24. Explain the influence of igneous rocks on landform development in East Africa.

25. Examine the influence of igneous rocks on landform development in East Africa.

Approach

- Define igneous rocks,
- Explain the process of formation,

- Identify the major categories of igneous rocks,
- Explain the landforms created by volcanic rocks, hyperbyssal and plutonic

That is extrusive volcanic rocks are associated with extrusive volcanic landforms such as composite cones, ash and cinder cones, Cumulo domes, lava plateaus, calderas, craters e.t.c

While

plutonic and hyperbyssal are associated with intrusive volcanic landforms such as batholiths, sills and dykes, ridges, arenas e.t.c after being exposed by denudation forces.

ROCKS IN EAST AFRICA

A rock is an aggregate of various minerals that make the solid part of the Earth crust.

Rocks in East Africa are categorized according to (a) Mode of formation/ origin (b) age.

When rocks are categorized according to Mode of formation, they fall under three types namely;

(a) Igneous (b) Sedimentary (c) Metamorphic

IGNEOUS ROCKS

Guiding questions

26. Account for the formation of igneous rocks in East Africa

Approach

- Define igneous rocks
- Explain the process of formation
- Identify the major types of igneous rocks,
- State and give the Characteristics, examples of each sub-type and areas where they are found in East Africa.

Answer guide.

Igneous rocks are fire formed rocks. They are formed through vulcanicity- a process by which magma is injected/ pushed into and onto the earth crust from the interior of the earth by pressure to form intrusive and extrusive volcanic rocks.

Vulcanicity is brought about by radio activity and geo-chemical reactions in the interior generating intense/ great heat and pressure; melting mantle rock into molten magma.

Some times molten magma forms as a result of Friction between moving rocks during plate movement and faulting.

High pressure pushes out molten magma into and onto the surface of crust; through lines a vent and fault lines created by tectonic forces/ movements such as faulting.

The injected and ejected materials solidify at different levels depending on the chemical composition of out pouring magma to produce various igneous rocks.

Igneous rocks are crystalline in nature (atoms are arranged in a definite manner). The size of the crystals depends on the chemical composition of magma, depth of cooling and solidification and exposure to oxygen.

Igneous rocks don't contain fossils and non-stratified.

Igneous rocks are sub-divided into three types depending on the size of crystals and the depth of solidification of magma namely**; extrusive volcanic rocks, hyperbyssal and plutonic igneous rocks.**

Extrusive volcanic rocks-are formed due to solidification of both acidic and basic lava **on** the surface of the crust.

They have **small crystals** because the rate of cooling is fast and exposure oxygen

Major examples include **Basalt, Rhyorite, Trachyte, andesite, Obsidian** and **Pumice.**

Volcanic rocks are found in volcanic regions such as mountain Kenya, Kilimanjaro, mufumbira, Elgon e.t.c.

Hyperbyssal rocks-are formed due to solidification of intermediate magma **near** the surface.

They have medium-**size crystals** because the rate of cooling is moderate.

Major examples include **quartz, dolerite and porphyry.**

Plutonic igneous rocks-are formed due to solidification of acidic magma **deep in the crust.**
They have **large crystals** because the rate of cooling is slow and lack of oxygen.
Major examples include **Granite, Diorite, Gabbro and Syenite.**
The rate of cooling is influenced by the chemical composition of the magma ejected from the mantle which in turn influences the process of crystallization. For example;
▪Acidic igneous rocks contain high amounts of silica which make them viscous, immobile and cool rapidly near the vent for example Rhyorite
▪Intermediate igneous rocks contain mixed mineral structures which make them fairly mobile example trachyte
▪Basic igneous rocks contain less silica content but much mica and olivine which make them very mobile and flow for long distance before cooling hence found far away from the vent for example basalt.
Hyperbyssal and plutonic rocks form intrusive igneous landforms which may later be exposed by denudational forces for example the Mubende batholiths, Inselburgs in Eastern Uganda e.t.c.
Impression marking……..25 mks
27. (a) Describe the formation of igneous rocks……15mks
(b) Explain the importance of igneous rocks in East Africa.
Approach

- In part (a) refer to the question above.
- Explain the positive and negative effects in part (b).

ECONOMIC IMPORTANCE OF IGNEOUS ROCKS

Positive effects……..7mks
▪Igneous rocks such as volcanic weather down into fertile volcanic soil that encourages crop cultivation for example Irish potatoes and vegetables in Kabale, Arabic coffee and bananas on the slopes of Mount Elgon and Kilimanjaro.
▪Igneous rocks are tourist attraction by forming attractive scenery hence source of foreign exchange used for economic development for example, mount Elgon, Kenya, Kilimanjaro, crater lakes, hot springs e.t.c
▪Source of valuable mineral ores for extraction for example Gold mining in Busiitema and Mubende, Iron and Copper in Mbeya and Kisoro, Diamonds in Mwandui near shinyanga in Tanzania
▪Provide building materials for example trachyte, Gabbro, dolerite are in setting foundation for heavy structures such as Dams, Bridges, storied buildings while Granite chippings are used in constructing non-skid surfacing roads.
▪Volcanic rock out crops are suitable sites for erecting communication equipments such as masks on Kololo hill, Kisoro, Mbale, Tororo and batholiths in Mubende.
▪Igneous rocks such as granites form strong basement used for erecting heavy structures such as Dams, storied buildings and bridges hence facilitate urbanization.
▪Igneous rocks provide opportunities for Education and research for example in the field of Geology, geo-thermal electricity development, mineral exploration e.t.c
▪Some igneous rocks contain hot springs suitable for developing geo-thermal power for example Olkaria geo- thermal power station in Kenya while kitagata and other hot springs are potential sites.
▪Igneous Rock Mountains are catchments for rivers that provide water for irrigation, domestic and industrial use for example, River Tana and Athi on Mount Kenya, River Manafa, Suam, Malaba, Sironko and Nzoia on mountain Elgon.
▪Igneous rocks are source of underground water basins / aquifers/artesian wells especially in areas where permeable rocks lay over impermeable rocks such as granites; used for domestic and industrial use.
▪widened employment base through mining and construction hence source of income used by people to raise their standards of living
▪Provide raw materials for construction industries

NEGATIVE EFFECTS…….3mks

▪Extrusive and intrusive igneous rocks form rock out crops that hinder construction of transport and communication networks for example Kigezi in southwestern Uganda.
▪Igneous rocks limit areas for settlement because of the rugged terrain for example in Kabale, batholiths in Mubende and Tororo.
▪Some igneous rocks such as granites weather down into coarse sand soil that discourages crop cultivation for example in Mubende.
▪If volcanic rocks are impermeable; they cause impended drainage that reduces the water table below hence limiting crop productivity.
▪Volcanic rock out crops are associated with landslide and soil erosion during the wet season which discourage settlement and agriculture for example in Mbale, Kigezi highlands, slopes of Mount Kenya, Meru and Kilimanjaro
▪In case igneous rocks contain minerals, they may hinder mining since they are hard to break or increase the cost of mining.
▪Some igneous rocks harbour pests such as snakes, rats and moles

SEDIMENTARY ROCKS

Guiding questions

28. (a)Describe the processes which have led to the formation of sedimentary rocks in East Africa

(b)Explain the importance of sedimentary rocks to East Africa.

Approach

- Define sedimentary rocks
- state the characteristics of sedimentary rocks
- Describe the processes / conditions of formation
- Identify and Explain the formation of the three types of sedimentary rocks
- Give examples of each type and where they are found
- In part (b) explain the positive and negative importance of sedimentary rocks

Answer guide

Sedimentary rocks are formed from deposition of sediments and other materials produced by weathering of igneous or metamorphic rocks.
The sediments are then transported by agents of erosion like running water, wind or ice and deposited in layers or strata on either dry land, valleys or under water for example sea bed, river bed e.t.c
The layers are separated by bedding planes which demarcate the end of one depositional cycle and the beginning of another; and can be horizontal, gently sloping or steeply dipping.
After million years, sediments are compressed, compacted, hardened and cemented together in various ways to form different sedimentary rocks.

STEPS OR PROCESSES INVOLVED IN THE FORMATION OF SEDIMENTARY ROCKS

Sedimentary rocks evolve through different stages after million years hence the processes have to be presented in the order. Sedimentary rocks are formed through the following processes
Weathering of the parent rocks to produce sediments through physical, chemical or organic processes.
Erosion and transportation of the sediments by running water, ice or wind
Deposition of the sediments on dry land, valleys and underwater in oceans, lakes or seas and rivers
Stratification of the deposited sediments by bedding planes to demarcate the end of old deposit and the beginning of a new deposit.
Compression of the stratified materials by the weight of the overlying new deposit
Consolidation/ compaction or hardening of the compressed materials

Lithification or cementation of the stratified materials by calcareous algae, siliceous and ferruginous materials

Transformation of cemented sediments into different types of sedimentary rocks

CHARACTERISTICS OF SEDIMENTARY ROCKS

Generally, sedimentary rocks consist of;

▪Fossils of dead plants and animals

▪Non-crystalline in nature

▪Have layers or strata

▪The strata or layers are separated by bedding planes of cementing materials

▪The strata are either horizontal, gentle dip or steeply dipping.

TYPES OF SEDIMENTARY ROCKS

Sedimentary rocks are sub-divided further into three types according to the origin of sediments. That is **mechanically** formed sedimentary rocks, **organically** formed sedimentary rocks and **chemically** formed sedimentary rocks.

MECHANICALLY / PHYSICALLY FORMED SEDIMENTARY ROCKS

They are formed from deposition and consolidation of sediments produced by physical weathering and agents of erosion for example;

Wind deposition forms **loess** common in arid areas in East Africa.

River deposition forms **lacustrine / alluvial deposit** found in river valleys, glacial deposition forms **moraine or till** found in valleys of glaciated mountains.

Wave deposition forms **marine** deposits.

Major Examples of resulting rocks or mechanically formed rocks include;

Sand stones, mudstones, clay stones, shale gravel, boulder-clay, grit e.t.c

ORGANICALLY Formed SEDIMENTARY ROCKS

They are formed from fossils of dead animals and plants for example;

(a) Deposition of animal remains such as Coral polyps form limestone rock called coral reefs and chalk common along the East African coast.

(b)Deposition and decomposition of Plant remains during the carboniferous period led to formation of **coal (**lignite, peat, and brown coal) found in Ruhuhu valley in Tanzania.

CHEMICALLY FORMED SEDIMENTARY ROCKS

They are formed from the evaporation and precipitation of salt solutions to form **rock salts found** around Lake Katwe in south western Uganda and south of Nyanza province in Kenya, **Soda ash** around Lake Magadi and Natron and **Dolomite, Gypsum, Bauxite. Other examples include Laterites** deposits found on hill tops in Central Uganda.

Impression marking…….15mks

IMPORTANCE OF SEDIMENTARY ROCKS

Positive effects of sedimentary rocks

-Weather down to form fertile soil on drainage basins hence supports crop cultivation for example alluvial soil in swamps, river valleys and lake shore supports yams, sugar cane, potatoes e.t.c.

-Coral limestone soils support agriculture for example coconuts, mangoes, citrus fruits, cashew nuts and cloves in Pemba, Mombasa and Zanzibar.

-Provide raw materials for the industrial and domestic use for example Rock salt, potash, phosphate, limestone used in making cement such as Bamburi

-Provide cheap building materials for example gravel and sand are used in mixing concrete, clay is used in making bricks, tiles, maxi pans e.t.c for example Lweza and Kajjansi clay industries.

-Limestone rocks are porous hence provide good source of underground water obtained through bore hole drilling for domestic use such as cooking, washing, drinking e.t.c

-Tourist attraction by forming attractive scenery hence source of foreign exchange used for economic development for example coral reefs and raised caves at the East African coast, stalactites and stalagmites in fort portal karst landscape e.t.c

-Source of mineral ores for extraction and mineral exports hence source of foreign exchange for example Diamonds in Mwandui, Gold, Tin, Coal, Cobalt, Tungsten e.t.c in western Uganda, Nyanza province in Kenya e.t.c

-some Sedimentary rocks are source of fuel for industrial and domestic use for example coal in the Ruhuhu valley in Tanzania, petroleum and natural gas in Kaiso-Tonya in Bunyoro and Malindi-Lamu region in Kenya.

-Sedimentary rocks are associated with flat landscape due to deposition hence ideal for grazing of live stock and settlement for example the Great Plains and the coastal areas like Mombasa.

-Widened employment base in the mining, construction, Art and Craft, Agriculture hence source of income to a vast population in the region.

-Alluvial soils support mangrove and riverine vegetation hence promote forestry for example in the coastal and river valley areas such as Rufiji.

-Provide opportunities for education and research for example Geology, Oceanography, and mineral exploration

-Coral and delta lagoons encourage fish farming for example at the coast, swamps and river valleys in different areas.

-Riverine and swampy vegetation support craft industry for example palm leaves and papyrus are used to make hats, hand bags e.t.c

-Coral reefs provide good sheltered harbors for shipping and development of ports for example Mombasa and Dar-es –Salaam.

-Some sedimentary rocks such as clay are Source of medicine "**emumbwa"** used mainly in central Uganda to cure various diseases

NEGATIVE EFFECTS

-Limestone and sandstone weather down into immature and infertile soils which discourage crop productivity for example in the Coastal areas

-Lime stone rocks and sandstones are very porous hence have limited sources of surface water supplies

-Peat soils, silt and clay encourage flooding during the wet-season; leading to destruction of crops, settlements and other properties

-Coral reefs are barriers to marine transport and fishing at the coast because they are hard and protrude hence wreck ships, fishing boats and nets.

-Sandstone, limestone and chalk form wastelands which discourage settlement and agriculture for example sand dunes.

-Riverine vegetation and lagoons encourage bleeding of disease causing vectors like mosquitoes which cause malaria e.t.c

-Some sedimentary rocks harbour pests such as snakes, rats and moles

METAMORPHIC ROCKS

Guiding question

29. (a)Account for the formation of metamorphic rocks in East Africa

(b)Explain the importance of metamorphic rocks to the people of East Africa

Approach

- Define metamorphic rocks,
- Identify and Explain the formation of major types of metamorphic rocks,
- Give examples of each type and where they are found
- In part (b) explain the positive and negative importance of metamorphic rocks,

Answer guide

▪Metamorphic rocks are changed rocks. They are rocks changed from originally igneous and sedimentary to new rocks with altered / changed structure and chemical composition (mineralogy, texture and internal structure)

▪Metamorphism of the rocks is caused by heat (thermal), **pressure** (dynamic) or **both (**thermal dynamic**);** producing three types of metamorphic rocks. That is:

(a)**Thermal (heat) metamorphism** occurs when magma comes into contact with the adjacent rocks during vulcanity; consequently melts them and alter their mineralogy for example Batholiths. Thermal metamorphism changes;

▪Lime stone to Marble ▪ Sandstones to Quartzite

(b)**Dynamic metamorphism (pressure)** occurs when Earth movements like faulting and folding exert pressure on the existing rocks and cause them to expand or contract. Dynamic metamorphism changes;

●Granites to Gneiss

(c)**Thermal –dynamic** metamorphism (heat and pressure) generated during mountain building, changes;

▪Clay to Slate ▪Coal to Graphite ▪Shale to Schist

Metamorphic rocks cover wide areas of Nyanza, Western Rift valley, Eastern and North Eastern Provinces of Kenya, Western, Central, Eastern and Northern parts of Uganda and central parts of Tanzania.

IMPORTANCE OF METAMORPHIC ROCKS

Positive

-Source of mineral ores for extraction example kimberlite in Mwandui contains diamonds.

-Provide raw materials for the industrial use for example graphite is used to make pencil tips, kimberlite for drilling bits e.t.c

-Some metamorphic rocks like gneiss are used as grinding stones

-Some Metamorphic rocks such as quartzite are used for road surfacing, slates for roofing and stair steps e.t.c

-Source of thermal energy for domestic and industrial use fore example graphite coal from Ruhuhu valley in Tanzania.

-Marble is used for decoration and making ornaments fore example garnet extracted from gneiss and schist.

-Metamorphic rocks fore example slate are used for study purposes and research.

-Metamorphic rock out crops such as quartzite and gneiss are suitable for erecting of communication equipments such as masks, water tanks, and military defense hardware

- Metamorphic rocks form strong basement used for erecting heavy structures such as Dams, storied buildings e.t.c example Owen falls, Nalubaale and Bujjagali dams in Uganda, Kindaruma, Kamburu and Gitaru dams in Kenya.

-Slate and shale weather down into fertile soil that supports crop cultivation for example in Nyanza province in Kenya, western Uganda e.t.c.

- Tourist attraction by forming attractive scenery hence source of foreign exchange used for economic development for example granitic tors near Mwanza.

- Metamorphic rocks form underwater basins/ aquifer or artesian wells hence source of water for domestic use.

- Metamorphic rocks have widened employment base through mining and construction hence source of income used by people to raise their standards of living

▪Provide raw materials for construction industry especially roads and houses

NEGATIVE EFFECTS

▪Metamorphic rocks such as Gneiss weather down into poor coarse soils that discourages crop cultivation

▪Some metamorphic rock out crops such as quartzite hinder construction of transport and communication networks

▪Metamorphic rock out crops encourage landslides inform of rock fall, slumping and soil erosion during the wet season which discourage settlement and agriculture

▪Some metamorphic rock out crops such as quartzite limit areas for settlement because of the rugged terrain for example in western Uganda and Kenya

▪Some metamorphic rocks for example slate are impermeable; leading to impended drainage that reduces the water table below hence limiting crop productivity for example Kigezi highlands, slopes of Mount Kenya, Meru and Kilimanjaro

▪In case metamorphic rocks contain minerals, they may hinder mining since they are hard to break or increase the cost of mining.

▪Some metamorphic rocks harbour pests such as snakes, rats and moles

30. (a)Distinguish between igneous and metamorphic rocks

(b)Explain the importance of rocks to East Africa.

Approach

- Define igneous and metamorphic rocks
- Explain the processes of formation for each type,
- State the Major categories and examples of each rock type.
- In part (b) explain the positive and negative importance of rocks

Answer guide

▪Igneous rocks are fire formed rocks.

▪Main process of formation is vulcanicity- a process by which magma is injected/ pushed into and onto the earth crust from the interior of the earth by pressure to form intrusive and extrusive volcanic rocks.

▪Vulcanicity is brought about by radio activity and geo-chemical reactions in the interior generating intense/ great heat and pressure; melting mantle rock into molten magma.

▪Igneous rocks are formed according to the chemical composition of magma. That is; acidic, basic and intermediate for example granite, dolerite, Gabbro, diorite, olivine e.t.c

▪Igneous rocks are also formed according to the physical structure that determines the rate of cooling and size of the rock crystals hence plutonic/ abyssal, hyperbyssal and volcanic rocks for example Syenite, quartz, obsidian, basalt, pumice e.t.c

▪Generally Igneous rocks are crystalline in nature, contain no fossils, some are spongy and others are glassy

Impression marking ……..……..08 marks

While

▪Metamorphic rocks are changed rocks.

▪Changes are brought about by heat (thermal), **pressure** (dynamic) or **both (**thermal dynamic**)** to produce new structures

▪Metamorphic rocks are more compact/ harder/ resistant than those which they are derived

▪Some metamorphic rocks are laminated in thin layers which easily split apart, and tend to be brittle

▪Examples of metamorphic rocks include Marble, Quartzite, Gneiss, Slate, Graphite, Schist e.t.c

Impression marking ……..……..07 marks

IMPORTANCE OF ROCKS TO EAST AFRICA

Positive

-Some rocks weather down into productive fertile soils that encourage crop cultivation for example volcanic and alluvial soils are supporting cultivation of vegetables, bananas, fruits e.t.c in various parts of East Africa such as Kabale

-Provide raw materials for the industrial and domestic use for example Rock salt, potash, phosphate, limestone used in making cement such as Bamburi, graphite is used to make pencil tips, kimberlite for drilling bits e.t.c
-Provide cheap building materials for example gravel and sand are used in mixing concrete; clay is used in making bricks, tiles, maxi pans, trachyte, Gabbro, dolerite are in setting foundation for heavy structures such as Dams, Bridges, storied buildings while Granite chippings are used in constructing non-skid surfacing roads.
-rocks are reservoirs for underground for example aquifers/artesian wells, springs e.t.c for domestic and industrial use
-rocks are tourist attraction by forming attractive scenery hence source of foreign exchange used for economic development for example coral reefs, caves , stalactites and stalagmites in Fort Portal , granitic tors, inselburgs e.t.c
-Source of mineral ores for extraction and mineral exports hence source of foreign exchange for example Diamonds in Mwandui, Gold, Tin, Coal, Cobalt, Tungsten, graphitize e.t.c in western Uganda, Nyanza province in Kenya e.t.c
-some rocks are source of fuel for industrial and domestic use for example coal in the Ruhuhu valley in Tanzania, petroleum and natural gas in lake Albert, geo-thermal power such as Olkaria geo- thermal power station in Kenya
-Widened employment base in the mining, construction, Art and Craft, Agriculture hence source of income to a vast population in the region.
- rocks such as sedimentary contain Coral and delta lagoons which encourage fish farming for example at the coast, swamps and river valleys in different areas.
-Rocks such as clay are used for pottery, making tiles, bricks, cups, plates, flower vases e.t.c
-Some rocks such as clay are Source of medicine "**emumbwa"** used mainly in central Uganda to cure various diseases
▪igneous and metamorphic rock out crops are suitable sites for erecting communication equipments such as masks on Kololo hill, Kisoro, Mbale, Tororo and batholiths in Mubende.
▪rocks provide opportunities for Education and research for example in the field of Geology, geo-thermal electricity development, mineral exploration, and Oceanography

NEGATIVE EFFECTS

▪Some rocks break down into coarse infertile soils that discourage crop cultivation for example granites produce sandy soils
▪Rock out crops can be a hindrance to agriculture because of the rugged terrain and hardness Hard and exposed rocks are barriers to transport and general construction works
▪Areas with porous rocks have limited surface water supplies for example volcanic rocks in Kisoro, Bunyaruguru e.t.c
▪Some rocks habour pests such as snakes, rats e.t.c
▪Igneous and metamorphic rocks are very hard hence may hinder mining or increase the cost incase they contain minerals

Factual marking……. ……....**positive…….07 mks**
Negative…….....**03mks**

31. Account for the formation of different types of rocks in East Africa.
32. Examine the processes responsible for the formation of various rock types in East Africa.
Approach

- Define a rock
- Identify the major rock types in East Africa i.e. igneous, sedimentary and metamorphic
- Describe how each rock type is formed
- State the characteristics of each type; give example areas where they are found.

📖 **Refer to the questions above.**

33. Explain the influence of igneous rocks on landform development in East Africa.

34. Examine the influence of igneous rocks on landform development in East Africa.
Approach

- Define igneous rocks,
- Explain the process of formation,
- Identify the major categories of igneous rocks,
- Explain the landforms created by volcanic rocks, hyperbyssal and plutonic

That is extrusive volcanic rocks are associated with extrusive volcanic landforms such as composite cones, ash and cinder cones, Cumulo domes, lava plateaus, calderas, craters e.t.c
While
plutonic and hyperbyssal are associated with intrusive volcanic landforms such as batholiths, sills and dykes, ridges, arenas e.t.c after being exposed by denudation forces.
📖 Remember to explain the formation of these landforms.

DAVISIAN CYCLE AND SLOPE DEVELOPMENT

(a) Describe the Davisian cycle of landform evolution
(b) Explain the relationship between rock hardness and slope formation in East Africa.
Answer guide
The Davisian cycle is named after William Morris Davis who propounded the Geomorphic cycle/ peneplanation cycle/ erosion cycle/ slope decline.
It is the modification of the physical landscape as a result of the action of natural agencies in an orderly progressive sequence; the cycle ranges from the up lift of the land into upland to an ultimate low, almost featureless plain.
Land forms evolve through a progressive sequence of stages/ age. For example youth full stage, mature stage, old age, rejuvenation.
The cycle begins with uplift of the land leading to building of highlands/ uplands. This can be due to earth movements or orogenic processes.
The uplift has to be simple and fast/ rapid enough that it does not experience significant erosion during this phase.
Uplifted land then undergoes a cycle of erosion/ down cutting by rivers, snow, wind e.t.c and weathering processes.
Rivers in the steep slopes of the uplifted landscape quickly deepen valleys by vertical erosion, flow at a high speed, forming v-shaped valleys.
As the process continues, the relief decreases, slopes and valleys begin to become gentler.
Lateral erosion is more dominant and the valleys become open and changed from v-shape to u-shape.
The relief later becomes relatively smooth and flood plains begin to develop hence landform evolution reaches the old stage.
Rivers deposit eroded materials from the youth full and mature stages.
Deposition results into meandering as the relief becomes more flat.
A Lowland finally develops and Davis calls this a peneplain or a level surface.
When the peneplain stage is achieved, uplift occurs so that the cycle starts again. This Davis referred to as a return to a level or point of origin.
Davis cycle points out the value of structure, process and stage/ time in landform evolution.
Impression marking…….15marks
b) Hard rocks are more resistant to erosion than soft rocks hence rocks such as quartzite, granites and Gabbro often form upland areas with convex or waxing slopes on top.
Below the waxing slope is the free face which is very steep sloping. This is due to erosion and weathering on a hard rock and mass wasting.
Down the free face is the constant or straight/ even slope that is gently sloping resulting from uniform weathering/ erosion of hard or soft rocks and deposition from the free face.

Soft rocks like clay and shale form lowlands that are deeply weathered or eroded to form concave slopes or waning slope. Such slopes may also result from deposition.
Diagram
Impression marking…….10marks

WEATHERING IN EAST AFRICA

Types of weathering

Weathering takes place in three forms. Namely;
Physical/ mechanical weathering, chemical weathering and biological weathering.
Physical weathering involves the disintegration of the rock into small fragments without a change in the chemical composition of the rock. Chemical weathering involves decomposition and change in the chemical composition of the rock and formation of new compounds.
Biological weathering involves physical disintegration and chemical decomposition of rocks by action of by living organisms.

PHYSICAL WEATHERING

Examine the physical weathering processes dominant in East Africa.
With reference to specific examples, explain the physical weathering processes experienced in East Africa.
Approach

- Define physical weathering
- State the factors that facilitate physical weathering
- Identify and explain the forms/ processes of physical weathering experienced in East Africa
- Give examples and draw diagrams where applicable

Answer guide
▪Physical weathering is the process that involves disintegration or break- down of rocks into smaller fragments/particles without any change in the chemical composition of rocks in situ.
▪Physical weathering involves a change in the size of the rock but the chemical composition of the resulting fragments remains the same as of parent rock.
▪Physical weathering occurs due to;

- temperature fluctuation like alternate heating and cooling,
- nature of the parent rock,
- frost action in mountainous areas and due to
- influence of plants and animals (biotic factors)

▪Physical weathering occurs in form of exfoliation, block disintegration, freeze and thaw, granular disintegration, pressure release, and aridity shrinkage and salt crystallization.
▪Physical weathering is dominant in areas that are;

- hot and dry,
- receiving low annual rain fall of less that 500mm with a prolonged dry season for example Northern, North Western and North Eastern Kenya, central Tanzania, North Eastern Uganda e.t.c

PROCESSES/ FORMS OF PHYSICAL WEATHERING

Exfoliation. This is the disintegration of rock by peeling off thin surface layers resulting from alternate heating/expansion and cooling/ contraction during day and night respectively.
▪in the dry areas, during the day it is hot, exposed rocks are heated leading to expansion of the rock while during the night temperatures rapidly fall leading to rapid cooling of the rock. Repeated expansion and contraction of rock surface layers eventually lead to shattering of the rock causing the surface layers peel off, leaving behind smooth rounded features called exfoliation domes while the inner parts remain unaffected.
▪Exfoliation domes are common in Machakos, Kitui, Nyika plateau, Seme hills in Kenya, Mubende, Ntungamo, Kumi, Akia hills in Lira, Parabong, Napak e.t.c
▪Exfoliation mainly affects homogeneous and jointed rock structure such as granite.

Block disintegration –refers to the break down of rocks into rectangular shaped blocks when jointed and homogeneous rocks are heated or cooled leading to expansion or contraction.
The large diurnal temperature range in dry areas resulting from alternate heating and cooling during day and night force joints or cracks in the rock to widen and get deeper which eventually cause such rocks to break down into large pieces along joints. For example Lodwar in Kenya, Bismarck rock at Mwanza in Lake Victoria, castle kopje Inselbergs in Ntungamo, Mubende, Kumi, Lugala and lion rock North West of Dodoma.
Granular disintegration- refers to the breakdown of rocks into tiny rock pieces/grains due to differential heating and cooling. This process affects rocks composed of different minerals (heterogeneous rocks) with different heating capacity. When such rocks are subjected to alternate heating/ expansion and cooling/ contraction, internal stresses and strains build up within the rock and eventually cause rock disintegration into tiny /smaller pieces called **granules**.
Granular disintegration mainly affects **coarse granites.**
Frost shattering/ freeze and thaw weathering. Takes place in well jointed rocks in snow capped mountains of East Africa such as Mount Kenya, Kilimanjaro and Rwenzori.
In these mountains, ice melts (thaws) during day due to warm weather, and water seeps and collects in rock joints, cracks or pores.
At night, temperature falls to 0 degree Celsius and water freezes, its volume expands by 10 %. This expansion exerts great force on the rock walls which eventually weakens the rock. Repeated action of freeze and thaw widen and deepen the joints and eventually the rock disintegrates to pieces called screes which accumulate at the base.
Pressure release or unloading .This process takes place when overlying rock layers, soil and other materials exerting pressure on granites below are removed by denudation forces such as erosion and mass wasting. The gradual removal of these materials reduces pressure and exposes rocks formally buried to alternate heating and cooling during day and night. Gradually the newly exposed granites expand and develop curved joints on the surface and eventually disintegrate into curved sheets. For example exposed granites in Apach, Serengeti and Rukwa
Salt crystallization. This is the process by which saline solution in rock salt crystallizes, accumulate and expand leading to rock disintegration along joints and cracks.
Salt crystallization mainly affects salt rock in semi arid basins. The occasional rain received percolates down into the rock and dissolves salt mineral to form salt solution. During the hot long dry season, the solution is brought to the surface by capillary. Water evaporates and salt crystals are left behind as tiny crystals which accumulate and overtime, exert pressure on rock walls which eventually lead to rock disintegration.
Salt crystallization is common around Lake Magadi and Naivasha in Kenya and Lake Katwe south western Uganda.
Aridity shrinkage or slaking- occurs on non-porous rocks like clay which absorbs water during rainy season and expands, while during the dry season loose water through evaporation and crack. Repeated alternate expansion and contraction eventually cause them to crumble into small elongated pieces.
Biological weathering or chelation. Combines the effects of plant roots, man and other living organisms for example;
▪plant roots growing into the rock increase internal stresses and strains causing rock disintegration via joints and crevices.
▪man through his activities such as mining and quarrying, construction, overgrazing e.t.c cause large scale disintegration of rocks
▪Movement/ trampling of herds of animals break down rocks especially in nomadic communities such as Karamoja.
▪small animals such as rodents like rats, mice, moles and squirrel make burrows in rocks which facilitate physical disintegration of rocks.

▪Insects such as locust and termites destroy the vegetation cover such as grass thereby exposing the rocks to agents of physical weathering.

PHYSICAL WEATHERING IN THE SEMI-ARID AREAS OF EAST AFRICA

Account for the dominance of physical weathering in the semi-arid areas of East Africa.

Approach

- Define physical weathering
- Areas dominated by physical weathering
- State the characteristics of semi-desert areas.
- Identify and define the physical weathering processes that dominate semi-arid regions
- Explain the factors or conditions favoring the dominance of physical weathering in semi arid areas
- Illustrate the points with examples and diagrams where applicable

Answer guide

Physical weathering is the process that involves disintegration or break- down of rocks into smaller fragments without any chemical changes in the composition of the rock.

Physical weathering is dominant in areas that are;

- hot and dry,
- Receiving low annual rain fall of less that 500mm with a prolonged dry season for example Northern, North Western and North Eastern Kenya, central Tanzania, North Eastern Uganda e.t.c

Semi arid regions are characterized by;

- Low rainfall of less than 500mm annually,
- Rainfall is unreliable,
- Low humidity,
- Low cloud cover,
- Hot/ very hot temperatures during the day and cool/cold during the night,
- Large diurnal range in temperature,
- Absence/ limited vegetation cover.

Physical weathering processes that dominate semi-arid regions include;

Exfoliation-the peeling off of surface layers of the rock as a result of expansion of the surface layers of the rock when heated and contraction when cooled

Block disintegration-the breakdown of rocks into rectangular shaped blocks when jointed rocks are heated or cooled leading to expansion or contraction

Granular disintegration- the breakdown of heterogeneous rocks into tiny particles/ grains due to differential heating and cooling

Salt crystallization- the process where saline solution in rock salt crystallizes after evaporation, accumulates in rock joints, cracks leading to internal stresses and strains resulting into rock disintegration

Aridity shrinkage- occurs on non-porous rocks like clay which absorbs water during rainy season and expands, while during the dry season looses water and cracks leading to disintegration.

FACTORS FAVORING PHYSICAL WEATHERING IN SEMI-ARID REGIONS IN EAST AFRICA

Physical weathering dominates semi- arid regions due to the reasons explained below

Climate- in semi-arid areas, during the day it is hot, exposed rocks are heated leading to expansion of the rock while during the night temperatures rapidly fall leading to rapid cooling of the rock, lead to peeling or breaking of the rock through the processes like exfoliation, granular disintegration, block disintegration e.t.c

▪In semi- arid areas during the short rainy season, non porous rocks like clay absorb water and expand while during the long dry season they lose water and crack resulting into rock disintegration

▪In semi arid areas there is limited cloud cover which leads to temperature fluctuations. That is, hot/very hot during the day, cool/cold during the night leading to expansion and contraction, resulting into break down of rocks

Nature of the rock

▪Jointed rocks in dry areas result into block disintegration when rocks break into rectangular blocks when heated or cooled.
▪Mineral composition-rocks having different minerals absorb heat an loose heat at different rates when heated or cooled respectively resulting into granular disintegration
▪Color of the rock-darker colored rocks absorb a lot of heat in semi-arid areas when heated leading to their disintegration.
▪Differences in rock hardness. Soft rocks in semi-arid area easily break down
Absence/ limited vegetation cover. This exposes the rock to extreme temperatures both during day and at night resulting into expansion and contraction of the rock surfaces leading to disintegration.

Biotic factors
▪Effect of plant roots where there is growth of xerophytic plants adopted to semi-arid conditions for example cacti, acacia, baobab e.t.c whose roots grow deeper breaking the rock
▪Impact of human activities like mining and quarrying that breaks the rock e.t.c, overgrazing which exposes the rock e.t.c
▪Movement/ trampling of herds of animals break down rocks especially in nomadic communities such as Karamoja.
▪small animals such as rodents like rats, mice, moles and squirrel make burrows in rocks which facilitate physical disintegration of rocks.
▪Insects such as locust and termites destroy the vegetation cover such as grass thereby exposing the rocks to agents of physical weathering.
IMPRESSION MARKING……25MKS

CHEMICAL WEATHERING

Examine the chemical weathering processes dominant in East Africa.
With reference to specific examples, explain the chemical weathering processes experienced in East Africa.
Approach
- Define chemical weathering
- State the factors that facilitate chemical weathering
- Identify and explain the forms/ processes of chemical weathering experienced in East Africa
- Give examples and draw diagrams where applicable

ANSWER GUIDE
▪Chemical weathering is the decomposition, decay, rotting of rocks in situ on or near the earth's surface.
▪In chemical weathering there is a total change in the chemical composition of the rock. That is; new compounds are formed.
▪It occurs as a result of;
- heavy/ adequate rainfall and high humidity that provide adequate water to act as a medium of chemical reactions and
- hot temperatures accelerate the rate of chemical reactions.

▪Chemical weathering takes place inform of carbonation, oxidation, hydrolysis, hydration, solution and reduction.
▪Chemical weathering processes are experienced on the northern shores of lake Victoria, limestone regions such as Bamburi near Mombasa, Kilifi and other coastal areas, Nyakasura in Fort Portal, Hima in Kasese and Tororo eastern Uganda e.t.c

PROCESSES OF CHEMICAL WEATHERING

Carbonation- is a chemical reaction that takes place when rain absorbs carbon dioxide from the atmosphere to form a weak acid called **carbonic acid**-which converts calcium carbonates (insoluble in nature) into calcium bi-carbonate easily washed away by rain leaving behind gullies called grikes.

▪Carbonation is common in limestone regions such as Nyakasura in Fort Portal, Tororo, Hima and along the coast in areas such as Bamburi near Mombasa in Kilifi, Athi river e.t.c

Oxidation- this is a chemical reaction that takes place between oxygen dissolved in water and rock bearing iron and aluminium ores for example clay.

- The reaction forms new compound/ oxide (rust) which are softer and weaker than the original and eventually the rock crumbles down.
- In well drained areas; oxidation of clay (rich in iron) produces red or brown colored soils called latosols common on hill tops in central Uganda and; lateritic soils/ red ferric compounds in tropical savanna.
- In water logged areas, oxidation changes clay to grey or blue color.

Solution- this is a process involving minerals dissolving in water for example rock salt, chalk, limestone, gypsum e.t.c

Hydrolysis- this is a reaction between hydrogen ions in water and metal ions in the rock to produce new compounds that are weaker and more soluble than original.

▪Hydrolysis for example decomposes

- feldspars in granites into kaolin clay- used in making tiles for example in Kajjansi on the shore of Lake Victoria along Kampala-Entebbe highway.
- Silicate mineral in igneous rocks increase in volume by hydrolysis leading to expansion and disintegration of igneous rocks in the tropics.

Hydration- this is a reaction involving rock minerals absorbing water, expand and change the internal structure by forming new compounds which are more soluble than original hence the rock crumbles easily. For example

- **Mica** absorbs water expands and change into mica hydrate easily washed away in solution.
- **Haematite** expands after absorbing water and changes into *Limonite.*
- Calcium sulphate changes into gypsum which is more soluble.

Reduction- involves removal of oxygen ions from the rock and addition of hydrogen ions. This process affects mainly iron bearing rocks in swampy areas for example

- Sulphate can be reduced to hydrogen sulphite,
- Ferric hydrate can be reduced to ions.

Spheroidal weathering. This is a reaction by which some Rock minerals absorb water, swell, expand and eventually force outer shell to peel off successively and the rock breaks down. Common in basalt rock

Chelation. This form of chemical weathering combines the chemical effect caused by man, plants and other living organisms for example;

(a) Influence of man. Man influence chemical weathering through;

▪Emission of industrial gases increasing acidity in rainwater which accelerate chemical processes like carbonation for example Hima cement factory in Kasese, Tororo cement factory, Paper factory in Webuye town in Western Kenya e.t.c

▪Dumping of industrial wastes/domestic/agricultural effluents on land, in water e.t.c which directly reacts/ increase the acidity in the environment thus increasing the rate of chemical weathering by carbonation e.t.c

▪Mining, quarrying, road construction and other activities like agriculture expose underlying rock to chemical weathering processes

▪Irrigation avail water that increase chemical weathering processes of hydration, hydrolysis, solution and carbonation

▪Urea and phosphate fertilizers produce acids such as ammonic acids which react with rock minerals and decompose the rocks chemically.

(b) **Vegetation**

▪Produce humic acids that assist in rock decomposition

▪Plant roots release mineral substances into the rock while extracting other mineral substances from the rock a processes known as Chelation

▪Plants like mosses, lichens (algae and fungi) live on bare rocks, Secrete acids that chemically decompose the rock and retain moisture that keeps the surface moist leading to rock decomposition.

(c) Other living organisms

▪Secrete acids that chemically decompose the rock for example uric acids decompose rocks,

▪Holes dug by burrowing animals, moles, termites e.t.c aid water to go to chemically weather the rock through solution, hydration, hydrolysis, carbonation e.t.c

▪herds of animals excrete wastes containing acids which react with rock minerals causing rock decay.

FACTORS FAVORING CHEMICAL WEATHERING IN EAST AFRICA

(a) Distinguish between physical weathering and chemical weathering

(b) Describe the factors which have favored the chemical weathering processes in East Africa.

Approach

- ❖ Define each type of weathering
- ❖ State factors influencing each type
- ❖ State the processes under each type

Answer guide

- Physical weathering is the disintegration of rocks into small particles or fragments in situ.
- It occurs due to temperature fluctuation like alternate heating and cooling, frost action and; due to influence of plants and animals (biotic factors)
- In physical weathering there is no change in the chemical composition of rocks instead rocks are broken down into small particles.
- Physical weathering occurs in form of exfoliation, block disintegration, aridity shrinkage, freeze and thaw e.t.c

Impression marking……..04mks

While

- Chemical weathering is the decomposition, decay, rotting of rocks in situ on or near the earth's surface.

▪It occurs as a result of;

- heavy/ adequate rainfall and high humidity that provide adequate water to act as a medium of chemical reactions and
- hot temperatures accelerate the rate of chemical reactions.
- In chemical weathering there is a change in the chemical composition of the rock. That is; new compounds are formed.
- Chemical weathering takes place inform of carbonation, oxidation, hydrolysis, hydration, solution and reduction.

Impression marking……..04mks

(b) **Factors/ conditions favoring Chemical weathering in East Africa**

Nature of the parent rock

(i) Mineral composition of the rock

▪Some **rocks rich in calcium carbonate** for example limestone weather easily by **carbonation**- a chemical reaction that takes place when rain absorbs carbon dioxide from the atmosphere to form a weak acid called **carbonic acid**-which converts calcium carbonates (insoluble in nature) into calcium bi-carbonate easily washed away by rain leaving behind gullies called grikes.

▪Carbonation is common in limestone regions such as Nyakasura in Fort Portal, Tororo, Hima and along the coast in areas such as Bamburi near Mombasa in Kilifi, Athi river e.t.c

▪rock minerals such as **feldspar and silicate** weather easily **by hydrolysis**-a reaction between hydrogen ions in water and metal ions in the rock to produce new compounds that are weaker and more soluble than original.

▪Hydrolysis for example decomposes

- feldspars in granites into kaolin clay- used in making tiles for example in Kajjansi on the shore of Lake Victoria along Kampala-Entebbe highway.
- Silicate mineral in igneous rocks increase in volume by hydrolysis leading to expansion and disintegration of igneous rocks in the tropics.

▪Some rocks rich in **iron and aluminium** weather easily **by oxidation**- a chemical reaction that takes place between oxygen dissolved in water and rock bearing iron and aluminium ores for example clay.

- The reaction forms new compound/ oxide (rust) which are softer and weaker than the original and eventually the rock crumbles down.
- In well drained areas; oxidation of clay (rich in iron) produces red or brown colored soils called latosols common on hill tops in central Uganda and; lateritic soils/ red ferric compounds in tropical savanna.
- In water logged areas, oxidation changes clay to grey or blue color.

▪Some rocks rich in **soluble minerals such as salt, calcium sulphate** e.t.c weather easily **by solution**- a process involving minerals dissolving in water for example rock salt, chalk, limestone, gypsum e.t.c

▪Some rocks **rich in feldspar and mica w**eather easily **by hydration**-a reaction involving rock minerals absorbing water, expand and change the internal structure by forming new compounds which are more soluble than original hence the rock crumbles easily. For example

- **Mica** absorbs water expands and change into mica hydrate easily washed away in solution.
- **Haematite** expands after absorbing water and changes into *Limonite*.
- Calcium sulphate changes into gypsum which is more soluble.

Iron bearing rocks in water logged areas weather easily **by reduction**-involves removal of oxygen ions from the rock and addition of hydrogen ions. This process affects mainly iron bearing rocks in swampy areas for example

- Sulphate can be reduced to hydrogen sulphite,
- Ferric hydrate can be reduced to ions.

(ii) jointing of the rock-presence of joints/ cracks/ crevices increase the surface area for chemical reactions and allow water to penetrate to chemically weather the rock

(iii) Permeability of the rock-when a rock is permeable it allows water to penetrate and weather the rock through processes like carbonation, hydration oxidation, hydrolysis e.t.c

Climate

▪Rainfall/ precipitation provide the water needed for chemical processes. Many areas of East Africa receive heavy rainfall throughout the year (Equatorial climate),

▪other areas receive moderate rainfall (savanna climate) and humid conditions are conducive for chemical weathering for most of the year.

▪Temperatures: most of the humid areas in East Africa have hot temperatures of over 20^0c which increase the rate of chemical reactions thus promoting chemical weathering. Carbonation also occurs under cold conditions.

Relief

▪Chemical weathering is more dominant on gentle slopes and low-lying areas as water accumulates and percolates to chemically weather the rock than on steep slopes.

However erosion on steep slopes exposes the rock to chemical weathering

Drainage

▪Leaching occurs on flatlands because of poor drainage. That is; rock minerals are dissolved and taken in solution to deep layers of the soil profile.

▪Poorly drained areas like floodplains chemical weathering is prevalent in form of processes like hydrolysis, reduction and solution which help to decompose the rock

Living organisms

(i) Influence of man. Man influence chemical weathering through;

▪Emission of industrial gases increasing acidity in rainwater which accelerate chemical processes like carbonation for example Hima cement factory in Kasese, Tororo cement factory, Paper factory in Webuye town in Western Kenya e.t.c

▪Dumping of industrial wastes/domestic/agricultural effluents on land, in water e.t.c which directly reacts/ increase the acidity in the environment thus increasing the rate of chemical weathering by carbonation e.t.c

▪Mining, quarrying, road construction and other activities like agriculture expose underlying rock to chemical weathering processes

▪Irrigation avail water that increase chemical weathering processes of hydration, hydrolysis, solution and carbonation

(ii) Vegetation

▪Produce humic acids that assist in rock decomposition

▪Plant roots release mineral substances into the rock while extracting other mineral substances from the rock a processes known as chelation

(iii) Other living organisms

▪Secrete acids that chemically decompose the rock for example uric acids decompose rocks,

▪Holes dug by burrowing animals, moles, termites e.t.c aid water to go to chemically weather the rock through solution, hydration, hydrolysis, carbonation e.t.c

Time

It takes time for the rock to undergo chemical weathering. The longer the time, the more the rock is chemically weathered, the shorter the time the less the rock is chemically weathered.

Impression marking…….17marks

Examine the conditions favoring chemical weathering in East Africa.

Approach

- ❖ Define chemical weathering
- ❖ Give and define chemical weathering processes experienced in East Africa.
- ❖ State areas experiencing chemical weathering processes
- ❖ Explain the factors or conditions favoring chemical weathering.
- ❖ Emphasis should be on climate, rock structure and description of the chemical weathering processes.

Account for the dominance of chemical in the humid areas of East Africa.

Approach

- ❖ Define chemical weathering
- ❖ Areas dominated by chemical weathering
- ❖ State the characteristics of humid areas.
- ❖ Identify and define the chemical weathering processes that dominate humid regions
- ❖ Explain the factors or conditions favoring the dominance of chemical weathering in humid regions
- ❖ Illustrate the points with examples and diagrams where applicable

Answer guide

▪Chemical weathering is the decomposition, decay, rotting of rocks in situ at or near the earth's surface at or near the surface.

▪In chemical weathering there is a total change in the chemical composition of the rock. That is; new compounds are formed.

Chemical weathering is dominant in areas;

▪experiencing Hot and wet conditions throughout the year,

▪Receiving heavy rainfall of over 1000mm annually for example northern shores of Lake Victoria and Windward slopes of major highlands such as Kigezi, Mount Kenya, Kilimanjaro, Meru, Elgon, Rwenzori,

▪Dominated by limestone, chalk, rock salt e.t.c limestone regions such as Bamburi near Mombasa, Kilifi and other coastal areas, Nyakasura in Fort Portal, Hima in Kasese and Tororo eastern Uganda. e.t.c

Humid regions are characterized by;

▪generally hot Temperatures throughout the year
▪Great uniformity of temperature throughout the year, ranging between 25^0c- 28^0c on average
▪Heavy rainfall and is well distributed throughout the year
▪Rainfall totals are over 1000mm per annum
▪Humidity is high due to high rate of evaporation and transpiration
▪Thick cloud cover throughout the year due to high rate of evapotranspiration and condensation
▪Thick and luxuriant vegetation cover for example tropical rain forests, mangrove forests e.t.c

Chemical weathering processes that dominate humid regions include;

Carbonation- is a chemical reaction that takes place when rain absorbs carbon dioxide from the atmosphere to form a weak acid called **carbonic acid**-which converts calcium carbonates (insoluble in nature) into calcium bi-carbonate easily washed away by rain leaving behind gullies called grikes.

▪ **Oxidation-** is a chemical reaction that takes place between oxygen dissolved in water and rock bearing iron and aluminium ores for example clay. The reaction forms new compound/ oxide (rust) which are softer and weaker than the original and eventually the rock crumbles down.

Hydrolysis- is a reaction between hydrogen ions in water and rock minerals to produce new compounds that are softer, weaker and more soluble than original.

Hydration- is a reaction involving rock minerals absorbing water, expand and change the internal structure by forming new compounds which are more soluble than original hence the rock crumbles easily

Solution- is a process involving minerals dissolving in water for example rock salt, chalk, limestone, gypsum e.t.c

Reduction-involves removal of oxygen ions from the rock and addition of hydrogen ions

Factors favoring the dominance of chemical weathering in humid regions in East Africa

Nature of the parent rock

(i) Mineral composition of the rock

▪Some **rocks rich in calcium carbonate** for example limestone weather easily by **carbonation**- a chemical reaction that takes place when rain absorbs carbon dioxide from the atmosphere to form a weak acid called **carbonic acid**-which converts calcium carbonates (insoluble in nature) into calcium bi-carbonate easily washed away by rain leaving behind gullies called grikes.
▪Carbonation is common in limestone regions such as Nyakasura in Fort Portal, Tororo, Hima and along the coast in areas such as Bamburi near Mombasa in Kilifi, Athi river e.t.c
▪rock minerals such as **feldspar and silicate** weather easily **by hydrolysis**-a reaction between hydrogen ions in water and metal ions in the rock to produce new compounds that are weaker and more soluble than original.
▪Hydrolysis for example decomposes

- feldspars in granites into kaolin clay- used in making tiles for example in Kajjansi on the shore of Lake Victoria along Kampala-Entebbe highway.
- Silicate mineral in igneous rocks increase in volume by hydrolysis leading to expansion and disintegration of igneous rocks in the tropics.

▪Some rocks rich in **iron and aluminium** weather easily **by oxidation**- a chemical reaction that takes place between oxygen dissolved in water and rock bearing iron and aluminium ores for example clay.

- The reaction forms new compound/ oxide (rust) which are softer and weaker than the original and eventually the rock crumbles down.

- In well drained areas; oxidation of clay (rich in iron) produces red or brown colored soils called latosols common on hill tops in central Uganda and; lateritic soils/ red ferric compounds in tropical savanna.
- In water logged areas, oxidation changes clay to grey or blue color.

▪Some rocks rich in **soluble minerals such as salt, calcium sulphate** e.t.c weather easily **by solution**- a process involving minerals dissolving in water for example rock salt, chalk, limestone, gypsum e.t.c

▪Some rocks **rich in feldspar and mica w**eather easily **by hydration**-a reaction involving rock minerals absorbing water, expand and change the internal structure by forming new compounds which are more soluble than original hence the rock crumbles easily. For example

- **Mica** absorbs water expands and change into mica hydrate easily washed away in solution.
- **Haematite** expands after absorbing water and changes into *Limonite*.
- Calcium sulphate changes into gypsum which is more soluble.

Iron bearing rocks in water logged areas weather easily **by reduction**-involves removal of oxygen ions from the rock and addition of hydrogen ions. This process affects mainly iron bearing rocks in swampy areas for example

- Sulphate can be reduced to hydrogen sulphite,
- Ferric hydrate can be reduced to ions.

(ii) jointing of the rock-presence of joints/ cracks/ crevices increase the surface area for chemical reactions and allow water to penetrate to chemically weather the rock

(iii) Permeability of the rock-when a rock is permeable it allows water to penetrate and weather the rock through processes like carbonation, hydration oxidation, hydrolysis e.t.c

Climate

▪Rainfall/ precipitation provide the water needed for chemical processes. Many areas of East Africa receive heavy rainfall throughout the year (Equatorial climate),

▪other areas receive moderate rainfall (savanna climate) and humid conditions are conducive for chemical weathering for most of the year.

▪Temperatures: most of the humid areas in East Africa have hot temperatures of over 20^0c which increase the rate of chemical reactions thus promoting chemical weathering. Carbonation also occurs under cold conditions.

Relief

▪Chemical weathering is more dominant on gentle slopes and low-lying areas as water accumulates and percolates to chemically weather the rock than on steep slopes.

However erosion on steep slopes exposes the rock to chemical weathering

Drainage

▪Leaching occurs on flatlands because of poor drainage. That is; rock minerals are dissolved and taken in solution to deep layers of the soil profile.

▪Poorly drained areas like floodplains chemical weathering is prevalent in form of processes like hydrolysis, reduction and solution which help to decompose the rock

Living organisms

(iv) Influence of man. Man influence chemical weathering through;

▪Emission of industrial gases increasing acidity in rainwater which accelerate chemical processes like carbonation for example Hima cement factory in Kasese, Tororo cement factory, Paper factory in Webuye town in Western Kenya e.t.c

▪Dumping of industrial wastes/domestic/agricultural effluents on land, in water e.t.c which directly reacts/ increase the acidity in the environment thus increasing the rate of chemical weathering by carbonation e.t.c

▪Mining, quarrying, road construction and other activities like agriculture expose underlying rock to chemical weathering processes

U.A.C.E revision Questions and Answers

▪Irrigation avail water that increase chemical weathering processes of hydration, hydrolysis, solution and carbonation

(v) Vegetation

▪Produce humic acids that assist in rock decomposition

▪Plant roots release mineral substances into the rock while extracting other mineral substances from the rock a processes known as chelation

(vi) Other living organisms

▪Secrete acids that chemically decompose the rock for example uric acids decompose rocks,

▪Holes dug by burrowing animals, moles, termites e.t.c aid water to go to chemically weather the rock through solution, hydration, hydrolysis, carbonation e.t.c

Time

It takes time for the rock to undergo chemical weathering. The longer the time, the more the rock is chemically weathered, the shorter the time the less the rock is chemically weathered.

. FACTORS THAT INFLUENCE WEATHERING IN EAST AFRICA

Examine the factors that affect the rate and character of weathering in East Africa.

Approach

- ❖ Define weathering and state types of weathering
- ❖ Explain the factors and show how they promote either physical or chemical weathering in East Africa.
- ❖ Examples of different rock types affected should be given.

Answer guide.

Weathering is the process of physical disintegration and chemical decomposition of rocks in situ by natural agents at the surface or near the earth's surface.

Weathering occurs inform of physical, chemical and biological forms. Weathering processes are influenced by; type of climate, nature of the parent rock, nature of relief, action of living organisms and time.

Climate- influences weathering directly and indirectly through its elements of rain fall, temperature and humidity. Variation in climate leads to different rates and types of weathering as shown below.

Equatorial climate-characterized by

- heavy rainfall above 1000mm and well distributed throughout the year,
- hot temperatures and great uniformity of temperature throughout the year, ranging between 25^0c-28^0c on average,
- high Humidity and Thick cloud cover e.t.c in areas such as the northern shores of Lake Victoria and coastal belt and windward slopes of major highlands **encourage chemical weathering processes than** physical weathering.

▪In addition the great depth of chemically weathered materials protects the underlying rocks from physical weathering.

▪Tropical rain forests produce humic and organic acids which decompose rocks very fast.

Tropical climate/Savanna climate characterized by;

- hot and wet, cool and dry seasons encourage **both chemical and physical weathering processes** respectively for example northern Uganda, and Miombo in central and southern Tanzania.

Arid and semi-arid climate-characterized by;

- high daily temperatures,
- large diurnal range of temperature,
- low annual rainfall less than 500mm,
- low humidity, low cloud cover and scanty vegetation cover lead to **dominance of physical weathering** processes inform of exfoliation, granular, block disintegration, aridity shrinkage and salt crystallization in Karamoja, Turkana e.t.c and **limited chemical weathering** due to shortage of moisture.

Alpine climate -experienced on mountain peaks such as Kilimanjaro, Rwenzori, Kenya characterized by;

- snow fall,
- cold temperatures,
- low rainfall e.t.c **encourage physical weathering** inform of freeze and thaw and limited chemical weathering due to extreme cold temperatures and shortage of liquid water.

Nature of the parent rock –influences weathering through hardness, jointing, mineralogy, color, texture, porosity and permeability.

Rock hardness. Hard rocks like granite (igneous) and Gneiss (metamorphic) are more resistant to physical weathering because they are formed under high temperature and pressure than those on the surface but weather fast chemically. Soft rocks weather very fast under the same conditions sandstone, clay and limestone.

Jointing of the rock- jointed rocks such as granites, chalk and limestone weather easily by both physical and chemical weathering than unjointed rocks. For example jointed rocks result into block disintegration and frost weathering when rocks are subjected to expansion and contraction. In addition joints/ cracks/ crevices allow water to penetrate to chemically weather the rock.

Mineral composition of the parent rock influences greatly the rate of chemical weathering especially in humid region as explained below

▪**rocks rich in calcium carbonate** for example limestone weather easily by **carbonation** for example limestone rocks in Nyakasura in Fort Portal, Tororo, Hima and Bamburi near Mombasa in Kilifi, Athi river e.t.c

▪Some **rocks rich in feldspar and silicate** weather easily **by hydrolysis** for example hydrolysis decomposes feldspars in granites into kaolin clay- used in making tiles in areas such as Kajjansi on the shore of Lake Victoria along Kampala-Entebbe highway.

▪Some rocks rich in **iron and aluminium** weather easily **by oxidation**; producing laterite soils

▪Some rocks rich in **soluble minerals such as salt, calcium sulphate** e.t.c weather easily **by solution**- for example rock salt, chalk, limestone, gypsum e.t.c

▪Some rocks **rich in feldspar and mica w**eather easily **by hydration**- For example mica, absorbs water, expands and change into mica hydrate easily washed away in solution. **Hematite** expands after absorbing water and changes into *Limonite*. Calcium sulphate changes into gypsum which is more soluble.

▪**Iron bearing rocks in water logged** areas weather easily **by reduction**- for example sulphate can be reduced to hydrogen sulphite; ferric hydrate can be reduced to ions.

▪In addition, rocks having different minerals absorb heat and loose heat at different rates when heated or cooled respectively resulting into granular disintegration.

Rock color. Dark colored rocks such as basalt absorb a lot of heat hence weather easily by physical processes while brightly colored rocks such as granites reflect back much heat hence take long to weather.

Rock texture. Coarse grained rocks such as Gabbro weather faster by chemical processes than Fine grained rocks such as andesite and basalt. This is because fine grained rocks are compact hence difficult to weather while coarse grained rocks are loosely packed thus weather fast.

Permeability of he rock- Permeable and pervious rocks weather easily by chemical processes because water percolates and decompose them through carbonation, hydration oxidation, hydrolysis e.t.c

Nature of relief. Relief refers to elevation and physical appearance of earth's surface. Relief influences weathering by determining the rate of percolation of water, erosion of weathered materials and the exposure of unweathered rocks. Consequently;

▪Steep slopes encourage high surface run off, exposing the rocks beneath to physical weathering inform of pressure release. However, Chemical weathering is limited because of limited infiltration or seepage.

▪Chemical weathering is more dominant on Gentle slopes and low-lying areas because of high rate of infiltration and percolation of water into the sub-layers. In addition, thick layers of weathered materials eroded from steep slopes retain a lot of moisture leading to rock decay.

▪Valleys containing water experience slow rate of chemical weathering inform of oxidation of clay, hydrolysis and hydration because water logging conditions and high rate of deposition limit physical weathering, common in swamps and broad valleys in western, eastern and central Uganda.

Influence of vegetation cover. Areas covered with forest vegetation experience Chemical weathering than physical weathering because;

▪The great depth of chemically weathered materials protects the underlying rocks from physical weathering.

▪Tropical rain forests produce huge amounts of humic and organic acids which decompose rocks very fast.

▪Plants like mosses, lichens (algae and fungi) live on bare rocks, Secrete acids that chemically decompose the rock and retain moisture that keeps the surface moist leading to rock decomposition.

▪plant roots growing into the rock increase internal stresses and strains causing rock disintegration via joints and crevices.

Influence of biotic factors such as man and other living organisms

(a)Influence of man

▪man encourages physical disintegration of rocks through his activities such as mining and quarrying, construction, agriculture, overgrazing which exposes the rock e.t.c

Man also influences chemical weathering through;

▪Emission of industrial gases increase acidity in rainwater which accelerate chemical processes like carbonation for example Hima cement factory in Kasese,Tororo cement factory, Paper factory in Webuye town in Western Kenya e.t.c

▪Dumping of industrial wastes/domestic/agricultural effluents on land, in water e.t.c which directly reacts/ increase the acidity in the environment thus increasing the rate of chemical weathering by carbonation e.t.c

▪Mining, quarrying, road construction and other activities like agriculture expose underlying rock to chemical weathering processes

▪Application of fertilizers such as Urea and phosphate produce acids such as ammonic acids which react with rock minerals and decompose the rocks chemically

▪Irrigation avail water that increase chemical weathering processes of hydration, hydrolysis, solution and carbonation

(b) Influence of Other living organisms

▪herds of animals' cause physical weathering through trampling. In addition, animals excrete wastes which contain acids which react with rock minerals causing rock decay.

▪small animals such as rodents like rats, mice, moles and squirrel make burrows in rocks which facilitate physical disintegration of rocks. In addition, the holes / tunnels provide access to air and water into the rock leading rock decay.

▪Insects such as locust and termites destroy the vegetation cover such as grass thus exposing rocks to agents of physical weathering.

Influence of Time

Rocks take time to weather. The longer rocks are exposed to agents weathering, the faster and deeper the disintegration and decomposition. Therefore old rocks weather faster than newly formed rocks.

INFLUENCE OF THE PARENT ROCK

To what extent does the rate and character of weathering depend on the nature of the rock?

To what extent does the rate and character of weathering depend on lithiology?

Approach

- Define weathering and state the types of weathering experienced in East Africa
- Give the 1St evaluation (to a larger extent) and explain how the nature of the rock or lithiology influences physical and chemical weathering
- Give the 2r d evaluation (to a large extent) and explain the role of other factors

Answer guide

Weathering is the process of physical disintegration and chemical decomposition of rocks in situ by nature agents at the surface or near the surface of the earth.

Nature of the rock influences the type of weathering to a large extent in terms of hardness, jointing, mineralogy, color, texture, porosity and permeability.

Rock hardness. Hard rocks like granite (igneous) and Gneiss (metamorphic) are more resistant to physical weathering because they are formed under high temperature and pressure than those on the surface but weather fast chemically. Soft rocks weather very fast under the same conditions sandstone, clay and limestone.

Jointing of the rock- jointed rocks such as granites, chalk and limestone weather easily by both physical and chemical weathering than unjointed rocks. For example jointed rocks result into block disintegration and frost weathering when rocks are subjected to expansion and contraction. In addition joints/ cracks/ crevices allow water to penetrate to chemically weather the rock.

Mineral composition of the parent rock influences greatly the rate of chemical weathering especially in humid region as explained below

▪**rocks rich in calcium carbonate** for example limestone weather easily by **carbonation** for example limestone rocks in Nyakasura in Fort Portal, Tororo, Hima and Bamburi near Mombasa in Kilifi, Athi river e.t.c

▪Some **rocks rich in feldspar and silicate** weather easily **by hydrolysis** for example hydrolysis decomposes feldspars in granites into kaolin clay- used in making tiles in areas such as Kajjansi on the shore of Lake Victoria along Kampala-Entebbe highway.

▪Some rocks rich in **iron and aluminium** weather easily **by oxidation**; producing

▪Some rocks rich in **soluble minerals such as salt, calcium sulphate** e.t.c weather easily **by solution**- for example rock salt, chalk, limestone, gypsum e.t.c

▪Some rocks **rich in feldspar and mica w**eather easily **by hydration**- For example mica, absorbs water, expands and change into mica hydrate; easily washed away in solution. **Hematite** expands after absorbing water and changes into *Limonite*. Calcium sulphate changes into gypsum which is more soluble.

▪**Iron bearing rocks in water logged** areas weather easily **by reduction**- for example sulphate can be reduced to hydrogen sulphite; ferric hydrate can be reduced to ions.

▪In addition, rocks having different minerals absorb heat and loose heat at different rates when heated or cooled respectively resulting into granular disintegration.

Rock color. Dark colored rocks such as basalt absorb a lot of heat hence weather easily by physical processes while brightly colored rocks such as granites reflect back much heat hence take long to weather.

Rock texture. Coarse grained rocks such as Gabbro weather faster by chemical processes than Fine grained rocks such as andesite and basalt. This is because fine grained rocks are compact hence difficult to weather while coarse grained rocks are loosely packed thus weather fast.

Permeability of he rock- Permeable and pervious rocks weather easily by chemical processes because water percolates and decompose them through carbonation, hydration oxidation, hydrolysis e.t.c

Other factors that influence weathering include;

▪Climate ▪ influence of relief ▪ Influence of vegetation cover ▪Influence of living organisms and ▪Time.

🕮 Remember to explain these factors.

INFLUENCE OF CLIMATE

"Climate more than other factors determine the nature and rate of rock weathering". Discuss.
To what extent does the character, nature and rate of weathering depend on the climate?

Approach

- Define weathering and state the types of weathering experienced in East Africa
- Give the 1St evaluation (to a larger extent) and explain how climate influences physical and chemical weathering directly and indirectly.
- Give the 2rd evaluation (to a large extent) and explain the role of other factors

Answer guide

Climate- influences weathering to a larger extent directly and indirectly through its elements of rain fall, temperature and humidity. Variations in climate lead to different rates and types of weathering as shown below.

Equatorial climate-characterized by

- heavy rainfall above 1000mm and well distributed throughout the year,
- hot temperatures and great uniformity of temperature throughout the year, ranging between 25^0c-28^0c on average,
- high Humidity and Thick cloud cover e.t.c in areas such as the northern shores of Lake Victoria and coastal belt and windward slopes of major highlands **encourage chemical weathering processes than** physical weathering.

▪In addition the great depth of chemically weathered materials protects the underlying rocks from physical weathering.

▪Tropical rain forests produce humic and organic acids which decompose rocks very fast.

Tropical climate/Savanna climate characterized by;

- hot and wet, cool and dry seasons encourage **both chemical and physical weathering processes** respectively for example northern Uganda, and Miombo in central and southern Tanzania.

Arid and semi-arid climate-characterized by;

- high daily temperatures,
- large diurnal range of temperature,
- low annual rainfall less than 500mm,
- low humidity, low cloud cover and scanty vegetation cover lead to **dominance of physical weathering** processes inform of exfoliation, granular, block disintegration, aridity shrinkage and salt crystallization in Karamoja, Turkana e.t.c and **limited chemical weathering** due to shortage of moisture.

Alpine climate -experienced on mountain peaks such as Kilimanjaro, Rwenzori, Kenya characterized by;

- snow fall,
- cold temperatures,
- low rainfall e.t.c **encourage physical weathering** inform of freeze and thaw and limited chemical weathering due to extreme cold temperatures and shortage of liquid water.

Other factors that influence weathering include;

▪Nature of the rock ▪ influence of relief ▪ Influence of vegetation cover ▪Influence of living organisms and ▪Time.

🕮 Remember to explain these factors.

To what extent has topography influenced the rate and nature of weathering in East Africa?
Approach

- Define weathering and topography.
- Give the 1St evaluation(to a large extent) and explain how topography promotes weathering
- Give the 2rd evaluation (to a larger extent) and explain the role of other factors
- Give examples where applicable

Topography/ Nature of relief. Relief refers to elevation and physical appearance of earth's surface. Relief influences weathering by determining the rate of percolation of water, erosion of weathered materials and the exposure of unweathered rocks. Consequently;

▪Steep slopes encourage high surface run off, exposing the rocks beneath to physical weathering inform of pressure release. However, Chemical weathering is limited because of limited infiltration or seepage.

▪Chemical weathering is more dominant on Gentle slopes and low-lying areas because of high rate of infiltration and percolation of water into the sub-layers. In addition, thick layers of weathered materials eroded from steep slopes retain a lot of moisture leading to rock decay.

▪Valleys containing water experience slow rate of chemical weathering inform of oxidation of clay, hydrolysis and hydration because water logging conditions and high rate of deposition limit physical weathering, common in swamps and broad valleys in western, eastern and central Uganda.

▪Chemical weathering dominates windward slopes due to high humidity, high rainfall and hot/cool temperatures. Physical weathering dominates the leeward side due to arid conditions

▪Mountains over 4000meters above sea level experience snow fall leading to freeze and thaw weathering

Other factors that influence weathering include;

▪Climate ▪ Nature of the rock ▪ Influence of vegetation cover ▪Influence of living organisms and ▪Time.

🕮 Remember to explain these factors.

Examine the causes and effects of weathering in East Africa.

Approach

- ❖ Define weathering and state the types of weathering
- ❖ Explain the causes of weathering.
- ❖ In part (b) explain the positive and negative effects of weathering
- ❖ Give examples where applicable

EFFECTS OF WEATHERING IN EAST AFRICA

Weathering has positive and negative effects

▪Weathering facilitates soil formation by breaking rocks to tiny particles called colloids; worked on further by other soil forming processes to produce mature soil that supports crop cultivation. For example volcanic soil in Kabale, slopes of mountain Kenya, Kilimanjaro e.t.c

▪Weathering supports tourism by creating beautiful landforms and scenery hence source of foreign exchange used for economic development for example, exfoliation domes and Inselbergs in Karamoja, parts of northern and eastern Uganda and Kenya, stalactites, stalagmites and caves in limestone regions such as Nyakasura in Fort Portal, Bamburi and Kilifi e.t.c.

▪Chemical Weathering inform of oxidation produces lateritic soils (murrum) used in road construction

▪Chemical Weathering inform of hydrolysis in granites produces kaolin clay-a raw material for building and construction industry, art and craft, pottery e.t.c for example bricks, tiles, maxi pans, cups, plates, flower vases e.t.c for example Kajjansi and Lweza clay works on Kampala- Entebbe highway.

▪physical weathering inform of exfoliation and pressure release weakens and exposes rocks containing minerals ores extracted for various use. For example limestone in Tororo, gold and diamonds in Mwandui in Tanzania

▪Weathering aid / helps erosion by producing screes which are easily carried away by agents of erosion to produce infertile soil.

▪Weathering of granites and quartz produces infertile soil which discourage crop-cultivation for example sandy soil, laterites on hill tops in Buganda and scree soil on hill slopes e.t.c

▪Weathering in highland areas weakens the slope leading to landslides which destroy property and loss of lives for example Bududa, Bundyibugyo, Kasese and slopes of Mountain Kenya, Kilimanjaro e.t.c

▪ Chemical weathering in limestone regions creates wastelands which discourage construction, crop cultivation and settlement thus limiting development/ urbanization.

▪Widened employment base in the mining, construction, Art and Craft and pottery industries hence source of income to various people in the country.

▪Weathering provides opportunities for Education and research for example in the field of Geology, construction e.t.c

▪Weathering affects outdoor works of art for example stone sculptures and monuments

▪Weathering defaces buildings, rusting of metals weakens structures such as bridges, storied buildings e.t.c some time resulting into loss of lives.

MASS WASTING IN EAST AFRICA

Examine the causes and effects of mass-wasting in East Africa.

Approach

- ❖ Define mass-wasting
- ❖ Identify and describe briefly types / processes of mass-wasting (slow movements and landslide)
- ❖ Explain the causes and the effects
- ❖ Give examples where applicable

Answer guide

Mass wasting is the creeping, flowing, sliding and falling of rocks and weathered materials down slope under the influence of gravity.

Water facilitates the movement by;

- increasing the weight of weathered materials along the slope and
- lubricating the surface which reduces friction or cohesion between the rock particles, weathered materials and the solid rock

Mass wasting occurs more frequently during the El-Nino season in form of slow and rapid movements as explained below.

PROCESSES OF MASS WASTING

Soil creep- is a process by which soil and fine materials move very slowly on gentle slope. It is difficult to detect because it is very slow and usually hidden by vegetation cover.

Soil creep is usually detected by the bending of tree trunks, fencing and telephone poles in the direction of soil creep.

Soil creep is common on slopes of Kololo hill, Nakasongola, Bushenyi and Kabale e.t.c

Solifluction- is a process by which saturated soil, gravel and weathered rocks move very slowly over the permafrost (frozen sub-soil/rock). It takes place on gentle slopes in glaciated mountains such as Kenya, Kilimanjaro and Rwenzori where freeze and thaw occurs.

Thawing of ice provides water which cause saturation of gravel and weathered materials on gentle slope, and lubrication causing them to slide down slowly over the permafrost.

Talus creep- is a process by which weathered materials called screes or talus and angular rock particles of all size moves slowly as a mass on a moderate to steep slope where freeze and thaw takes place. Talus creep is also confined to glaciated mountains.

Frost weathering produces screes of different size. When ice or snow melts or thaws, these particles are saturated and lubricated hence move down as a mass under the influence of gravity over the permafrost.

Rock slump-is a process involving rapid/ sudden movement of large masses of rock debris over steepened slope such as escarpments and cliffs created during road construction, wave and river erosion. Rock slump leaves behind a scar on the slope.

Mud flow / earth flow -is a process involving rapid movement of super saturated mixture of mud, gravels, boulders and other unconsolidated material on moderate to steep slope.
Mud flow is common in arid and semi-arid such as Karamoja and volcanic regions such as mount Meru and Rungwe in Tanzania, Sabinio in south western Uganda e.t.c
Rock slide-involves rapid movement of large quantities of rocks and debris over very steep slope due to earth movements such as earth quakes and gravity. Rock slide is more pronounced in highland regions such as Kabale.
Rock fall-is a process by which individual rocks or boulders fall freely on very steep slopes such as cliffs.
Avalanche- refers to rapid down slope flow of a large mass of ice and snow. Avalanches in East Africa are restricted to mount Rwenzori, Kilimanjaro and Kenya.

Causes of mass wasting in East Africa

Climatic factors. Climate influences mass-wasting through its elements of rain fall and temperature fluctuation. That is;

- Heavy rain fall such as El-Nino provides huge quantities of water which percolate and soak rock debris and other materials making them heavier and easy to move down slope as a mass.
- Water also lubricates the surface between rock debris and the underlying solid rock causing materials to slide, slump or flow down slope. For example in highlands such as Kigezi, Elgon region, Kilimanjaro e.t.c
- Temperature fluctuation facilitates thawing leading to Solifluction, talus creep, rock fall and avalanche in glaciated mountains such as Rwenzori, Kenya and Kilimanjaro.
- The pounding effect of rain drops causes splash erosion which weakens the soil structure resulting into mud flow and rock slump.
- Cloud thunder produces vibrations which set in motions weathered and unconsolidated materials down slope inform slumping/ landslides.

Relief / topography or nature of the slope and influence either slow movements or landslides depending on the angle of the slope. Thus;

- Very steep /vertical relief encourages rock fall, rock slides and avalanche because gravity increases with increase in gradient. It is common in highland areas such as Kigezi, slopes of Mount Elgon, Bundibugyo e.t.c
- Dipping /inclined or steep relief encourages slumping for example along cliff face, road cuttings and scarps common in highlands where roads and settlements exist.
- Gentle / moderate slopes encourage mud flows, Solifluction, soil and talus creep because gravity reduces with decrease in gradient.

Nature of rock/ rock structure. The structure of the rock in terms of alignment, jointing and permeability determines the occurrence of mass-wasting in the following ways

- Where impermeable rock layer such as granite and gneiss lie on top of permeable rock layer such as limestone, chalk and sandstone on a steep slope, triggers off slumping and sliding movements.
- Likewise where permeable rock layer lie on top of an impermeable rock layer on a steep gradient, slumping and sliding movements may occur after saturation of the permeable rock layer.
- Similarly, jointed rocks in the slope encourage mass wasting than unjointed rocks because joints/ cracks allow percolation of water into the rock causing saturation and lubrication which ultimately lead sliding movements.

Nature of soils present in an area- determines the rate and type of mass-wasting in the following ways;

- Volcanic and sandy soils are loose and thus saturate/ soak very fast during heavy down pour leading to mud flow common in arid and volcanic regions.
- Clay soil becomes slippery after absorbing water, increase in weight and lubricate very fast hence move down slope inform of slides over steep slopes and creep on moderate slopes.

Crustal instabilities- such as earth quakes and earth tremors vigorously shake the already unstable slope causing rock slides on steep slopes , slumping and creeping of weathered and unconsolidated materials on gentle slope, for example in Bundyibugyo, Kasese, Fort Portal and Rift Valley escarpments.

Effect of heavy mobile machinery such as tractors, Lorries and trailers moving through highlands produce strong vibrations that vigorously shake the slope/ hill; causing rock fall, rock slide and slumping in hilly areas for example along Kabale-Katuna road, Bundyibugyo- Fort Portal road e.t.c and soil creep on gentle slopes.

Volcanic eruption- causes earthquakes which destabilize the slope, and also yield volcanic ash and lava which easily soak and flow down slope as mud flow for example mount Meru and Longonot, Ol'Doinyo Lengai e.t.c

Steepening of the slope through road and house construction, wave and river erosion creates under cuttings and cliffs which lead to slumping and rock slides and fall ,for example along lakes shores, river banks, East African coast and highland areas.

Over loading of the slope with water tanks, settlements, planted forests e.t.c destabilize the slope equilibrium leading to slope failure inform of landslides for example slopes of mountain Elgon, Kenya, Meru, Kigezi and other hill slopes heavy settled on.

Removal/ Destruction of slope vegetation cover -through deforestation, overstocking and over grazing, mining e.t.c weakens the soil structure and expose unconsolidated materials to direct effect of rainfall leading to saturation, lubrication and flow of materials down slope in form of mud flow , soil creep and slumping for example in Kigezi , Kenya highlands, Bududa, Kapchorwa, Kitui, Turkana, Sironko e.t.c

Effect of man's activities such as mining and quarrying; involves use of explosives which produces tremors that set in motion unconsolidated materials down slope. In addition, cliffs are created, vegetation cover destroyed leading to mass movement of materials down slope. For example stone quarrying in Muyenga, Mukono, Masese in Jinja, limestone and vermiculite in Mbale, murrum on hill tops in Buganda, wolfram in Kabale, Cobalt in Kasese, Diamond in Shinyanga, Gold e.t.c

Action of living organisms for example burrowing animals such as rabbits, rats, and squirrels, and earth worms create tunnels which provide easy passage to water into rocks leading to saturation, lubrication and chemical weathering weaken soil and rocks making them to move down slope easily.

Large herds of animals grazing on steep slopes or hills for example cattle, goats, buffaloes and elephants loose rocks and produce minor tremors as they rush down to watering points result into mass movement of unconsolidated materials down slope. For example in Kigezi, Ankole hills, Moroto e.t.c

EFFECTS OF MASS WASTING IN EAST AFRICA

Mass wasting is associated with positive and negative effects

Soil creep and mud flow cause severe loss of top fertile soil resulting into low crop productivity/ yields for example in Kigezi, Manafwa, Sironko, Kapchorwa, Mbale and Rwampara hills in Mbarara.

Land slides lead to massive loss of human life and livestock for example cattle, goats and birds. For example, the 2006/7 El-Nino caused land slides that destroyed homesteads in Kisuro village in Kapchorwa, Maziba and Ndorwa counties in Kabale, Bushanja and Nyarubuye in Kisoro.

Destruction of valuable asserts such as houses, house hold items and agricultural plantations/ gardens. For example the 2006/7 El-Nino caused land slides that destroyed banana and coffee plantations, cotton, Irish potatoes e.t.c in Kabale, Manafwa, Sironko, Bubulo in Mbale, Kasese and Bundyibugyo.

Soil creep and land slides destroy transport and communication lines making communication very difficult, for example 2006/7 El-Nino caused land slides that destroyed Kisoro- Katuna road, Fort Portal- Bundibugyo road, Kapchorwa - Bukwa road e.t.c. Most bridges, railway and telephone lines were destroyed for example Siron-Ngagata road, Siron, Powut and Silanwa bridges in Kapchorwa,

Kigarama-Kivu road, Rwakihirwa Bridge in Kabale, Nalugungu-Elgon road, Simu corner-Kaserem road in Sironko e.t.c

Mass wasting across a river valley blocks the valley; forcing the river to pond back its water leading to the formation of temporary reservoir or a permanent lake for example Lake Bujjuku in mountain Rwenzori and Lake Mbaka in southern Tanzania.

Deposition of materials by Landslides and soil creep produce fertile soils down slope in valleys and low lying areas encourage crop cultivation for example banana, potatoes, yams and vegetables in Kabale , Sironko e.t.c, coffee on the slopes of mountain Elgon, Kenya and Kilimanjaro.

Mass wasting inform of slumping, rock slides and soil creep expose underlying minerals making mining easy and cheap for example lime stone in Sukuru hills, Diamond in Mwandui Tanzania Gold in Bushenyi e.t.c

Mass wasting facilitates soil formation by removing overlying materials; exposing fresh rocks to agents of weathering for example in highlands such as Kigezi e.t.c

Mass wasting is a source of education material and research for example causes of mass wasting, mitigation measures e.t.c for example in Bududa and Bundibugyo

Mass wasting contributes to landform development by creating beautiful scenery such as terracetes on Ankole hills, scars created by slumping and straight slopes in Kabale and Rukungiri.

Mass wasting aid soil erosion by transporting weathered and unconsolidated materials down slope in form of mudflows, slides, soil creeps and falls. For example in Kigezi, mountain Elgon slopes, Nyanza province in Kenya, Kondoa and Ukambari in Tanzania.

Mass wasting causes destruction of forest vegetation in highland areas, for example on mountain Elgon and Kigezi leading to loss of forest resources.

Land slides lead to displacement and resettlement of people while destruction of crops often results into famine, starvation and some times death for example in Kasese, Kigezi, Bulucheke and Bundyibugyo.

Landslides increase government expenditure inform of relief emergence and resettlement of people.

Landslides inform of Soil creep, slumping and mud slides increase silting of drainage systems such as culverts and destruction of transport network. In addition it increases maintenance costs inform of dredging.

landslides such as mudflow and slumping lead to contamination of water sources and loss of marine organisms for example lake Mutanda (24 km^2), Murehe (4 km^2), Kyahifi (1 km^2) and Kayumbo (2 km^2) in Kisoro.

Landslides affect education through increased absenteeism of both children and teachers because of impassable muddy roads and blocking of roads by landslides for example in Kigezi, Bududa, Bulucheke e.t.c. for example the 2006/7 El-Nino caused land slides that blocked roads and disorganized End of year Exam programme Kabale and Kisoro because roads were blocked hence scouts and Examination papers could not reach examination centers in time.

To what extent has climate influenced the nature of mass wasting in East Africa?

Approach

- Define mass wasting
- Give the 1^{St} evaluation (greater extent) and explain the role of climate; stating the types of mass wasting facilitated.
- Identify and describe briefly the forms/ types or processes of mass wasting
- Give the 2^{rd} evaluation (great extent) and explain other factors

Answer guide

Mass wasting is the flowing, creeping, sliding or falling of rocks and weathered materials down the hill/slope under the influence of gravity.

Climate influences different processes of mass wasting to a larger extent through its elements of rain fall and temperature. That is,

- Heavy rain fall such as El-Nino provides huge quantities of water which percolate and soak rock debris and other materials making them heavier and easy to move down slope as a mass.
- Water also lubricates the surface between rock debris and the underlying solid rock causing materials to slide, slump or flow down slope. For example in highlands such as Kigezi, Elgon region, Kilimanjaro e.t.c
- Temperature fluctuation facilitates thawing leading to Solifluction, talus creep, rock fall and avalanche in glaciated mountains such as Rwenzori, Kenya and Kilimanjaro.
- The pounding effect of rain drops causes splash erosion which weakens the soil structure resulting into mud flow and rock slump.
- Cloud thunder produces vibrations which set in motions weathered and unconsolidated materials down slope inform slumping/ landslides.
- Heavy rain fall increases river's erosive power leading to undercutting and formation of cliffs which encourage to slumping and rock fall.
- Climate indirectly dictates the type of vegetation which in turn influence mass wasting. For example low annual and unreliable rainfall leads to savannah and semi desert vegetation which facilitates mud flows, soil creep e.t.c depending on the relief of the area.
- Climate also influences the nature of the soil which in turn influences the nature of mass wasting for example Low and unreliable rain fall leads to formation of skeletal soils which easily move down slope inform of mud flows.

Climate therefore influences both slow movements and land slides/fast movements such as;

Soil creep- refers to extremely slow down slope movement of soil and fine materials on very gentle slope. Soil creep is common on slopes of Kololo hill, Nakasongola, Bushenyi and Kabale.

Solifluction- refers to the slow movement of saturated soil, gravel and weathered rocks over the permafrost (frozen sub-soil/rock). It takes place on gentle slopes in glaciated mountains such as Kenya, Kilimanjaro and Rwenzori where freeze and thaw occurs.

Talus creep- is the gradual down slope movement of weathered materials called screes or talus and angular rock particles of all size as a mass on a moderate to steep slope where freeze and thaw takes place. Talus creep is also confined to glaciated mountains.

Rock slump-refers to rapid/ sudden movement of large masses of rock debris over steepened slope such as escarpments and cliffs created during road construction, wave and river erosion. Rock slump leaves behind a scar on the slope.

Mud flow / earth flow - is the rapid movement of super saturated mixture of mud, gravels, boulders and other unconsolidated material on moderate to steep slope,common in arid and semi-arid such as Karamoja and volcanic regions such as mount Meru and Rungwe in Tanzania, Sabinio in south western Uganda.

Rock slide-involves rapid movement of large quantities of rocks and debris over very steep slope due to earth movements such as earth quakes and gravity. Rock slide is more pronounced in highland regions such as Kabale.

Rock fall-is a process by which individual rocks or boulders fall freely on very steep slopes such as cliffs.

Avalanche- refers to rapid down slope flow of a large mass of ice and snow. Avalanches in East Africa are restricted to mount Rwenzori, Kilimanjaro and Kenya.

Other factors that influence mass wasting include;

Nature of Relief, rock structure, absence of vegetation cover, earth quakes, human activities, action of living organisms e.t.c.

🕮 **Remember to explain these factors.**

To what extent has relief influenced the nature of mass wasting in East Africa?

Approach

- ❖ Define mass wasting
- ❖ Identify and describe briefly types /processes of mass wasting

- Give the 1St evaluation (large extent) and explain the role of relief
- Give the 2r d evaluation (larger extent) and explain other factors that cause mass wasting

To what extent has man influenced the nature of mass wasting in East Africa?

Approach

- Define mass wasting
- Identify and describe briefly types /processes of mass wasting
- Give the 1St evaluation (larger extent) and explain the role man in promoting mass wasting
- Give the 2r d evaluation (large extent) and explain the physical factors that cause mass wasting

Man has promoted mass wasting to a larger through;

▪Mining and quarrying ▪Removal/ destruction of slope vegetation cover ▪Over loading of the slope

▪over-Steepening of the slope ▪ over loading of the slope ▪grazing animals on steep slopes

▪construction of roads and houses in highland areas, ▪poor farming methods such as monoculture, over stocking and over grazing, up and down hill cultivation ▪ heavy settlent on steep slopes, ▪ use of heavy trucks such as trailers, buses and lorries.

Physical factors include, heavy rain fall, nature of soils, rock structure, earth quakes, river and wave erosion, nature of relief , type of soil and action of burrowing animals such as rodents and moles.

🕮 **Remember to explain these factors.**

LAND SLIDES IN EAST AFRICA

Causes of land slides in East Africa

Account for the occurrence of landslides in East Africa.

Approach

- Define landslides
- Identify and describe briefly types /processes of landslides
- Give examples of areas in East Africa experiencing landslides
- Explain the causes of landslides

Answer guide

Land slides are rapid and sudden movements of rock and soil materials along slopes under the influence of gravity. Landslides occur more frequently during the El-Nino season.

PROCESSES OF LAND SLIDES

The Processes of land slides commonly experienced in highland areas of East Africa include;

Talus creep- is the gradual down slope movement of weathered materials called screes or talus and angular rock particles of all size as a mass on a moderate to steep slope where freeze and thaw takes place. Talus creep is also confined to glaciated mountains.

Rock slump-refers to rapid/ sudden movement of large masses of rock debris over steepened slope such as escarpments and cliffs created during road construction, wave and river erosion. Rock slump leaves behind a scar on the slope.

Mud flow / earth flow - is the rapid movement of super saturated mixture of mud, gravels, boulders and other unconsolidated material on moderate to steep slope, common in arid and semi-arid such as Karamoja and volcanic regions such as mount Meru and Rungwe in Tanzania, Sabinio in south western Uganda.

Rock slide-involves rapid movement of large quantities of rocks and debris over very steep slope due to earth movements such as earth quakes and gravity. Rock slide is more pronounced in highland regions such as Kabale.

Rock fall-is a process by which individual rocks or boulders fall freely on very steep slopes such as cliffs.

Avalanche- refers to rapid down slope flow of a large mass of ice and snow. Avalanches in East Africa are restricted to mount Rwenzori, Kilimanjaro and Kenya.

Landslides are commonly experienced in highland areas during the wet season for example slopes of mountain Elgon (Kapchorwa Manafwa, Sironko and Mbale), Kilimanjaro, Rwenzori, Meru, Ol'Doinyo Lengai, Kasese, Kigezi and Kenyan highlands, Bundyibugyo, Moroto.

Causes of landslides

Heavy rain fall such as El-Nino and Orographic received in highland areas provides huge quantities of water which infiltrate and soak rock debris and other materials, making them heavier. Water also lubricates the surface between rock debris and the underlying solid rock. Consequently, materials slide, slump or flow down as a mass.

Temperature fluctuation facilitates thawing leading to Solifluction, talus creep, rock fall and avalanche in glaciated mountains such as Rwenzori, Kenya and Kilimanjaro.

Cloud thunder produces vibrations which set in motions weathered and unconsolidated materials down slope inform slumping.

The steep gradient of relief accelerates landslides because gravity increases with increase in gradient. This explains why land slides are frequent in highland regions than anywhere else.

Presence of weak volcanic and sandy soils are loosely packed thus saturate/ soak very fast during heavy down pour leading to mud flow especially in arid and volcanic regions. Areas with clay soil, landslides take place because clay becomes slippery after absorbing water, increase in weight and lubricate very fast hence slide down over steep slopes.

Crustal instabilities- such as earth quakes and earth tremors vigorously shake the already unstable slope causing rock slides on steep slopes and slumping of weathered and unconsolidated materials on gentle slope, for example in Bundibugyo, Kasese, Fort Portal and Rift Valley escarpments.

Nature of rock/ rock structure for example**;**

- Where impermeable rock layer such as granite and gneiss lie on top of permeable rock layer such as limestone, chalk and sandstone on a steep slope, triggers off slumping and sliding movements.
- Likewise where permeable rock layer lie on top of an impermeable rock layer on a steep gradient, slumping and sliding movements may occur after saturation of the permeable rock layer.
- Similarly, jointed rocks in the slope encourage mass wasting than unjointed rocks because joints/ cracks allow percolation of water into the rock causing saturation and lubrication which ultimately lead sliding movements.

Heavy traffic on roads in highlands such as trailers ,tractors, Lorries and buses produce strong vibrations that vigorously shake the slope; causing rock fall, rock slide and slumping for example along Kabale-Katuna road, Bundyibugyo- Fort Portal road e.t.c

Volcanic eruption- causes earthquakes which destabilize the slope, and also yield volcanic ash and lava which easily soak and flow down slope as mud flow for example mount Meru and Longonot, Ol'Doinyo Lengai e.t.c

Steepening of the slope through road and house construction, wave and river erosion creates under cuttings and cliffs which lead to slumping, rock slides and fall ,for example along lakes shores, river banks, East African coast and highland areas.

Over loading of the slope with water tanks, settlements, planted forests e.t.c destabilize the slope equilibrium leading to slope failure for example slopes of mountain Elgon, Kenya, Meru, Kigezi and other hill slopes heavy settled on.

Removal/ Destruction of slope vegetation cover -through deforestation, overstocking and over grazing, mining e.t.c weakens the soil structure and expose unconsolidated materials to direct effect of rainfall leading to saturation, lubrication and flow of materials down slope in form of mud flow and slumping for example in Kigezi , Kenya highlands, Bududa, Kapchorwa, Kitui, Turkana, Sironko e.t.c

Mining and quarrying in highlands involves use of explosives which produce tremors that set in motion unconsolidated materials down slope. In addition, cliffs are created, vegetation cover is destroyed leading to mass movement of materials down slope. For example stone quarrying in

Muyenga, Mukono, Masese in Jinja, limestone and vermiculite in Mbale, murrum on hill tops in Buganda, wolfram in Kabale, Cobalt in Kasese, Diamond in Shinyanga, Gold e.t.c

Action of living organisms for example burrowing animals such as rabbits, rats, and squirrels, and earth worms create tunnels which provide easy passage to water into rocks leading to saturation, lubrication and chemical weathering weaken soil and rocks making them to easily move down slope in form of landside.

Large herds of animals grazing on steep slopes or hills for example cattle, goats, buffaloes and elephants make rocks loose, and also produce minor tremors as they rush down to watering points result into mass movement of unconsolidated materials down slope. For example in Kigezi, Ankole hills, Moroto e.t.c

Effect of **River and wave erosion create** cliffs which facilitate slumping of the over lying materials and rock fall especially in coastal areas, river banks and lake shores.

Heavy Settlement on steep slopes leads destruction of slope vegetation exposing the slope to rain drop erosion, saturation and lubrication responsible for slope failure. In addition undercutting of the slope for construction creates, cliffs which encourage slumping, rock fall and slides for example on Kampala hills, slopes of mountain Elgon, Kenya, Kilimanjaro, Kigezi and Bundibugyo

Poor farming methods such as monoculture, up and down hill cultivation, over stocking and overgrazing weaken the slope leading to slope failure in form of landslides.

Examine the landslides types experienced in mountainous regions of East Africa Approach

- Define land slides
- State the highland/ mountainous regions in East Africa experiencing landslide
- Outline causes of landslides in those regions. That is, heavy rainfall, steep gradient, earth quakes, weak volcanic soils, removal of slope vegetation, heavy settlement on slopes, poor farming methods, under cutting of slope base , mining and quarrying, e.t.c
- Explain the types of land slides experienced. That is mud flows, rock fall, rock slides, slumping, and talus creep.

🕮 **Remember to explain these processes**

To what extent has relief contributed to the occurrence of land slides in highland areas of East Africa?

- Define land slides
- Identify and describe briefly types of land slides
- State the highland/ mountainous regions in East Africa experiencing landslide
- Give the 1^{St} evaluation (large extent) and explain the role of relief.
- Give the $2^{r\,d}$ evaluation (large extent) and explain other factors

Answer guide

Relief to a large extent influences landslides in East Africa in the following ways;

- Very steep /vertical relief encourages rock fall, rock slides and avalanche because gravity increases with increase in gradient. It is common in highland areas such as Kigezi, slopes of Mount Elgon, Bundibugyo e.t.c
- Dipping /inclined or steep relief encourages slumping for example along cliff face, road cuttings and scarps common in highlands where roads and settlements exist.
- Gentle / moderate slopes encourage mud flows, Solifluction, soil and talus creep because gravity reduces with decrease in gradient.
- Explain the role of other factors influencing the occurrence of landslide in highland areas of East Africa

Examine the causes and effects of landslides in East Africa.

- Define landslides
- Identify and describe briefly types /processes of landslides
- Give examples of areas in East Africa experiencing landslides
- Explain the causes and effects of landslides

🕮 **Refer question—above**

Measures being taken to control landslides in East Africa

Take note of the tense

Adaptation and mitigation Measures landslides and mass wasting

•Planting of trees on bare slopes through Districts Environment officers and local leaders because tree roots bind soil particles, protect the slope from saturation and lubrication responsible for slope failure. For example pine, Cordia Africana and Eucalyptus on most bare hills on the slopes of mountain Elgon, Manafwa district.

•Retaining walls are constructed along the bottom of steep slopes such as road cuttings and cliffs to support the upper part of the slope and prevent it from collapsing, for example on most heavily settled hills such as Muyenga and Kololo, road cuttings on major roads such as Kabale- Katuna road

•Re -afforestation programmes are being implemented in high land areas affected by deforestation. This is because trees protect soil and other weathered materials from rain drop erosion, saturation and lubrication. Tree roots also bind soil particles hence consolidate the slope. For example planting of pine, wattle and eucalyptus trees in Kigezi, Kabale, Bushenyi kikuyu highlands, Sironko and Mbale

•Practicing Agro forestry in highland areas. That is, planting of trees and crops. Trees are being planted where poor cover crops are grown on slopes to reduce the effect of raindrop erosion for example coffee, cocoa and palm trees are planted alongside maize, onions, millet and sorghum.

•Controlled mining and quarrying is enforced in highlands for example banning the use of explosives in highland areas, control mining at base of hills and enforcing refilling of mining pits. For example in Kabale and Kigezi

•Resettling excess population to reduce excess pressure on hills for example the government has resettled people in Bududa to Kiryadongo in Masindi, in 1960's government resettled Bakiga in Kibaale from Kabale.

•Hill slope tillage is discouraged during the wet season because it increases infiltration, saturation and lubrication which cause landslides. For example in Kigezi and Kabale, tilling of land is done during the dry season.

•Planting of cover crops such as pumpkins, potatoes ,and Mulching using maize stalks, banana fibers and stems on slopes to reduce on the infiltration rate, saturation and lubrication. In addition Napier grass is being planted on river banks and cliffs to prevent slumping. For example in districts of Sironko, Mbale and Manafa

•In other areas District Environment officers are discouraging terracing on steep slopes because terraces act as water collecting points increasing high infiltration into the soil. For example in Kigezi and kikuyu highlands e.t.c

•Draping metallic mesh/ nets are set up to trap loosened rocks or rock fall and slide on cliffs in some places such as Kololo, Buziga and Muyenga steel mesh screens are used to trap rolling rocks and materials sliding down slope

•The government set up departments such as National Forestry Authority (NFA) to guide and manage land use in fragile areas including those prone to landslides through sensitization works, seminars

•Improved drainage systems such as small canals, tarps are made to drain away excess water in the slope to reduce saturation and lubrication.

•Engineering works such as stone pitching on cliffs and road cuttings on major roads such as Kabale- Katuna road is done to prevent slope failure

•Controlled grazing by reducing the number of animals moving on slopes where landslides are pronounced. For example paddocks are created in Kabale, slopes of mountain Kenya, Kilimanjaro, Elgon and other landslide prone areas to prevent over grazing which leaves soil bare and loose.

•Strengthening environmental agencies such as National Environment Authority (NEMA), National forestry Authority(NFA) to regulate and guide land use in areas prone to mass wasting, for example settlement and agriculture on steep slopes are banned to reduce landslides.
•Continuous sensitization of the masses and opinion leaders living in fragile zones about the dangers of poor land use, for example National Environment Management Authority and National Forestry Authority are training leaders and masses in conservation, adaptation and mitigation measures of landslides through proper land use and management such as mulching to reduce soil erosion, lubrication, slumping e.t.c.
•Government has gazetted mountain slopes and other land slide prone areas as National Game parks and Forest reserves to protect them from human degradation, for example Rwenzori Mountain National park, Elgon National park and Mgahinga National Park.
•The metrology department has been strengthened to collect, assess data and disseminate information about El-Nino rains which trigger off landslides.

GLACIATION IN EAST AFRICA

Formation of a glacier

A glacier is a mass of ice-sheet with limited width moving outwards from an area of accumulation (snow field) down slope along a pre-existing river valley under the influence of gravity.
Glaciers in East Africa are formed on the peaks of mountain Rwenzori, Kilimanjaro and Kenya where air temperature fall below 0^0 Celsius, causing water vapor to condense and freeze into crystals called **snow.**
Snow falls to surface and collects in niviation hollows/ depression in the mountain sides in areas where the rate of snow fall exceeds melting. Continuous snow fall increase the depth and weight of snow year after year.
The weight of newly added snow load compress and compact snow into small ice crystals separated by air spaces. More snow fall exerts pressure on the bottom layers and causes some ice crystals to melt.
The melting water percolates down into the air space where it re-freezes causing the snow to turn into coarser and stiffer mass of ice called firn or **nêvê**.
In time, all the air spaces in the **nêvê** disappear and eventually the neve is compacted into a solid mass of ice called glacier; pulled out of the niviation hollows down slope by gravity.

Conditions/factors favoring glacial formation in East Africa

Glaciers are experienced on three mountains in East Africa because of the following conditions.
–High altitude. The snow line in East Africa is 4700 m (16,000 ft) above sea level. At this altitude, temperatures are cold enough to allow formation of snow, snow fall and permanent snow cover from which glaciers finally form. This is the reason why glaciers are limited to mountain Kilimanjaro, Kenya and Rwenzori which reach this altitude.
–Presence of basins/hollows, valleys and depressions in which ice accumulates.
– Presence of steep and gentle slopes encourages movement of ice downwards.
–Low temperatures allow water vapor and rain to condense into ice crystals called snow from which glaciers finally form.
–Heavy rain fall especially on the windward sides provides ample water form which snow form.

Processes of glacial Erosion

Glaciers erode through the following processes;
Sapping, Plucking, abrasion, basal sapping and back wall recession.
Sapping- refers to the break-up of rocks by alternate freezing and thawing of water at the bottom of cracks and in the mass of ice, side and floor of the valley or the side of a mountain. This process widens and deepens rock joints.
Plucking- refers to the tearing away of rocks protruding on the valley floor and sides by ice. That is, ice freezes rock protrusions and as it flows down slope, frozen rock protrusions are pulled away and

the fragments are refrozen into the base and sides of the glacier. Plucking enlarges and deepens the niviation hollows and joints in the rock.

Abrasion- refers to is the wearing away of rocks by the grinding and scratching action of rocks frozen into the bottom and sides of the glacier. Abrasion over deepens basins and polishes hard rocks on the valley floor.

Basal sapping/ head wall recession- a process by which two cirques cut back to back.

Rotational slip-refers to the circular rotation of ice in the cirque leading to polishing of the surface of the cirque**.**

Back wall recession –refers to back to back erosion by two adjacent cirques and usually shapes arêtes, cirques and pyramidal peaks.

Glacial erosional landforms in East Africa

Glacial erosional landforms are found in the glaciated highlands and low land areas for example cirques, arêtes, pyramidal peaks, glacial troughs, hanging valleys, roche-montonnêe, Craig and tail, truncated spurs, rock steps and basins.

(a)Account for the occurrence of glaciers in East Africa

(b)Describe the processes which have led to the formation of any one glacial erosional feature in East Africa.

Approach

- Define a glacier and explain briefly how it is formed
- Identify areas in East Africa where glaciers occur
- Explain the conditions responsible for the occurrence of glaciers
- Identify any one erosional land form and explain the processes involved in its formation.
- Show how landform shapes are achieved.
- Give examples and draw diagrams showing the features.

Answer guide

A glacier is a mass of ice-sheet with limited width, moving outwards from an area of accumulation (snow field) down slope along a pre-existing river valley, under the influence of gravity.

Glaciers form when snow falls and accumulates in niviation hollows or depressions in the mountain sides, where temperatures fall below 0^{o} c.

Compression and compaction occur due to the weight of the newly added snow load; causing ice in the bottom layer to melt, water percolates down filling the Air spaces between ice crystals.

Refreezing takes place causing the snow to turn into coarser and stiffer mass of ice called firn or **nêvê**.

In time, all the air spaces in the **nêvê** disappear and eventually the neve is compacted into a solid mass of ice called glacier; pulled out of the niviation hollows down slope by gravity.

Glaciers in East Africa are limited to mountain Kilimanjaro, Kenya and Rwenzori because of;

High altitude above 4700 m (16,000 ft) above sea level encourages formation of snow and snow fall, and permanent snow cover.

Presence of hollows, valleys and depressions in which snow and ice accumulates.

Presence of steep and gentle slopes encourages movement of ice downwards.

Low temperatures allow water vapor and rain to condense or freeze into ice crystals called snow, from which glaciers finally form.

CIRQUES

A cirque (corrie) is a steep-sided rock basin, semi-circular in shape cut into valley head and mountain sides. Many cirques are small and some have steep back walls hundreds of meters high.

Cirques usually develop from **niviation hollows** formed when snow occupying crevices / cracks is subjected to freeze and thaw caused by temperature changes (rise and fall in temperature).

Sapping due to continuous alternate freezing and thawing eventually weakens the rock and paves way for plucking.

Plucking widens niviation hollows with the help of abrasion which scour and polishes scours the valley floor with deep grooves and striations depending on the hardness of the rocks frozen into the base of the glacier and on the valley floor.

The back wall of the basin/hollow is steepened by **back wall recession** and deepened by basal sapping or rotational slipping of ice occupying the depression.

Debris is removed from the hollow by Solifluction creating semi-circular basin known as a cirque, some times filled with water to form lakes called tarns for example;

- lac du Catherine, lac du Speke, and Noir on mountain Rwenzori,
- Teleki, Hidden, Hobley, Tyndal, Simba and Hohnel cirques on mountain Kenya and
- Mawenzi tarn on mountain Kilimanjaro.

Diagram

Arêtes. An arête is a narrow, steep-sided rock ridge separating two or more cirques formed when two cirques erode back ward toward each other through a process called headward recession. Arêtes are found on the foot hill of mountain Rwenzori and Kenya.

Pyramidal peaks. A pyramidal peak is a sharp steep-sided rock ridge surrounded by a system of radiating arêtes.

A pyramidal peak is formed where three or more cirques erode back wards into the original mountain peak by the process called back wall recession or head ward erosion.

Since pyramidal peaks develop from radiating arêtes formed back wall recession of cirques, then processes of plucking and abrasion are important in the formation of **Pyramidal peaks**, for example;

- Stanley and Margherita peaks on mountain Rwenzori,
- Midget, Nelion and Batian, Lenana, Sendeyo peaks on mountain Kenya
- Kibo peak on mountain Kilimanjaro.

Diagram showing Arêtes and Pyramidal peaks

Glacial toughs / U- shaped valleys. A glacial trough is a wide, flat bottomed valley with steep sides and a roughly U- shaped cross profile.

Glacial toughs develop from glacial erosion in the former river valley with interlocking spurs.

Glaciers occupied the river valley and as glaciers advanced, they eroded and straiten the interlocking spurs into steep sides by plucking while the valley floor was widened and deepened by abrasion and rotational slip to attain a U-shaped cross profile for example;

- Mugusu, Bujuku and Mubuku valleys on Mountain Rwenzori,
- Teleki, Hobley and Nyamindi valley on mountain Kenya,
- Karanga valley on the slopes of Kibo on mountain Kilimanjaro.

Hanging valley- This is a small tributary valley left hanging high above the glacial trough and separated from it by a water fall or a steep slope.

The hanging valley is formed when small glaciers occupying small river valley erode the valley through plucking and abrasion but not faster like the main glaciers occupying the glacial trough.

Hanging valleys are found on mountain Rwenzori, Kenya and Kilimanjaro.

Diagram showing Hanging valley and Glacial trough

Roche-montonee- this is an out crop of a resistant rock on the floor of a glacial trough with a gentle and a smooth side on the upstream end and a steep and rough slope on the down-stream side.

The Roche-montonee is formed when the glacier passes over a hard rock and polishes or smoothes it by abrasion into a gentle slope on the up-stream side while plucking roughens and steepens the downstream end.Roche-montonee are found on the;

- floor of upper Mubuku and Gorges valley in mountain Kenya and
- the slopes of Mawenzi peak on mountain Kilimanjaro.

Diagram showing the Roche-montonee

Craig and tail. A Craig is a mass of hard rock with a steep slope on the up-stream side protecting the weak rock on the lee ward side form being completely worn down by advancing glaciers.

The steep side of the Craig is a result of plucking by the advancing glaciers while the gentle and elongated tail is produced by deposition of weathered rock debris produced by plucking.
Craig and tail are found in the saddle between kibo and Mawenzi on Kilimanjaro, Kenya and Rwenzori.

Diagram showing the Craig and tail

Rock steps and basins- these are rock protrusions and depressions on the floor of the glacial trough. They are formed due to unequal erosion on the floor of a glacial trough composed of hard and weak rocks. When two glaciers meet, the immense weight and pressure is exerted on the weak rocks which are eroded easily by plucking and abrasion to form shallow basins while the hard rocks are polished through abrasion and rotational slip to form steps.
With time, water from melting glaciers occupies the shallow basins to form rock basin lakes, for example;

- Lac Vert and Lac Noir in the upper floor of Kamusoso valley, Bujuku and Mubuku on mountain Rwenzori,
- Lake Michealson, Carr and Encharted on mountain Kenya.

Diagram showing Rock steps and basins

Other features created by glacial erosion include truncated spurs, rock benches and trough end.

DEPOSITIONAL GLACIAL LAND FORMS IN EAST FRICA

(a) Describe the processes by which a glacier is formed.
(b) With reference to specific examples, describe the landforms associated with glacial deposition in the highland areas of East Africa.

Approach

Define a glacier and give the types of glaciers

- ❖ State the conditions that favor glacial formation in East Africa
- ❖ Describe the processes.
- ❖ Identify and describe the landform, showing the processes involved
- ❖ Draw diagrams and give examples where applicable from highland areas of East Africa.

Answer guide

A glacier is a mass of ice-sheet with limited width moving outwards from an area of accumulation (snow field) down slope along a pre-existing river valley under the influence of gravity.
Glaciers have different names for example mountain glaciers and alpine glaciers and, move continuously from higher to lower ground under the influence of gravity and are enclosed within valley walls.
Glaciers in East Africa are limited to mountain Kilimanjaro, Kenya and Rwenzori because of;
High altitude above 4700 m (16,000 ft) above sea level encourages formation of snow and snow fall, and permanent snow cover.
Presence of hollows, valleys and depressions in which snow and ice accumulates.
Presence of steep and gentle slopes encourages movement of ice downwards.
Low temperatures allow water vapor and rain to condense or freeze into ice crystals called snow, from which glaciers finally form.
Heavy rain fall especially on the windward sides provides ample water form which snow develops.
Glaciers form when snow falls and accumulates in niviation hollows or depressions in the mountain sides, where temperatures fall below 0^{o} c.
Compression and compaction occur due to the weight of the newly added snow load; causing ice in the bottom layer to melt, water percolates down filling the Air spaces between ice crystals.
Refreezing takes place causing the snow to turn into coarser and stiffer mass of ice called firn or **nêvê**.
In time, all the air spaces in the **nêvê** disappear and eventually the neve is compacted into a solid mass of ice called glacier; pulled out of the niviation hollows down slope by gravity.

Therefore, the Processes of glacier formation include;

- Alimentation- which involves accumulation of snow in the basin or hollow from direct snow fall and avalache,
- Compression- by addition of successive layers of firn,
- Compaction-by the weight of newly added snow load,
- Sublimentation- molecules of water vapor escape from snow flakes and reattach themselves so that crystalline granules become more highly packed,
- Stratification- section through a snow field distinguishing annual contribution of snow,
- Firnification- a process for formation of firn or nerve.

Formation of Glacial depositional landforms East Africa

Glacial depositional landforms in highlands include;

Eskers, Kame, Erratics, Till plain, Drumlin, Outwash plains and Kettle holes.

Moraine-This is the material transported and deposited by glaciers. It includes rocks, huge boulders and sand. The moraine carried at the side is called **lateral moraine**. When two glaciers join, they form **medial moraine** and the debris at the tip advancing glaciers form **terminal moraine.** Moraines are found in the Gorge valley.

Diagram showing different moraines

Till plain- this is an extensive area of monotonous landscape formed when moving ice transports boulders and clay, burying former hills and valleys, for example Teleki valley on mountain Kenya and Mubuku valley on mountain Rwenzori.

Out-wash plain- this is a wide and gently sloping **plains** of gravel, sand, clay, silt and boulders deposited haphazardly by the glacier.

An Out-wash plain is formed when melt waters from a stagnant glacier carry and deposit sorted materials near the mouth of a glacier and further down slope, for example the out-wash plain between Kibo and Mawenzi on mountain Kilimanjaro, Mubuku and Bujuku valleys on Rwenzori and Teleki valley in Kenya.

Drumlins are ridges or small elongated and oval shaped hills about l00 m high made of boulders and clays on outwash plain. They are formed when fragments of ground moraines are compressed over the rocks underneath and consequently mounded into oval shaped hills by advancing glaciers. They exist on Teleki valley in Kenya.

Diagram

Erratics/ boulders- These are big boulders transported by moving ice for a long distance and deposited as ice melts. They are geologically different from the local rocks. Erratics are found on Nithi River, Bujuku and Kamusoso valleys in Rwenzori.

Kame-this is an irregular mound or hill of sand and gravel formed by deposition of sediments from the stream emerging from a glacial tunnel. That is, as the stream emerges from the tunnel to the out-wash plain, reduction in pressure cause the stream to deposit the sediments in front of the tunnel and gradually accumulate to form a kame, for example in Kamusoso valley (Rwenzori) and Hobley in mountain Kenya.

Kame moraine- refers to irregular undulating moulds of bedded sand and gravel deposited randomly (cone fans or deltas). Kame-moraines are arranged in a chaotic and complicated manner and formed due to melt water from long stagnant and slowly decaying ice sheets.

Kame- terrace- this is a narrow flat topped terrace like ridge of sand and gravel along the valley sides. Kame-terraces are formed when heat absorbed by rocks on the valley sides melt ice sheets in contact with it. Melt water create streams which occupy the trough between the glaciers and its enclosing valley wall. Deposition of sand and gravel from melt water occupied the trough between the glacier and its enclosing valley.

Deglaciation on the valley made deposition to collapse at the front and retain sufficient flatness adjacent to the valley sides to form a Kame, found on the Kamusoso valley in mountain Rwenzori and Hobley valley on mountain Kenya.

Diagram

Kettle. Small circular depression in out-wash plain formed when a portion of glacial ice is buried by a layered drift or enclosed by terminal moraine. As ice melts, a depression is produced and sometimes filled with water to form a small lake, for example Lake Mahoma at the junction between Mubuku and Bujuku rivers on mountain Rwenzori.

Eskers- an esker is along winding and steep-sided ridge made of sand and gravel formed on the bed of streams flowing through a glacial tunnel. The tunnel through which the steam flows may get blocked or may collapse and water melts away and consequently the materials being transported are deposited to form a ridge of sand. **Eskers** are found in Teleki valley, River Nithi, Gorges valley on mountain Kenya.

Factors responsible for limited glacial activity in East Africa

Account for limited glaciation in East Africa

Approach

- Define glaciation and briefly explain how glaciers form
- State the conditions that favor glacier formation in East Africa and areas affected by glaciation.
- Explain the factors limiting occurrence of glaciation

Answer guide

Glaciation is the process by which glaciers shape the surface of the earth by erosion and deposition creating erosional and depositional landforms respectively.

Explain briefly the formation of glaciers and factors favoring glaciation on mountain Kilimanjaro, Kenya and Rwenzori. **Refer to the questions above.**

Glacial activity is limited in East Africa because of;

Low altitude- altitude refers to the height above sea-level. Most highlands in East Africa with the exception of mountain Kilimanjaro, Rwenzori and Kenya don't reach the snow line which is approximately above 4800m above sea-level. Consequently moisture does not condense into snow from which glaciers develop hence limited glaciation.

Latitudinal location. East Africa lies astride the equator where the sun is present almost throughout the year leading to hot temperatures which cause high rate of thawing than snow formation and fall.

Nature of precipitation. Most areas in East Africa receive precipitation in form of rain fall due to high temperatures yet glacial formation require precipitation in form of snow which is received on mountain Kenya, Kilimanjaro and Rwenzori.

Influence of volcanicity. Most mountains in East Africa are volcanic in origin and are located in active volcanic zones. This keeps them warm because of the heat trapped inside leading to high rate of thawing, for example mountain Ol'Doinyo Lengai in Tanzania and Elgon.

Low annual rain fall. Highlands located in arid regions in East Africa such as Karamoja, north eastern Kenya and central Tanzania receive Low annual rain fall incapable of supporting snow formation at high rate than thawing hence limited glaciation.

The rain shadow effect. Some highlands in East Africa lie on the lee-ward side of major high-lands experiencing dry descending winds which are warm hence discourage snow and ice formation, for example, Karamoja and Northern Kenya lie on the lee-ward side of Ethiopian highlands and in the path of dry north east trade prevailing winds.

Shape of highlands/ mountains – Ash and Cinder cones in East Africa are conical shaped with steep slopes leading to slipping of snow down slope instead of accumulating in basins to form glaciers.

Influence of global warming. Increased emission of green house gases such as carbon dioxide in the atmosphere has resulted into steady rise in the average surface temperatures responsible for melting and receding of Alpine glaciers. This is the reason for rapid disappearance of mountain glaciers, For example glaciers on mountain Rwenzori covered $6km^2$ but now cover $0.86\ km^2$ due to Global warming.

Man's activities such as burning of fossils for fuel, industrialization, deforestation, bush burning e.t.c are increasing the concentration of Green House Gases in the atmosphere responsible for Global warming and retreat of mountain glaciers hence limited coverage. For example Hima factory in Kasese near Rwenzori is producing acid rain which has a diverse effect on the ice on mountain Rwenzori.

Influence of aspect- has affected glaciation in East Africa in such as a way that during the northern summer, the north facing slopes are over heated hence lose the ice due to high temperatures than the south facing slopes. During the southern summer, the south facing slopes are over heated causing melting of ice while the north facing slopes are sheltered hence experience more ice.

Absence of thick cloud cover especially in arid areas leads to high direct insolation which increase the rate of thawing or melting of ice hence limiting the coverage of ice, For example mount Napak in Karamoja, mount Marsabit and other highlands in north eastern parts of Kenya.

On the other hand, Equatorial regions have relatively permanent cloud cover which reduces the amount of insolation received through absorption and reflection leading to high glacial coverage.

Presence of numerous rivers radiating from mountains is reducing the height of mountains through erosion hence reducing the snow line and glacial coverage, for example mountain Kenya.

ECONOMIC IMPORTANCE OF GLACIATION

Examine the economic importance of glacial activities in East Africa.

Approach

- Define glaciation, briefly explain how glaciers form
- State the conditions that favor glacier formation in East Africa and examples of glaciated areas.
- Outline glacial landforms in highlands of East Africa
- explain the positive and negative importance glacial landforms to man

Answer guide

Glacial land forms create beautiful scenery which support tourism hence source of foreign exchange used for economic development for example pyramidal peaks, arêtes, hanging valleys and glacial troughs in mountain Rwenzori, Kenya and Kilimanjaro.

Glacial troughs are used as natural routes in highlands and access to steep and rugged mountain tops, for example Mubuku valley provides access to Rwenzori summit.

Glaciers provide water inform of rivers and streams for domestic and industrial use, for Example River Mubuku and Nyamwamba provide water used in Kasese and Kilembe.

Glaciated highlands modify micro-climate inform of temperate climate suitable for crop cultivation and settlement, for example coffee growing on the lower slopes of mountain Kilimanjaro and Kilimanjaro

Glacial troughs contain palatable pastures suitable for grazing livestock for example in Kasese

Rivers radiating from glacial peaks provide water for hydro-power generation for Example River Mubuku in Kasese and Kilembe town.

Glaciers are source are source of education material and research.

Glaciated highlands are associated with cool and cold weather which discourage breeding of disease vectors like mosquitoes and tsetse flies which are a nuisance to man.

Glacial troughs and out-wash plains contain fertile soils used for crop-cultivation for example Irish potatoes on the slopes of Rwenzori due to presence of clay alluviums

Cool conditions and gentle slopes favor settlement for example Bamba and Bakonjo on mountain Rwenzori, the chaaga the slopes of on mountain Kilimanjaro.

Negative effects

Many out wash plains contain infertile sandy soils and gravel which discourage crop cultivation hence create extensive waste land.

Arêtes and pyramidal peaks are associated with avalanche which claim lives and destruction of property

Arêtes and pyramidal peaks encourage soil erosion which hinder settlement and agriculture for example landslides in Kasese.
Glaciated Highlands are barriers to development of transport and communication net work because they make construction difficult and expensive.
High altitude limits settlement and agriculture due to cold conditions and rare field air.
Glaciated highlands are suitable hide outs for rebels who cause insurgence for example Defunct Allied Democratic Forces in Rwenzori.
Glaciated highlands cause aridity on the lee ward side because of the effect of dry descending winds for example kasese is partly dry because it's on the lee ward side of mountain Rwenzori.

Account for the formation of landforms found along the river profile.
Approach

- Define a river & the river profile
- identify the three courses of the river profile
- give the characteristics of each course and the dominant processes in each course
- explain the formation of landforms, draw diagrams and give examples

Answer guide
A river is a body of water flowing down slope in a defined channel on the surface of the earth while a river profile refers to the length of the river channel from its source to its mouth.

The river profile is divided into three stages or courses. Namely;
a. youthful/ upper stage **b.** mature /middle stage **c.** old/senile stage.

The youthful stage includes the area where the river originates. It is sometimes called torrent stage, juvenile or the upper valley stage. A river in this stage has the following characteristics;

The river flows against a steep gradient/ slope, flows very fast and in a turbulent manner, carries a lot or less water and load depending on its source (lake or highland), vertical erosion dominates this stage and the river flows in a deep narrow valley with a v-shaped cross profile.

Major landforms found in this stage are**; v-shaped valleys', interlocking spurs potholes, waterfalls, plunge pools, rapids and gorges.**
The river creates the landforms mentioned above through the following processes of erosion; **abrasion, hydraulic action, solution and attrition.**
Abrasion/corrasion occurs when the river uses the load it is carrying to wear away its bed and banks. The river uses boulders, pebbles and other particles being transported/ carried to wear down its valley sides and bed. Through abrasion, the river is able to deepen and widen its valley.

Solution/ corrosion. This is the solvent action of water flowing over chalk and limestone rocks. Through corrosion, the river is able to deepen and widen its valley.
Attrition occurs when pebbles and boulders being transported wear down as they hit and collide against each other and gradually reduce in size. As this load reduces in size, the river easily carries it down with less energy.
Hydraulic action. The hydraulic action of fast flowing water sweeps out loose materials in jointed rocks and compresses air in joints and cracks. As water retreats, the compressed air suddenly expands. Repeated action of compression and expansion of air gradually weakens and breaks rocks in the valley sides. Through this process, the river is able to widen its valley.
The processes explained above have facilitated the formation of the following landforms below.

V-shaped valleys- are deep narrow valleys with a v-shaped cross-profile. They are formed where vertical erosion exceeds lateral erosion.
The river covers its entire bed, which is deepened by vertical erosion more rapidly than weathering and wasting that wear back and widen the valley slopes/ sides. In this way, the river attains its v-shape.
V-shaped valleys exist on the upper stage of River Bujuku and Mubuku on mount Rwenzori, R. Isiolo Tana and Sagana on Mount Kenya e.t.c.

DIAGRAM

Pots-holes- are circular depressions in the bed of the river. They are formed by the drilling or excavating action of pebbles and boulders swirling and eddying against uneven bed of a fast flowing river.
Potholes are found in the upper course of River Ikiwe, south of Machakos in Kenya, River Mubuku on Mount Rwenzori and River Suam, Manafa and R. Sironko on the slopes of Mount Kenya.

DIAGRAM

Gorges- a gorge is a deep narrow steep-sides river valley. Gorges are formed in various ways;
(a). **a gorge** may be formed where a water fall slowly retreats up-stream though head ward erosion usually along a fault line. As the river retreats, it forms a gorge for example ***Murchison gorge created by Murchison falls.***

DIAGRAM
(b). A gorge may also be formed where a river flow across a region subjected to slow up- lift. This forced the river to erode vertically at the same rate of up-lift so that the river maintains its course of flow or base level. The gorge formed in this manner is called antecedent gorge for example the **Great Ruaha river gorge in Iringa highlands in Tanzania**

DIAGRAM
(c). A gorge may be formed when a river flows through an area composed of alternating hard and weak rocks such as igneous and sedimentary rocks. Through vertical erosion, the river erodes the weak rock more rapidly to deepen the valley than the hard rocks that form the steep sides of the valley for example **Maruba gorge on** river **Ikiwe in Kenya.**

DIAGRAM

Water falls- a waterfall is a sharp break in the channel bed of a river where the river spills over. Waterfalls are formed in various ways;
(a) Vertical faulting across the upper course of the river creates a fault scarp over which the river spills over to form a waterfall. **For example Karuma and Kabalega or Murchison falls in the upper course of river Nile, kalambo falls in Tanzania.**

DIAGRAM
(b)A waterfall is formed because of lava deposited across the riverbed to form sills and dykes that are resistant to erosion than the surrounding rocks.
The river flows over sills and dykes on the upstream edge but erodes the surrounding weak rocks on the down streamside to form a waterfall. For example **Bujagali and Rippon falls in Jinja in the upper course of River Nile, Sezibwe falls in Lugazi, pipa falls on Mount Elgon e.t.c**

DIAGRAM

(c)In glaciated highlands, waterfalls are formed where the hanging valley descends into or joins the main valley. For example **Athi falls on Mount Kenya and Bujuku falls on mount Rwenzori.**

DIAGRAM

Plunge pools- a plunge pool is a wide hole found at the base of a waterfall. Formed by the undercutting force of falling water on the riverbed with weak rocks.

Rapids-are numerous huge hard rocks protruding on the riverbed where the river swirls and eddies or winds and twists around. For example at **Bujagali on river Nile.**

DIAGRAM

Interlocking spurs-are alternating protrusions or bends of hard rocks on either side of the river valley.

Interlocking spurs are formed when the river dodges obstacle of hard rocks in it's channel. This is partly because the river has less water and therefore unable to erode the hard rocks.

Consequently, the river erodes the weak rocks on the out side bank of the valley and avoids and twists around the resistant rock in the inner bank to form a spur which alternate on each side of the river valley to interlock.

They occur on river Bujuku on Mount Rwenzori, River Ruvuma in Tanzania and river Tana in Kenya.

DIAGRAM

Canyon- is an extremely over deepened gorge. It is formed when the river over deepens its valley through continuous vertical erosion of its bed and minimal weathering and wasting of its valley sides, to form a very deep and relatively wide valley called a canyon. For example Kilombero **River as it flows into Lake Tanganyika**.

Diagram

Middle stage of the river. This is the area between the upper course and the old stage. It is some time called middle/valley stage.

A river in this stage has the following characteristics;

The river flows against a gentle gradient/ slope, speed is moderate, huge volume of water and load in the channel because many tributaries are established, lateral erosion dominates, the river flows in a wide v-shaped valley because of lateral erosion on the valley sides, meanders begin to form due to erosion on concave bank and deposition on the inner bank.

Major landforms in this stage include; meanders, bluffs/ river cliffs and slip-off slope.

Meanders- are curved bends of a river channel. Meanders are formed because of alternating erosion on the outside bank of the curve and deposition on the inner side bank of the curve. As the river flows down stream, water on the outside bank flows faster than water flowing on the inner side bank. Consequently, there is rapid erosion on the outside bank and deposition on the inner side bank, which leads to development of deep and shallow sections on the bed of the river channel across which a river meanders

Diagram

Bluffs- a bluff is a cliff or steep slope formed due to erosion on the outside (concave) bank of the curve.

Slip-off slope –is a gentle slope formed due to deposition of sediments on the inner side (convex) bank of the curve.

Rivers with meanders bluffs and slip-off slopes in East Africa include RiverTana, Ngaila on Kano plains, Nyando and Nzoia in Kenya, Rufiji in Tanzania and Ruizi and Semliki in Uganda.

Diagram

The old stage of the river. This part includes the area where the river ends or pours its water. It is sometimes called the senile stage/ last/ flood plain stage.

A river in this stage has the following characteristics;

The river flows against a low gradient, the speed is very low, river carries more load and less water, deposition dominates erosion, river flows in a wide valley made of alluvium deposits called a flood plain.

Major landforms formed in this stage include; ox-bow-lakes, meander scars, levees, braided channel, deltas and alluvial fans.

A flood plain is a wide, gentle, flat, swampy plain of alluvium on the floor of a river valley across which a river flows in a meandering manner. Flooding is frequent. A flood plain develops from prolonged deposition of alluvium materials like silt because of a low gradient, less water in the channel, flooding e.t.c.

Rivers flowing in flood plains include, R.Tana in Garissa, Ngaila, Semliki, Ruizi, mpanga, Nyando, pangani e.t.c

Ox-bow lakes- formed when a meander loop is cut off from the main river.

As the river flows in a meander channel, it erodes its concave bank faster and deposits the materials on the inner bank leaving a narrow neck of land.

During the flooding season, the river erodes away the meander neck and flows straight. The materials deposited seal off the meander loop to form the ox-bow lake, which may dry out during the dry season to form a meander scar. ***Ox-bow lakes are found on the lower course of R.Tana, semliki, Ngaila and Nyando.***

Diagrams

Levees- are raised embankments built by a river on either sides of its channel.

Levees -are formed through successive flooding and deposition of alluvium sediments by the river.

When the river floods, it over flows its channel. Friction between the river and the banks cause the river to drop the heavy load. Repeated flooding and deposition raise the height of the riverbanks to form levees, which are usually about 1-2 metres high and often prevent floodwater from returning to the main channel. This encourages the formation of swamps in the flood plain.

Deferred tributaries- a deferred tributary is a tributary river forced to flow parallel to the main river for a long distance before rejoining the main river at a deferred confluence or junction

Formed when floodwaters build a levee across the original confluence of two rivers. ***Found on R. Ngaila and Nyando flowing into Lake Victoria, southeast of Kisumu in Kenya.***

Braided channel- is a wide shallow channel with many sand and gravel deposits that force the main river to divide and sub-divide into numerous small channels that interconnect to each other.

Formed where the river banks consist of sand and gravel or when a river has a large load in the dry season but because of a low gradient and less water in the channel, the river is forced to deposit its load on the bed, blocking its channel. Repeated deposition builds islands of sand and gravel in the channel that force the main river to sub-divide into many small channels that interconnect each other.

Found on R.Tana, Galana, Ngaila, Nyando and R.Kilombero.

Diagram

Alluvial fans- alluvial fan is a fan shaped deposit of fairly coarse materials laid down by a stream with a large load as it emerges from a steep, narrow valley onto a wide gentle plain.

A sharp increase in the channel width and a decrease in the gradient cause a reduction in the stream energy resulting in sudden deposition ***e.g. River Kilombelo from Uchungwe highlands, Lume fan formed by river lume as it reaches the semliki plains on the west of Rwenzori.***

Diagram

Deltas- a delta is a large, flat, lowlying, swampy plain of river deposits laid down where a river flows into the sea or lake. Most deltas have a triangular shape.

Deltas -are formed in areas where the gradient of the river is very low at its mouth and where there no strong waves to carry away the sediments laid/deposited. The low gradient forces the river to deposit its large load that spreads out over a wide area. Continued deposition cause the river mouth to divide into distributaries. During the flood season, levees, sandbars and spits develop and prevent floodwaters from returning to the main stream, forming lagoons.

More deposition fills up the lagoons with sediments and gradually swampy vegetation like mangrove colonizes the lagoons. With time, the lagoons and the swampy vegetation disappear especially during the dry season, forming a dry land on the floodplain.

Deltas are found on RiverTana, Rufigi, Galana, Semliki e.t.c

Account for the development of landforms in the juvenile stage of a river.

Approach

Define a river and the juvenile stage

Outline the characteristics of the juvenile stage

- Identify and explain the processes of river erosion
- Identify the features and describe how their formation
- Give examples and draw diagrams where applicable

Answer guide

A river is a body of water flowing down slope in a defined channel on the surface of the earth while the juvenile stage is the area where the river originates e.g. highlands like mount Rwenzori, lakes like Victoria e.t.c. It is sometimes called torrent stage, or the upper valley stage.

A river in this stage has the following characteristics;

The river flows against a steep gradient/ slope, flows very fast and in a turbulent manner, carries a lot or less water and load depending on its source (lake or highland), vertical erosion dominates this stage and the river flows in a deep narrow valley with a v-shaped cross profile.

Major landforms found in this stage are**; v-shaped valleys, interlocking spur potholes, waterfalls, plunge pools, rapids and gorges.**

The river creates the landforms mentioned above through the following processes of erosion; **abrasion, hydraulic action, solution and attrition.**

N.B. REFER TO QUESTION…..FOR EXPLANATION, DIAGRAMS AND EXAMPLES.

DELTAS IN AFRICA

(a)Distinguish between a delta and an estuary.

(b) Account for the formation of deltas in Africa.

Approach

- ❖ Define each landform/ feature
- ❖ State the characteristics of each landform and examples
- ❖ Out line the conditions which favor formation of deltas
- ❖ Identify types of deltas and explain the process of their formation.

Answer guide

- **A delta** is a large flat low lying swampy plain characterized by several distributaries, lagoons and vegetation.
- A delta usually has a triangular shape formed where the river enters a lake, sea or ocean.
- Examples of major deltas in Africa include; Nile delta in Egypt, Niger delta, Semliki delta, Omo delta e.t.c

Where as

- An estuary is a deep submerged/ drowned river valley with a V- shaped cross profile pointing landward.
- Most estuaries are a result of submergence of lowland coasts due to a rise in sea-level
- It is relatively clear of sediments and allows easy mixing of channel and sea/ lake water
- Examples of estuaries exist on river Congo, Gabon, Gambia, cross river in Nigeria, river Sierra Leone, river Senegal e.t.c

(b) Conditions favoring formation of a delta.

- **The** river must have a large load of sediments which are laid to form a delta.
- Sheltered coast preferably tide less to allow deposition and accumulation of sediments.
- The sea adjoining the delta should be shallow to prevent sediments from disappearing in deep water.
- **There** should be no strong currents running at right angle to the river mouth to prevent washing away of the sediments.
- The river should flow at a low velocity to allow deposition of sediments in the river's mouth.
- The River's load must be deposited faster than it can be washed away by currents.

A delta thus forms through the following processes;

Processes of delta formation

- Deposition of sediments near the river's mouth,
- Coagulation of fine materials after mixing with salty sea water,
- More deposition and Coagulation of materials block the river channel hence force it to divide into several new smaller channels called distributaries near the mouth.

- Each distributary disposes off its load by extending the natural levees into the sea. Gradually, levees are converted into curved spits.
- As more deposition takes place, some parts of the sea/ lake are completely cut off to form lagoons later colonized by swampy vegetation.
- Further deposition fills up the lagoons and the delta takes more solid appearance though it is still swampy and is usually covered with water-loving shrubs and trees.
- Plants/ vegetation colonize the upper delta, and swamps disappear leaving a dry land.
- Eventually the older parts of the river become part of the flood plain.
- The characteristics of the delta formed depend on the nature and quality of sediments.

Types of deltas

Deltas are of three types, namely; Arcuate, Estuarine and Bird's foot/ Digitate delta

Arcuate delta- is formed from deposition of both fine and coarse sediments such as gravel. It has a triangular shape and is crossed by many distributaries, for example Nile delta and Niger delta.

Diagram

Estuarine delta- is built by rivers depositing materials in an estuary forming sand banks and islands, around which several distributaries wind.

They take the shape of the estuary for example river Congo between banana and Boma.

Diagram

Bird's foot delta- is **formed** by river depositing very fine sediments called silt in the river's mouth where wave energy is too low to remove it.

There are few very long distributaries bordered by levees, jut out from the shore for example River Omo in Ethiopia as it enters Lake Turkana in Kenya.

Diagram

Describe the similarities and differences between deltas and alluvial fans.

Approach

- ❖ Define each landform
- ❖ State the most outstanding characteristics of each landform
- ❖ Explain the similarities and differences between the two features with emphasis on shape, composition and conditions of formation.

Answer guide.

- **A delta** is a large flat low lying plain composed of silt, boulders, pebbles and gravel deposited at the mouth of the river.
- Examples of major deltas in Africa include; Nile delta in Egypt, Niger delta, Semliki delta, Omo delta e.t.c

Where as

- Alluvial fans are fan shaped deposits of gravel, silt and boulders left by the river as it emerges from a narrow valley on to a wide or gentle plain.
- Example include Lume fan by river Lume on Semliki plain on the west of Rwenzori, Kilombero fan by Kilombero River as it emerges from Uchungwe highlands.

Similarities between deltas and alluvial fans

- **In terms of shape,** both landforms open out in a funnel shape. That is, they are wide sea ward and narrow inland.
- **Composition,** both features consist of both coarse and fine sediments. The finest materials deposited furthest while the coarse ones lay near the apex.
- **Conditions of formation,** both features are formed where the gradient and velocity of river flow are low.
- Both landforms divide into smaller channels called distributaries.

Differences between deltas and alluvial fans

- Delta form at the river mouth or where the river enters the lake, sea or ocean
- Have marked distributaries

- Formed in the old stage of the river or senile stage.
- Deltas are associated with swamps, lagoons, spits and bars
- Deltas form where there are sheltered bays, no currents and obstruction
- Deltas are mainly made of fine sediments.

While

- Alluvial fans develop inland far away from the sea, lake or ocean
- They have less distinct distributaries
- They are some times formed in the youth full stage or torrent stage of the river.
- Alluvial fans are not associated with swamps, lagoons, spits and bars
- They have steeper gradient towards the apex
- They are mainly made of coarse materials
- Don't require sheltered bays, low tidal currents e.t.c which must prevail for the formation of deltas.

Examine the processes leading to the formation of deltas and the importance of deltas.

Approach

- ❖ Define a delta and give examples of major deltas
- ❖ Outline the conditions for delta formation
- ❖ Identify the three types of deltas
- ❖ Explain the positive and negative effects of deltas.

📖**Refer to the question above for conditions types and processes of delta formation.**

Positive Effects

- ▪Deltas and the associated land forms such as Lagoons and levees form beautiful scenery which promotes tourism; a major source of foreign exchange used for economic development for example the Nile delta in Egypt.
- ▪Deltas contain Fertile Alluvial soils which encourage crop cultivation for example in the Nile delta In Egypt.
- ▪Deltas are suitable sites for settlement and urbanization for example Cairo city in Egypt is found in the Nile Delta.
- ▪Deltas contain petroleum, a viable source of fuel for example Niger Delta and Rufiji Delta.
- ▪Lagoons in Deltas are suitable sites for small scale fishing.
- ▪Deltas especially in the tropics contain mangrove forests which support lumbering and building materials such as poles.
- ▪Deltas are water logged hence modify micro climate of the surrounding areas through evapo - transpiration.
- ▪Deltas are source of education material and research for example petroleum.

Negative Effects

- ▪Deltas are associated with water logging conditions which encourage breeding of disease vectors such as mosquitoes which cause malaria, Snails cause Bilhazia
- ▪Deltas are associated with floods during the wet season causing destruction crops and settlement.
- ▪Deposition of sediments in the river mouth makes navigation or water transport difficult.
- ▪Salinity of sea water and accumulation of sand in deltas discourage agriculture and settlement in deltas.
- ▪Swampy vegetation in the delta acts as habitant for dangerous animals such as crocodiles, snakes, and monkeys which discourage settlement.

DRAINAGE PATTERNS IN EAST AFRICA

With References to specific examples, explain the conditions which have favored the development of the following drainage patterns in East Africa.

Radial, Dendritic, Trellis, annual, Centripetal, Parallel

Approach

- ❖ Define drainage pattern
- ❖ State, define and describe each pattern

- ❖ Relate each pattern to; rock structure and nature of precipitation received in the catchment area.
- ❖ Draw relevant diagrams
- ❖ Give examples of rivers in each pattern

Answer Guide

Drainage pattern refers to the lay out /plan made by the river and its tributaries on the surface of the earth or drainage basin.

Major drainage patterns in East Africa include;

Radial pattern

▪This is a system where rivers and their tributaries flow outwards in all directions from **a central raised point** such as a dome or volcanic cone down wards. For example a volcanic mountain, ridge or highland

▪Radial pattern is associated with rivers originating from highland areas such as conical or dome shaped hills or mountain usually snow capped, with a crater or caldera.

Conditions for development;

▪Presence of a dome shaped uplands such as a volcanic mountain, ridge e.t.c to shed water in different directions.

▪**Nature of the slope.** Radial pattern develops in rivers flowing down slope in all directions on **steep slopes** in highlands.

▪**Rock structure**. Radial pattern develops in areas with hard homogenous rocks which offer uniform resistance and shape.

▪ Radial pattern also develops in areas receiving **heavy precipitation** in form of rain fall or glaciers in the catchment area to maintain stream flow until the pattern is complete.

Diagram

Examples include; rivers originating from mountain Rwenzori, Elgon, Kenya and Kilimanjaro, for Example River Sironko, Manafwa, Malaba and Nzoia on mountain Elgon.

DENDRITIC PATTERN

▪This is a system shaped like a tree where tributaries from many directions join the main river at **acute angles** (less than 90^0).

Conditions for development;

▪Rock structure. Dendritic pattern develops in areas with massive homogenous rocks which offer uniform resistance to erosion for example crystalline rocks such as granites.

▪The tributaries erode uniformly and join the main stream at acute angles.

▪Presence of heavy and reliable rainfall in the catchment area to maintain stream flow until the pattern is complete.

▪Relief. Dendritic pattern develops on gently dipping relief/slope to enable streams flow in one general direction.

Diagram

Examples of rivers displaying dendritic pattern include River Malagarasi, river Ruvuma and Rufiji in Tanzania, River Nzoia, Athi, Galana and Nyando in Kenya, River Okoth and Aswa in Northern Uganda.

ANNULAR PATTERN

▪This is a system where tributaries join the main stream at sharp angles but in a series of curves for example around a crater or caldera or around dissected dome.

Conditions for development;

▪The river must be flowing sharply in a series of curves in a volcanic area

▪There must be a dissected plateau /dome with alternating hard and soft rocks or ▪faulted zones where streams erode valleys in less resistant strata.

▪Presence of a dome/crater/basin.

- Presence of heavy and reliable rainfall to maintain stream flow until the pattern is complete.
- There should be a large catchment area.
- Rivers must flow in concentric curves

Diagram

Examples of rivers displaying this pattern include rivers flowing around Ngorongoro crater in Tanzania and around Lake Bosmutwi in Ghana

TRELLIS / rectangular DRAINAGE PATTERN

- This is a system where tributaries join the main river at approximately right angles (90^0). The main area is called the consequent river and the tributaries subsequent.

Conditions for development include;

- Rock structure. Trellis pattern develops in areas of heterogeneous rocks in alternating hard and soft rocks lying at right angel to the general slope.
- Nature of the slope. Trellis pattern develops on gentle slope for the main stream and steep sloping areas for the tributaries.
- Presence of reliable rainfall in the catchment area to maintain stream flow until the pattern is complete.
- There must be a large catchment area to provide ample water for streams to flow continuously
- Presence of fault lines created by faulting and joints in the rock along which tributaries flow until they join the main stream at approximately right angles
- Trellis pattern also develops in areas where river capture took place or takes place

Examples of rivers displaying this pattern include river Aworanga, Tochi and Achwa in Northern Uganda west of Gulu town, and river Kericho in Kenya.

CENTRIPETAL PATTERN

- This is a system where rivers flow in wards towards a depression or basin usually a lake from the surrounding higher/ raised areas.

Conditions for development include;

- Presence of a depression where rivers flow into from all directions
- The river flows in accordance to the slope of the land.
- Presence of heavy rainfall in the catchment area to maintain stream flow until the pattern is complete.
- Rivers flow on gentle slope down ward to the basin

Diagram

Examples of rivers displaying this pattern include river Katonga, Kagera and Nzoia flowing into Lake Victoria. River Molo, Ol Mulutan, Loboi and Arabel drain into Lake Baringo in Kenya.

PARALLEL PATTERN

- This is a system where the main river and its tributaries flow from the same water shed more or less parallel to each other.

Conditions for development include;

- **Rock structure**. Parallel pattern develops in areas of uniform or heterogeneous rocks
- **Relief**. It develops in areas of steep such as escarpment or gentle slopes.
- Develops in areas of **heavy rainfall** to supply water for stream flow until the pattern is complete.

Diagram

Examples of rivers displaying this pattern include river Nkusi and Hoima from mountain Rwenzori flow parallel to each other before joining Lake Albert.

To what extent has the nature of the rock influenced the development of drainage patterns in East Africa.

Approach

- Define the term drainage pattern
- state the major drainage patterns in East Africa
- Give the 1st evaluation and explain the role of rock structure

- Give the 2rd evaluation and explain the role of other factors

Answer Guide

▪Drainage pattern refers to the lay out/ plan made by rivers and their tributaries on the landscape.

The major drainage patterns in East Africa include radial, trellis, centripetal, annular e.t.c

▪The rock structure has influenced the development of drainage patterns to a large extent in the following ways;

▪Homogenous rocks /crystalline rocks like igneous have influenced the formation of dendritic and radial patterns.

▪Alternate belts of hard and soft rocks lying at right angels to the general slope influence trellis pattern.

▪Jointed, faulted rocks influence rectilinear pattern

▪Soft and hard rock bands laid side by side influence the development of parallel pattern.

Other factors that equally influence the development of drainage patterns in East Africa include;

Relief/ nature of the slope. That is

▪Gently dipping slopes influence dendritic patterns

▪Steep slopes on volcanic domes encourage radial pattern

▪Escarpments /steep slopes encourage parallel pattern.

Tectonic history of the area for example

▪Volcanicity led to formation of domes or highlands with craters which encourage radial drainage pattern.

▪Faulting influence rectilinear and parallel drainage patterns for example faulting produced rectilinear drainage pattern in Northern Uganda and parallel drainage pattern on Butiaba and Aberdare escarpments.

▪Warping influences centripetal pattern. For example up warping in western and Eastern Uganda and down warping in central Uganda facilitated centripetal in central Uganda. That is Lake Victoria.

Climate. That is most drainage patterns develop or pass in areas that receive adequate and reliable rainfall to maintain and enable streams complete the pattern.

River capture influences trellis pattern.

Account for the development of the following drainage patterns in East Africa

Dendritic, annular and rectangular

Approach

- Define each pattern
- State the conditions and
- Describe the process of formation
- Draw diagrams and give examples.

Answer guide

Dendritic pattern

📖Definition

Conditions for development;

▪It develops on massive homogenous rock structure. That is; rocks which offer uniform resistance to erosion for example crystalline rocks such as granites.

▪There must be heavy and reliable rainfall to maintain stream flow until the pattern is complete.

▪It develops on gentle slopes of sedimentary strata.

▪It also may also develop on massive crystalline rocks such as granites to enable streams flow in one general direction.

<u>Process of development of dendritic pattern</u>

▪There must be a consequent river (Main River) where the insquent streams develop from by head ward erosion.

▪Minor steams may also develop from insquent streams as obsquent streams.

▪Finally the pattern of the drainage develops resembling the branches of a tree.

Diagram

Examples of rivers displaying dendritic pattern include River Malagarasi, river Ruvuma Mara and Rufiji in Tanzania, River Nzoia, Athi, Galana and Nyando in Kenya, River Okoth and Aswa in Northern Uganda.

Annular

📖**Definition and Conditions for development**

Processes for the development of Annular pattern

It develops around dissected domes where subsequent streams are eroding valley in less resistant strata.

Streams follow circular courses around the dome, conforming to the weaker rock out crops and flow outwards.

Diagram

Examples include rivers that flow around Ngorongoro crater in Tanzania and around Lake Bosmutwi in Ghana.

Rectangular pattern

- This is a system where tributaries join the main river at approximately sharp right angles (90^0). It is similar to trellis only that streams tend to take sharp angular bends along their courses.
- It develops in faulted regions where rectangular cracks develop in the rock and rivers flow along such cracks or joints until they join the main stream at approximately right angles.

Conditions that favor the development of rectangular drainage pattern

- There must be reliable rainfall to enable rivers flow continuously.
- There must be a large catchment area to provide ample water for streams to flow continuously.
- Presence of heterogeneous rocks in alternating hard and soft rocks lying at right angle to the general slope.
- Found in fault zones and some times where river capture takes place.
- Rectangular pattern develops in areas of gently sloping landscape.

Process of development of rectangular pattern

- Develops in areas with alternate layers of hard and soft rocks (heterogeneous) that lie at right angles to the general slope down which the main river flows.
- The major and minor rivers flow in accordance with the slope direction.
- Obsquent streams flow in opposite directions to the slope joining other streams at right angles.
- It can also develop due to river capture where parallel rivers mainly drain water from others leading to abrupt change of direction hence angularity.

This pattern of development is facilitated by continuous flow or permanent flow of stream in an area with some reasonable rainfall.

Diagram

Examples include river Aworanga, Tochi and Achwa in Northern Uganda west of Gulu town and river Kericho in Kenya.

LAKES IN EAST AFRICA

A lake is a body or mass of water occupying a hollow or depression in the earth crust. Lakes are formed when water collects and accumulates in such depressions.

CLASSIFICATION OF LAKES

Lakes in East Africa are classified according to the mode of formation of the lake basin. Thus lakes are categorized into;

- Tectonic lakes- this category includes lakes produced by earth movements such as faulting and warping and volcanicity.
- Volcanic lakes - this category includes explosion crater lakes, caldera lakes and lava dammed lakes.
- Erosional lakes- this category includes glacial Erosional lakes such as tarns, rock basin and trough lakes.

- Depositional lakes- this category includes ex-bow lakes, lagoon lakes and moraine dammed and kettle lakes.
- Man-made lakes - this category includes lakes formed through mining, damming of rivers, fish ponds e.t.c
- Solution lakes- this category includes lakes produced chemical weathering in chalk and limestone areas.

LAKES FORMED BY EARTH MOVEMENTS

Earth movements can be defined as diastrophic movements caused by forces of compression, tension, up-lifting, warping, folding and faulting. They occur on a major scale and minor scale and can be both rapid and slow.

Tectonic/earth movements are caused by faulting and warping which influenced the formation of fault lakes and down-warped lakes respectively.

Lakes formed by faulting

Faulting is an endogenetic process in which the hard rocks of the earth crust are fractured and rocks are displaced on either side of the fault line. Faulting is caused by radio-activity and geo-chemical reactions in the earth's interior generating tensional, compressional and up-lift forces in the crust.

Faulting led to formation of **a rift valley**. Secondary faulting on the rift valley floor caused some parts to sink down hence forming depressions / hollows which later got filled with water to **rift valley lakes**.

Most rift valley lakes are long, narrow, deep and most of them are salty for example, lake Albert, George in Uganda, Turkana,Baringo,Nakuru,Naivasha and Magadi in Kenya, Natron, Manyara ,Eyasi, Rukwa and Tanganyika in Tanzania.

In some cases faulting was accompanied by tilting of land on one side to form tilt block landscape composed of angular ridges and depressions as in the case of step faulting. Water collected in the depressions to form tilt block lakes for example Lake Olbolossat found in Kenya on the western corner of the Aberdare ranges.

Lakes formed by down-warping / crustal warping

Warping is the gentle bending of the earth crust upwards and down wards. (Up-warping and Down warping).

In East Africa convective currents sinking back into the mantle pulled down the central region of the East African plateau leading to the formation of a wide and shallow depression.

At the same time, crustal up-warping by rising convective currents in western and Eastern Uganda caused river reversal into the depression forming lakes such as Victoria, Kyoga and Wamala in Uganda.

Down warped lakes tend to be large, shallow with irregular and swampy shore lines, numerous bays and inlets.

Lakes produced by volcanicity/ volcanic lakes

Volcanicity is the process through which gases and molten rock/magma are extruded onto the earth's surface under high pressure. Volcanic lakes include explosion crater lakes, caldera lakes, crater lakes and lava dammed lakes.

Explosion crater lakes -are formed from violent gaseous explosion that removes the over lying crystalline rocks to form wide circular depressions which are filled with water from rain, internal springs and rivers for example Lake Katwe, Kasenyi, Kikorongo in Queen Elizabeth, Rutoto, Nyamsingire, Nyungu and Nyamunuka, all in south western Uganda.

Caldera lakes- are formed due to violent eruption blowing off the top of a volcano or subsidence of top of the volcano into the chasm/vent to create a huge, wide and a circular depression filled with water from rain fall and glaciers for example Lake Ngozi, south East of Mbeya Embagai and Ngorongoro, all in Tanzania.

Crater lakes- produced by a violent eruption which blows off the top of a volcano to form a small and circular depression filled with water to form a lake. They are found on the summit of dormant

and extinct volcanoes for example Lake Katungi in Bushenyi, Gisozi in Kisoro, crater lake on Mount Elgon, Kenya, Kilimanjaro and Muhavura, Menengai crater in Kenya's rift valley and Lake Simbi in south- Nyanza district (Kenya) and Lake Paradise on the summit of mount Marsabit. Crater lakes are usually very small.

Lava dammed lakes – are formed when basic lava from an erupting mountain blocks the river valley; causing back ponding behind the lava dam to form a lake for example Lake Bunyonyi, Mutanda, kyahifi, kayumbo and Murehe, in Kigezi south western Uganda, Lake Saka in Fort Portal.

Lakes produced by erosion.

This category consists of lakes produced by glacial erosion, through plucking, abrasion and ice wedging, creating hollows and traps which are filled with water to form cirque lakes, rock basin rocks and trough lakes.

Cirque / Tarn lakes -are formed in the arm-chair like depressions existing in the sides of glaciated mountain due to niviation, plucking, abrasion and back wall recession. For example, Lac du Speke, Lac Catherine, lake kitandara and Bujuku, on mount Rwenzori. Tyndal tarn, Teleki, Hidden, Gallery and Thompson tarns on Mount Kenya , Kalanga and Mawenzi tarn on Mount Kilimanjaro.

Diagram showing the formation of tarn lakes

Rock basin lakes -are formed by the scouring action of ice resulting into shallow hollows which are filled with water. They are formed where rocks are easily eroded or where the valley becomes narrow. For example Lac Vert and Lac Noir in the upper floor of Kamusoso valley on mountain Rwenzori, Lake michealson, Carr and Encharted lakes on mountain Kenya.

Diagram showing the formation of a rock basin lake

Trough lakes -are formed in the elongated hollows excavated on the floor of u-shaped valleys. They are common on Mount Kenya where numerous glacial troughs exist for example Teleki, Hobly gorges and mickinder.

Lakes produced by deposition

They are formed when depositional materials block the channel or inlet of some kind thus trapping water to form a lake.

This category consists of lakes produced by river deposition, glacial deposition, wave deposition, coral deposition and deposition by landslides as shown below;

Lakes produced by river deposition. That is ox-bow and delta lakes.

Ox-bow lakes are formed by rivers meandering on the flood plain in the lower course. **Ox-bow lake** are formed when the original meander is cut-off from the main channel due to erosion on the concave side (outside bank) and deposition on the convex side (inner bank) of the river channel to produce a meander neck.

When the river floods, the meander neck is broken through and the river flows straight hence bypassing the meander; which is now cut off and sealed by deposits to form ox-bow lakes for example on the lower course of River Tana at Garisa, River Semliki in western Uganda, River Rwizi at Mbarara, River Nzoia&Nyando on the kano plains of Kenya and River Rufiji in Tanzania.

Diagram showing the formation of an Ox-bow lake

Delta lakes - are formed in the delta found on the flood plain where alluvial deposits form levees which prevent flood water from getting back into the river and its tributaries ,for example Lake Magomeni and Lake Mwananyamara on river Sinza and Luhanga in Tanzania.

Lakes produced by glacial deposition

That is, moraine dammed lakes and kettle lakes.

Moraine dammed lakes- are formed when terminal moraine blocks the river valley and the water from the melting glacier was trapped and accumulated behind the moraine barrier to form a lake for example Lac Gris on mountain Rwenzori, Lake Hohnel and Hut tarn on mountain Kenya.

Kettle lakes- are formed when the mass of ice enclosed in a terminal moraine melts away and a depression is created on the top of an out wash plain in the glaciated lowland. The depression was

filled with water to form a small lake for example Lake Mahoma at the junction between Mubuku and Bujjuku rivers on mountain Rwenzori.

Lakes produced by wave deposition

Lagoon lakes -are formed when long shore drift/ strong wind moves materials and deposit them along the beach or build sand bars and spits which enclose water to form a lagoon lake cut off completely from the main lake. For example lake Nabugabo on the western shores of Lake Victoria was formed when a bar cut-off part of Lake Victoria near Bukakata.

Coral Deposition along the East African coastline enclosed water to form lagoon lakes for example at Mombasa and Dar-es-salaam.

Depositional lakes produced by mass-wasting /landslides. Rock waste / debris may slump or slide blocking the river valley to form a lake for example Lake Mbaka in Tanzania, Lake Bujuku and Lake Nyabihoko.

MAN MADE LAKES

Man made lakes- are formed through man's activities such as;

Mining of sand and clay through open cast method creates depressions which are filled with rain water to form lakes for example Lake Kajjansi near Lake Victoria on Entebbe road.

Damming of the river valley for hydro electricity generation and irrigation creates lake reservoirs on the upstream end of the river. For example lake Kindaruma and Kamburu on the Tana River in Kenya, reservoirs on river Kibimba in Eastern Uganda

Excavation lakes -are formed when man intentionally digs a lake for recreation purposes for example Kabaka's lake in Ndeba and Omugabe's lake in Mbarara, valley dams, fish pond lakes, lakes in pastoral areas , near swamps e.t.c

Solution lakes

Solution Lakes are formed when water fills pits /hollows left behind by carbonation in lime stone area. They exist in Nanyuki in Kenya and Nyakasura in Fort portal.

Account for the formation of lakes in East Africa

- Define a lake
- Identify the processes responsible for formation of lakes in East Africa
- Describe the lakes produced by each process. That is;

Tectonic lakes. This category includes Rift valley lakes- produced by faulting; tilt block lakes, down warped lakes and volcanic lakes such as caldera, explosion crater lakes, and lava dammed

Erosional lakes- produced by glaciers for example cirque lakes, rock basin lakes and trough lakes.

Depositional lakes- produced by rivers, waves and mass wasting leading to Ox-bow lakes Delta, Moraine dammed lakes, Kettle lakes, Lagoon lakes, Coral Deposition and mass-wasting /landslides

Damming of the river channel by man for generation of hydro power

Chemical weathering produced -solution lakes

TECTONIC LAKES

To what extent are the lakes in East Africa a result of tectonic movements?

Approach

- Define a lake and tectonic movements
- Give the 1St evaluation (larger) and describe the lakes produced by faulting, down warping and volcanicity
- Give the 2rd evaluation (small) and explain other processes responsible for lake formation in East Africa like erosion, deposition, man-made lakes and solution lakes.
- Draw diagrams and give examples where applicable.

Answer guide

A lake is a body or mass of water occupying a hollow or depression in the earth crust.

Tectonism is a general term used to refer to all processes that originate from the vertical, tensional and compressional forces generated by the vertical and horizontal flow of convective currents underneath the crust due to radio- activity and geo-chemical reactions in the interior of the earth.

- Tectonic movements are to a larger extent responsible for formation of lakes in East Africa through, faulting, warping and volcanicity. That is;
- Faulting led to formation of rift valley lakes and tilt block lakes.
- Down warping led to formation lakes Victoria, Kyoga and Wamala.
- Volcanicity led to formation of crater lakes, caldera lakes, explosion crater lakes and lava dammed lakes.

Other processes to a smaller extent are responsible for formation of lakes for example, erosion, deposition, man made lakes and solution lakes.

🕮 **Remember to explain these processes**

To what extent have earth movements been responsible for the formation of lakes in East Africa?

Approach

- ❖ Define a lake and earth movements
- ❖ Give the 1St evaluation and describe the lakes produced by faulting and warping
- ❖ Give the 2r d evaluation and explain other processes responsible for lake formation in East Africa like volcanicity, erosion, deposition, man-made lakes.
- ❖ Draw diagrams and give examples where applicable.

Answer guide.

A lake is a body or mass of water occupying a hollow or depression in the earth crust.

Earth movements can be defined as diastrophic movements caused by forces of compression, tension, up-lifting leading to faulting, warping and folding.

Earth movements occur on both major scale and minor scale and can be both rapid and slow.

Earth movements to a larger extent responsible for formation of lakes in East Africa Earth movements are caused faulting and warping which influenced the formation of fault lakes and down-warped lakes respectively as explained below.

Lakes formed by faulting

Faulting is an endogenetic process in which the hard rocks of the earth crust are fractured and rocks are displaced on either side of the fault line. Faulting is caused by radio-activity and geo-chemical reactions in the earth's interior generating tensional, compressional and up-lift forces in the crust.

Faulting led to formation of **a rift valley**. Secondary faulting on the rift valley floor caused some parts to sink down hence forming depressions / hollows which later got filled with water to **rift valley lakes**.

Most rift valley lakes are long, narrow, deep and most of them are salty for example, lake Albert, George in Uganda, Turkana,Baringo,Nakuru,Naivasha and Magadi in Kenya, Natron, Manyara ,Eyasi, Rukwa and Tanganyika in Tanzania.

In some cases faulting was accompanied by tilting of land on one side to form tilt block landscape composed of angular ridges and depressions as in the case of step faulting. Water collected in the depressions to form tilt block lakes for example Lake Olbolossat found in Kenya on the western corner of the Aberdare ranges.

Lakes formed by down-warping / crustal warp

Warping is the gentle bending of the earth crust upwards and down wards. (Up-warping and Down warping).

In East Africa convective currents sinking back into the mantle pulled down the central region of the East African plateau leading to the formation of a wide and shallow depression.

At the same time, crustal up-warping by rising convective currents in western and Eastern Uganda caused river reversal into the depression forming lakes such as Victoria, Kyoga and Wamala in Uganda.

Down warped lakes tend to be large; shallow with irregular and swampy shore lines, numerous bays and inlets.

Other processes to large extent responsible for formation of lakes include;

Volcanicity- led to formation of volcanic lakes such as explosion crater lakes, caldera lakes and lava dammed lakes.

Erosion- glacial erosion led to formation of tarns, rock basin and trough lakes.

Depositional – led to formation of ex-bow lakes, lagoon lakes and moraine dammed and kettle lakes.

Damming of the river channel for hydro- power generation

Chemical weathering led to the formation of Solution lakes in chalk and limestone areas.

🕮 **Remember to explain these processes.**

DEPOSITIONAL LAKES

To what extent are lakes in East Africa a result of depositional processes?

Approach

- Define a lake and identify the depositional processes that created lakes in East Africa.
- Give the 1St evaluation (large) and describe the lakes produced by depositional processes
- Give the 2r d evaluation(larger) and explain other processes responsible for lake formation in East Africa like faulting, down warping, volcanicity and erosion
- Draw diagrams and give examples where applicable.

Answer guide.

A lake is a body or mass of water occupying a hollow or depression in the earth crust.

Depositional processes to a large extent responsible for formation of lakes through river deposition, glacial deposition, wave deposition and mass wasting as explained below.

River deposition led to formation of ox-bow lakes and delta lakes

Glacial deposition led to formation of moraine dammed lakes and kettle lakes.

Coral and Wave deposition led to formation of lagoon lakes.

Damming of the river valley by landslides

Other processes to a larger extent are responsible for formation of lakes for example, faulting, warping, volcanicity, erosion, and chemical weathering

🕮 Remember to explain these processes.

EROSIONAL LAKES

To what extent are lakes in East Africa a result of Erosional processes?

Approach

- Define a lake and identify Erosional processes that created lakes in East Africa.
- Give the 1St evaluation(small) and describe the lakes produced by Erosional processes
- Give the 2r d evaluation(larger) and explain other processes responsible for lake formation in East Africa
- Draw diagrams and give examples where applicable.

Answer guide.

A lake is a body or mass of water occupying a hollow or depression in the earth crust.

Erosional processes to a small extent responsible for formation of lakes through glacial erosion as explained below.

This category consists of lakes produced by glacial erosion, through plucking, abrasion and ice wedging, creates hollows and traps which are filled with water to form cirque lakes, rock basin rocks and trough lakes.

Cirque / Tarn lakes -are formed in the arm-chair like depressions existing in the sides of glaciated mountain due to niviation, plucking, abrasion and back wall recession. For example, Lac du Speke, Lac Catherine, lake kitandara and Bujuku, on mount Rwenzori. Tyndal tarn, Teleki, Hidden, Gallery and Thompson tarns on Mount Kenya , Kalanga and Mawenzi tarn on Mount Kilimanjaro.

Diagram showing the formation of tarn lakes

Rock basin lakes- are formed by ice scouring action resulting in shallow hollows that are filled with water. They are formed where rocks are easily eroded or where the valley becomes narrow. For example Lac Vert and Lac Noir in the upper floor of Kamusoso valley on mountain Rwenzori, Lake michealson, Carr and Encharted lakes on mountain Kenya.

Diagram showing the formation of a rock basin lake

Trough lakes - are formed in the elongated hollows excavated on the floor of u-shaped valleys. They are common on Mount Kenya where numerous glacial troughs exist for example Teleki, Hobly gorges and mickinder.

Other processes to a larger extent are responsible for formation of lakes for example, faulting, warping, volcanicity, deposition and chemical weathering

GLACIAL LAKES

To what extent are lakes in East Africa a result of glaciation?

Approach

- Define a lake and identify the glacial processes that created lakes in East Africa.
- Give the 1St evaluation (large) and describe the lakes produced by glacial Erosional and depositional processes.
- Give the 2rd evaluation (larger)and explain other processes responsible for lake formation in East
- Draw diagrams and give examples where applicable.

Answer guide

Describe the lakes produced by glacial erosion and deposition for example;

Glaciation through erosion, by plucking, abrasion and ice wedging, creates hollows and traps which are filled with water to form cirque lakes, rock basin rocks and trough lakes.

Glaciation deposition led to formation of moraine dammed lakes and kettle lakes.

Other processes to a larger extent are responsible for formation of lakes for example, faulting, warping, volcanicity, deposition and chemical weathering

🕮 **Remember to explain these processes**

Account for the formation of either Lake Albert or Lake Magadi.

Approach

- Define a lake
- Select one lake and state the category,
- Identify and describe the process of its formation
- State the characteristics.
- Draw diagrams

Answer guide

A lake is a body of water contained in a hollow or depression.

Lake Albert is a rift valley lake formed as a result of faulting- an endogenetic processes in which the hard rocks of the earth crust are fractured and rocks are displaced on either side of the fault line.

The faulting that formed Lake Albert was a result of heating by radioactive decay and geo-chemical reactions in the core and mantle; resulting into development of convective currents which stressed, strained and fractures the crust in form of tensional and compressional forces respectively.

THEORIES FOR FORMATION OF LAKE ALBERT

That is; tensional theory, compressional theory, differential uplift theory e.t.c

According to tension force theory; heating by radioactive decay and geo-chemical reactions produced convective currents,

When convective currents reached the earth crust they diverged leading to development of tensional forces that caused normal faulting in the crust.

Side blocks moved away from each other while the middle block sank under its own weight.

Continued convective currents resulted into secondary faulting and secondary sinking of rift valley floor to form depression (secondary depression or hollow)

Hollow was filled by water from streams and rivers like Semliki, muzizi, Nkusi, Victoria Nile e.t.c as well as rain water.
The lake formed is deep, with steep banks, elongated, with regular shoreline.
Diagram
According to compression theory; there was heating by radioactivity and geo-chemical reactions that resulted into convective currents
When convective currents reached the earth crust, they tended to converge leading to compressional forces that led to reverse faulting.
The side-way blocks tended to override the middle block which remained below as rift valley.
As convective currents continued, there was secondary faulting that resulted into formation of secondary depression or hollow.
Hollow was filled with water from streams and rivers like Semliki, Muzizi, Nkusi, Victoria Nile e.t.c as well as rain water.
The lake formed is deep, with steep banks, elongated, with regular shoreline.
Diagram
According to differential up-lift theory, in the interior of earth, there was heating by radioactivity and geo-chemical reactions leading to convective currents.
The convective currents resulted into faulting that divided the earth crust into blocks. Side blocks rose faster while the middle block rose slowly to form the rift valley.
As convective currents continued rising, there was secondary faulting of part of the rift alley floor that resulted into secondary up-lift that formed a secondary depression or hollow.
Hollow was filled with water from streams and rivers like Semliki, muzizi, Nkusi, Victoria Nile e.t.c as well as rain water.
The lake formed is deep, with steep banks, elongated, with regular shoreline
Diagram
Note. Lake Magadi should be treated in a similar way.
Lake Magadi has the following characteristics.
Elongated, narrow, steep banks, salty, has internal drainage with seasonal streams and shallow.
Other theories may be discussed but at least any two theories should be given

CORAL LANDFORMS IN EAST AFRICA

Account for the formation of coral landforms in East Africa
Approach

- Define clearly coral landforms
- Describe the process of formation
- Identify the types
- Explain conditions which favor their formation in East Africa
- Explain the theories put forward to explain the formation of coral landforms

Answer guide
Coral landforms/ reefs are offshore limestone rock platforms formed by continuous deposition and accumulation of shells or skeletons of small marine organisms known as coral polyps.
Polyps are minute living organisms rich in calcium carbonate and when they die; their skeletons get deposited and accumulate on the continental shelf where they are compacted and cemented together to form coral reefs.
The processes of coral formation therefore involve;
▪The death of coral polyps and deposition of skeletons rich in calcium carbonate on the continental shelf
▪Over time, the coral deposits increase in weight, become compressed and compacted and cemented together

▪In this way, large banks of consolidated rocks are gradually built up, called coral reefs
▪The process of cementation and consolidation of coral reefs is facilitated by other organisms such as algae (calcareous algae) and echinoderms.
▪The nature of the coral landforms formed depends on the position and shape of the landmass on which they have accumulated. Thus there are three types of coral reefs namely; fringing, barrier and atoll

Types of coral reefs

Fringing reef - a narrow coral platform of about one kilometer wide joined to the coast or separated from it by a shallow lagoon which may disappear at low water level.
▪A fringing reef is formed very close to the coast with its leeward edge sloping steeply into the sea floor.
▪Fringing reefs can be seen at the East African coast near Kilifi, Tiwi and Mombassa in Kenya and Oyster Bay at Dar es Salaam in Tanzania.

Diagram

Barrier reef - a wide coral plat form formed much farther or several kilometers from the coast and separated from it by a much deeper and relatively wider lagoon.
▪Barrier reefs can be cited at Mayotte Island between Mozambique and Madagascar.

Diagram

An atoll is a circular shaped coral reef surrounding a wide and fairly deep flat-floored lagoon and generally broken in places by narrow channels.
Atolls are formed very far from the coast for example Aldabra atoll reef lies 700 km off the coast of East Africa, Chumbe Island found on Zanzibar

Diagram

Conditions that favor development of coral reefs

The growth and development of coral landforms along the East African coast is facilitated by;
▪Warm temperatures of tropical climate between 20^0c-30^0c ideal for growth of coral polyps. This applies to areas 30^0 N and south of the equator for example Indian Ocean coast
▪ Availability of salty, well oxygenated seawater with a salinity level of 27-40 parts per 1000 parts of ocean water provides adequate calcium carbonate taken up from sea water by coral polyps used to build and harden their shells /skeletons.
▪Existence of clear, silt free and calm water away from river mouth allows coral growth.
▪Existence of shallow continental shelf with depth less than 60 meters allows penetration of sun light to the sea bottom. This enables planktons on which polyps feed to carry out photosynthesis.
▪Presence of plentiful supplies of planktons on which polyps feed and survive
▪Presence of solid rock bed along the coast upon which coral reefs grow. A continuous continental shelf along the coast is ideal for the growth of coral reefs.
▪Occurrence of sea-level changes/ isostatic adjustments. That is, increase in the sea level encourages coral deposition while a fall in the sea level exposes the coral reefs.
▪Presence of calm/ stable water hence no strong waves such as typhoons to destabilize normal growth and accumulation of coral reefs.
▪Presence of coral polyps in abundance which when die; deposit skeletons of calcium carbonate which accumulate to form coral landforms.
▪The warm Mozambique Ocean current that washes the East African coast helps to maintain the temperatures of the Indian Ocean and thus enables the polyps to survive.

Theories of coral reef formation

The formation of barrier reefs and atolls has created a lot of controversy as they have been found at far greater depths, in some areas exceeding 1000 meters; a level where polyps cannot survive. As a result, relevant theories have been put forward to explain this anomaly. That is subsidence theory, deglaciation theory and antecedent theory.

Subsidence theory by Charles Darwin 1842

Charles Darwin explained that the process of coral formation was gradual and occurred due to subsidence of a volcanic island.

Darwin's theory explains that volcanic eruption formed a volcanic island on the ocean floor.

Coral polyps established and colonized the edge of the volcano hence formed a fringing reef.

The volcanic island slowly subsided due to isostatic re-adjustments that followed eruption. Such subsidence increased the depth of water beyond the level at which coral polyps could survive.

Consequently, some polyps died while others survived on the flanks/ sides and started to grow to keep pace with the changes in the water depth.

The polyps that survived grew vigorously upwards and outwards and in the process transformed into barrier reefs and eventually into atolls when the volcano completely submerged.

N.B. the diagrams should show the upward ad outward growth.

Deglaciation theory by Daly

Daly based his theory on the sea level changes during and after the ice age, not subsidence of the volcanic island.

According to Daly, before the ice age or glaciation, fringing corals colonized the edge of a Marine Island due to warm water and other conditions that favor coral growth and development.

During the ice age/glaciation, a lot of water was locked up in ice-sheets and caused a fall in the sea level. The cold conditions killed some coral polyps while maximum erosion removed the top of the island and the reef to form a wave cut platform.

After the ice age, the return of warm conditions resulted into deglaciation, a rise in the sea level and growth of corals.

As sea level increased, the polyps that survived on the flanks of the wave cut platform grew vigorously upwards and outwards to keep pace with the changes in the water depth and be maintained at the surface water.

Through this process, coral reefs that colonized the flanks gradually transformed into barrier reefs and finally into atolls when the island/ wave cut platform submerged completely.

Diagram

Antecedent theory by sir john Murray

According to Murray, there existed stable submarine plat forms on which pelagic deposits including corals accumulated at a depth below 60 meters. Barrier reefs and atolls began to form on these platforms as fringing reefs.

As reefs grew upwards and outwards, they were pounded by waves such that masses of coral fragments accumulated on the seaward side; cemented and consolidated into hard reefs .The polyps inside the reef however died due to lack of food and their skeletons dissolved in water to form a lagoon inside the reef.

This changed the barrier reef in to atoll.

Diagram

Examine the relevance of Darwin's theory to the understanding of the formation of coral landforms in East Africa.

Approach

- Define clearly coral landforms
- Describe the process of formation
- Identify the types
- Explain conditions which favor their formation in East Africa
- Explain the formation of coral reefs with reference to Darwin's theory.

Theories put forward to explain the formation of coral reefs.

The formation of barrier reefs and atolls has created a lot of controversy as they have been found at far greater depths, in some areas exceeding 1000 meters, a level where polyps cannot survive. As a result, relevant theories have been put forward to explain this anomaly including Darwin's theory of subsidence

Subsidence theory by Charles Darwin 1842

Charles Darwin explained that the process of coral formation was gradual and occurred due to subsidence of a volcanic island.

Darwin's theory explains that volcanic eruption formed a volcanic island on the ocean floor.

Coral polyps established and colonized the edge of the volcano hence formed a fringing reef.

The volcanic island slowly subsided due to isostatic re-adjustments that followed eruption. Such subsidence increased the depth of water beyond the level at which coral polyps could survive.

Consequently, some polyps died while others survived on the flanks/ sides and started to grow to keep pace with the changes in the water depth.

The polyps that survived grew vigorously upwards and outwards and in the process transformed into barrier reefs and eventually into atolls when the volcano completely submerged.

N.B. the diagrams should show the upward ad outward growth.

Relevance of the theory

▪The theory is relevant because there was actual submergence of the East African coastline evidenced by presence of rias such as Mombassa and mud flats in submerged coastal areas.

▪Volcanic islands are also present off the coast of East Africa in Indian Ocean.

Examine the relevance of Daly's theory to the understanding of the formation of coral landforms in East Africa.

Approach

- Define clearly coral landforms
- Describe the process of formation
- Identify the types
- Explain conditions which favor their formation in East Africa
- Explain the formation of coral reefs with reference to Daly's theory

Theories put forward to explain the formation of coral reefs.

The formation of barrier reefs and atolls has created a lot of controversy as they have been found at far greater depth, in some areas exceeding 1000 meters, a level where polyps cannot survive. As a result, relevant theories have been put forward to explain this anomaly including Daly's theory of deglaciation

Deglaciation theory by Daly

Daly based his theory on the sea level changes during and after the ice age, not subsidence of the volcanic island.

According to Daly, before the ice age or glaciation, fringing corals colonized the edge of a Marine Island due to warm water and other conditions that favor coral growth and development.

During the ice age/glaciation, a lot of water was locked up in ice-sheets and caused a fall in the sea level. The cold conditions killed some coral polyps while maximum erosion removed the top of the island and the reef to form a wave cut platform.

After the ice age, the return of warm conditions resulted into deglaciation, a rise in the sea level and growth of corals.

As sea level increased, the polyps that survived on the flanks of the wave cut platform grew vigorously upwards and outwards to keep pace with the changes in the water depth and be maintained at the surface water.

Through this process, coral reefs that colonized the flanks gradually transformed into barrier reefs and finally into atolls when the island/ wave cut platform submerged completely.

Diagram

Relevance of the theory

▪Daly's theory explains why lagoons at the coast of East Africa have fairly flat floors.

▪The coast of East Africa has experienced sea level changes as evidenced by submergence landforms like rias, estuaries, creeks and emergent landforms like raised beaches, cliffs e.t.c

Examine the relevance of Murray's theory to the understanding of the formation of coral landforms in East Africa.

Approach

- Define clearly coral landforms
- Describe the process of formation
- Identify the types
- Explain conditions which favor their formation in East Africa
- Explain the formation of coral reefs with reference to Murray's theory.

Answer guide

Theories put forward to explain the formation of coral reefs.

The formation of barrier reefs and atolls has created a lot of controversy as they have been found at far greater depths, in some areas exceeding 1000 meters, a level where polyps cannot survive. As a result, relevant theories have been put forward to explain this anomaly including Murray's theory

Antecedent theory by sir john Murray

According to Murray, there existed stable submarine plat forms on which pelagic deposits including corals accumulated at a depth below 60 meters. Barrier reefs and atolls began to form on these platforms as fringing reefs.

As reefs grew upwards and outwards, they were pounded by waves such that masses of coral fragments accumulated on the seaward side; cemented and consolidated into hard reefs .The polyps inside the reef however died due to lack of food and their skeletons dissolved in water to form a lagoon inside the reef.

This changed the barrier reef in to atoll.

Relevance of the theory

▪John Murray's theory is relevant because it helps to explain why barrier reefs and atolls are found in deep water over 60 meters deep.

Economic importance of coral reefs

Positive

▪Coral reefs are tourist attractions because of their beautiful shapes and color which make them unique hence a source of foreign exchange for Kenya and Tanzania. For example fringing reefs at Bamburi, Shungyu in Dar es Salaam.

▪Coral reefs contain limestone which is extracted for production of cement used in construction works for example Bamburi cement.

▪Coral reefs are source of education material and research. For example in the field of oceanography, geomorphology and search for oil prospects.

▪Coral reefs weather down into fertile soils which support crop cultivation for example coconuts, mangoes, citrus fruits and cashew nuts and cloves in Pemba, Mombasa and Zanzibar.

▪Coral reefs contain limestone used in manufacturing fertilizers rich in calcium carbonates hence boosts crop cultivation.

▪Fringing reefs have favored the development of ports by protecting the harbor from destructive waves which would otherwise have destroyed the coast through flooding. For example port Mombasa and Dar es Salaam.

▪Fringing reefs also protect beach swimmers from dangerous marine organisms such as crocodiles and hippos because they find it difficult to cross the reefs to the beach. This promotes tourism.

▪Coral reefs are potential areas for mining oil because they contain a lot of fats which sip down and accumulate into rock strata to form oil wells.

▪Fishing is carried out in the coral lagoons. For example fish, crabs and lobsters

▪Lagoons are also used for recreation purposes such as swimming and sun bathing especially tourists.

Negative effects

▪Coral reefs weather down into poor sandy soils which discourage growing of other crops apart from coconut and cloves.
▪Fringing and barrier reefs are obstacles to marine transport and fishing because they form hard projecting rocks which wreck ships, fishing boats and nets.
▪Coral lagoons are colonized by mangrove vegetation during the low tides leading to spread of disease vectors such as mosquitoes which cause malaria.
▪Fringing reefs limit the size of docking area at Mombasa and Dar es Salaam Ports which results into congestion of ships and limited space for ocean wagons.

SEA LEVEL CHANGES OR EUSTATISM

(a) Explain the causes of sea-level change in the coastal areas.
(b)Examine the landforms resulting from sea level changes.
Approach

- Define sea level change and state the types of sea level changes
- In part (b) Identify and describe the formation of both submerged and emerged coastal landforms in highland and low land areas
- Draw diagrams and give examples where applicable from East Africa and outside East Africa.

Answer guide
Sea level changes refer to the rise and fall of the sea level in relation to the land along the coastal areas. **Alternatively, sea level changes can be defined as** the vertical movement of land relative to the sea along the coastal regions.
When sea level changes occur worldwide is called **eustatic or major change** and when it occurs on minor or local scale is called **isostatic change**.

TYPES OF SEA LEVEL CHANGES

Sea level changes are either positive or negative. Positive eustatism/ change occurs when the sea level rises in relation to the land and produces submerged coasts and their related landforms.
Negative eustatism/ change occurs when the sea level falls in relation to the land and produces emerged coasts and their related landforms.

CAUSES OF SEA LEVEL CHANGES

Sea level changes are caused by climate, glaciation and deglaciation, Change in ocean temperatures, Occurrence of earth movements, deposition of sediments and global warming.
Climatic changes. Pluviation period characterized by heavy rain fall such as El-Nino and monsoon lead to the rise in sea level while desiccation/ prolonged drought period leads to a fall in sea level.
Glaciation and deglaciation. Glaciation during the last ice age caused a fall in sea level because huge quantities of water froze into ice on high mountains and ice-sheets in Polar Regions. Deglaciation during the inter-glacial period characterized by warmer conditions, melted thick ice sheets from continental landmasses, forming rivers; which drained huge volumes of water into the sea; leading to a rise in the sea level.
Change in ocean temperatures. When world temperatures increase for example due to volcanicity on the ocean floor, water in oceans expands and the volume of water increases causing a rise in sea level. On the other hand when temperature falls for example during winter, water in oceans contracts and the volume falls; leading to a fall in sea level relative to the land.
Influence of global warming**.** The steady rise in the average temperature over the surface of the earth is affecting climate by melting ice on continental landmasses, bringing erratic rains and flooding hence the rise in sea level.
On the other hand, global warming is accelerating evaporation and aridity leading to the fall in sea level.
Occurrence of earth movements/ tectonic movements at the coast. Earth movements are forces that originate from the interior of the earth due to plate tectonism for example faulting, warping and volcanism.

Earth movements are responsible for sea level changes in the following ways;
▪Warping movements-up- warping / up lifting of coastal areas and down warping of ocean basins leads to a fall in sea-level while up-warping of ocean basins and down-warping of coastal areas leads to a rise in sea level.
▪Occurrence of Volcanicity on ocean floor. Volcanoes formed where tectonic plates meet at convergent boundary/ subduction zones, displace water in oceans up-wards causing a rise in sea level.
▪Plate tectonism. The divergence of oceanic plates at mid-ocean ridges leads to expansion/ widening of ocean floor and a fall in sea level.
Other hand, convergence of tectonic plates leads to contraction/ narrowing of ocean floor and a rise in sea level.
▪Faulting in coastal areas leads to down thrust of some parts causing a fall in the sea level.
Isostatic readjustments. When huge quantities of materials are added on to continental landmasses for example ice sheets during the quaternary era, increase the weight of continents forcing them to sink down slowly, displacing water upwards hence a rise in sea level.
▪Deglaciation of huge ice sheets and erosion on the continental landmasses reduces the weight of continents and cause isostatic uplift of landmass which ultimately leads to a fall in sea level.
▪Deposition of sediments on the ocean floor such as alluvium by rivers**,** construction works in water, cultivation along the coast e.t.c reduces the size of the ocean basin, displaces water upwards leading to the rise in sea level.

LAND FORMS PRODUCED BY SEA LEVEL CHANGES

(b)When the sea level rise in a highland coast, the coast is submerged and the following landforms are created;
Rias. A ria is a funnel shaped drowned river valley at the sea. Before submergence, the river flows into the ocean through a valley. When the sea level rise, the river valley is flooded or submerged at the sea to form a ria.
Rias are wider and deeper seawards and narrower and shallower landwards which gives them a funnel shape.
Rias are formed on coastlands where hills and river valleys meet the sea approximately at right angles for example Kilindini harbor on which Mombasa port is established, Mtwara, Tanga, Dar es Salaam, Lamu e.t.c along the East African coast. Rias also found on southern shores of Lake Victoria.
Dalmatian coast/ longitudinal coastline. This is a coast with a chain of off islands running parallel to it. A Dalmatian coast is Formed in areas where elongated hills / ridges and valleys lie parallel to the coast before submergence.
When the sea level rises, valleys are flooded or submerged to form sounds while the un submerged hilltops form a chain of islands running parallel to the coast line. The submerged valleys/ sounds separate islands from the main land to form a dalmatian coast. For example, Smith sound on the southern shores of Lake Victoria at Mwanza, Bamburi hills south of Bukoba on Lake Victoria, Dalmatian coast of Pemba and Zanzibar islands of Tanzania e.t.c.
Fiords are drowned u-shaped glacial troughs with steep walls seawards in highland coasts. Fiords are Formed when sea level rises and floods glacial troughs/ valleys formed initially by glaciers over deepening the valleys below sea level. Fiords have steep sides and deeper seawards. For example the coast of Norway, British Columbia, southern Chile e.t.c
Peninsulas. A peninsular is an elongated piece of land projecting seawards. They are formed in areas where highlands lie at right angles to the coast. When the sea level rises, valleys are flooded / submerged leaving elongated pieces of land projecting seawards. For example Entebbe peninsular and Mweya peninsular.
Submerged lowland coasts. When a lowland coast is submerged the following landforms are produced:

Estuaries- are submerged river valleys in lowland coasts with a v-shaped cross profile pointing landwards. They are Formed when sea level rise along a lowland coast causing the sea to penetrate inland to a considerable distance along river valleys. They are wider and deeper landwards. For example river Rufiji in Tanzania, river kibanga at Mombasa, estuaries of Thames e.t.c

Creeks -are narrow inlets at the coast formed by submergence/ drowning of small streams in lowland coast due to rise in sea level. For example Chake- chake, Mtwapa, Makupa e.t.c along Mombasa on Kenyan coast.

Mud flats, **lagoons and marshes**. Mud flats are plat forms made of deposits of fine silt and alluvium deposited by rivers or waves. Continuous deposition of these sediments builds sand spits and bars. When the sea level rise, seawater is enclosed behind spits and bars to form a lagoon usually colonized by marshes and mangrove swamps. These features are Found at Mombasa, Dar es Salaam e.t.c.

Landforms created by the fall in the sea-level/ Emerged landforms

When the sea level falls the formally submerged landforms are exposed to form emerged landforms in **highland and lowland coasts:**

Emerged landforms in **highland coasts**

Raised cliffs. A raised cliff is a steep rock face along the sea coast that is no longer in contact with the sea. Before submergence, waves attacked coastal rock and through processes of abrasion, hydraulic action and solution, a notch formed, enlarged and deepened. With time, land above the notch lost support and collapsed to form a cliff.

When sea level falls, new cliffs are created and the old cliffs that are no longer in contact with the sea are left behind high above the present water level hence the name-raised. Raised cliffs are Found at Mombasa.

Raised terraces are former wave cut plat forms which are no longer in contact with the sea created by materials eroded from the cliff. When sea level falls, new wave cut plat forms are created and the old terraces which are no longer in contact with the sea and left high above the current sea level hence the name raised terraces.

Raised beaches. These are beaches which are no longer in contact with the sea left high above the current sea level.

Before submergence, sand and shingle materials are deposited by constructive waves to form a gently sloping platform called beach at the coast.

When sea level falls, the beach loses contact with the sea and left behind high above the current sea level as a dry land hence the term-raised beach. For example Dar es salaam, Mombasa, Tanga e.t.c

Raised caves, geos and blowholes. Continuous wave erosion against jointed coastal rock through abrasion, hydraulic action and solution create large holes in the cliff face called caves. When the roof of the cave collapses, it forms a narrow inlet called a geo and a blowhole when waves erode the roof of a cave to the surface.

When sea level falls, all these features reappear behind high above the current water level.

The fall in the sea level in lowland coast creates coastal plains and Fiards.

coastal plains formed when the continental shelf is exposed after a fall in the sea level. The coast line of Coastal plains have no bays and head lands.

Fiards-are are drowned u-shaped glacial troughs/ valleys formed along lowland coasts. They have a broader u-shaped profile than the fiord. For example the coast of south East Sweden, coast of Nova Scotia and Maine

(a)**Account for the development of sea level changes in the coastal areas of East Africa.**

(b)Explain the effect of sea level changes on landform development in the coastal areas of East Africa.

Approach

- Define sea level changes and types of sea level changes
- Explain the causes of sea level changes with examples

- In part (b) Describe the formation of both submerged and emerged coastal landforms in highland and low land areas
- Draw diagrams and give examples from East Africa.

Causes include; Climatic changes in form of Pluviation and desiccation/ prolonged drought Glaciation and deglaciation, Change in ocean temperatures, Influence of global warming Occurrence of earth movements/ tectonic movements, Deposition of sediments on the ocean floor and Isostatic readjustments.

🕮 **Remember to explain these causes.**

Landforms created a rise in sea level in submerged highland coasts include;

Rias, Dalmatian / longitudinal coast and peninsulas

Landforms created a rise in sea level in submerged low land coasts include;

Estuaries, creeks, mudflats and lagoons colonized by marshes and mangrove vegetation.

Emergent land forms in **highland coasts include;**

raised cliffs, raised terraces, raised beaches, raised caves, geos and blow holes.

Emergent land forms in lowland **coasts include;**

Coastal plains with no bays and headlands.

Exclude fiords and Fiards because they are not found in East Africa.

🕮 **Remember to explain the formation of these land forms**

(a)Explain the causes of sea level changes in the coastal areas of East Africa.

(b)Describe the landforms resulting from a rise in the sea level.

Approach

- Define sea level changes and types of sea level changes
- Explain the causes of sea level changes with examples
- In part (b) Describe the formation of submerged landforms in highland and lowland coasts
- Draw diagrams and give examples from East Africa.

Causes include; Climatic changes in form of Pluviation and desiccation/ prolonged drought Glaciation and deglaciation, Change in ocean temperatures, Influence of global warming Occurrence of earth movements/ tectonic movements, Deposition of sediments on the ocean floor and Isostatic readjustments.

🕮 **Remember to explain these causes.**

submerged landforms in highland coasts include;

Rias, Dalmatian / longitudinal coast and peninsulas

submerged landforms in low land coasts include;

Estuaries, creeks, mudflats and lagoons colonized by marshes and mangrove vegetation.

🕮 **Remember to explain the formation of these land forms**

(a)Differentiate between emergence and submergence of coastline.

(b)Describe the landforms resulting from a rise in the sea level.

Approach.

- Define emergence and submergence coastline
- Outline the causes of each type of coastline.
- Identify submergence landforms, describe the process of formation and
- Give examples.

Answer guide.

▪Emergence coastlines are coastlines where land has risen relative to the sea or where the sea level has fallen relative to the adjacent land.

▪This make area formerly under water become dry land/ exposed.

▪Emergence coastline is produced by: desiccation/ prolonged drought, fall in temperatures of ocean water, down warping of ocean basins and up warping of the coast, expansion of sea floor and Glaciation.

While

▪Submergence coastlines are coastlines where the sea has risen relative to the coast or where the coast has fallen relative to the sea.

▪This results into flooding or submergence of formally dry land.

▪Submergence coastlines are produced by deglaciation, Pluviation, up warping of the sea and down warping of the coast, rise of ocean water temperatures, contraction of sea floor, sedimentation e.t.c

(b)A rise in sea level creates submerged landforms for example;

submerged landforms in highland coasts include;

Rias, Dalmatian / longitudinal coast and peninsulas

submerged landforms in low land coasts include;

Estuaries, creeks, mudflats and lagoons colonized by marshes and mangrove vegetation.

🕮 **Remember to explain the formation of these land forms**

Examine the landforms resulting from sea level changes in East Africa

Approach

- Define sea level changes and types of sea level changes
- Outline the causes of sea level changes with examples
- Describe the formation of both submerged and emerged coastal landforms in highland and low land areas
- Draw diagrams and give examples from East Africa.

Causes include; Climatic changes in form of Pluviation and desiccation/ prolonged drought Glaciation and deglaciation, Change in ocean temperatures, Influence of global warming Occurrence of earth movements/ tectonic movements, Deposition of sediments on the ocean floor and Isostatic readjustments.

🕮 **Remember to explain these causes.**

Landforms created a rise in sea level in submerged highland coasts include;

Rias, Dalmatian / longitudinal coast and peninsulas

Landforms created a rise in sea level in submerged low land coasts include;

Estuaries, creeks, mudflats and lagoons colonized by marshes and mangrove vegetation.

Emergent land forms in **highland coasts include;**

raised cliffs, raised terraces, raised beaches, raised caves, geos and blow holes.

Emergent land forms in lowland **coasts include;**

Coastal plains with no bays and headlands.

Exclude fiords and Fiards because they are not found in East Africa.

🕮 **Remember to explain the formation of these land forms**

(a) Account for the occurrence of eustatic changes in East Africa

(b) Explain the effects of eustatic changes on landform development in East Africa.

Approach

- Define eustatic changes and types of eustatic changes
- Outline the causes of eustatic changes with examples
- In part (b) describe the formation of both submerged and emerged coastal landforms in highland and low land areas
- Draw diagrams and give examples from East Africa.

Eustatic changes (sea level change) refer to the rise and fall of the sea level in relation to the land along the coastal areas.

Eustatism could be worldwide called **eustatic or major change** or on minor or local scale is called **isostatic change**.

Eustatism could either positive or negative.

Positive eustatism/ change occurs when the sea level rises in relation to the land and produces submerged coasts and their related landforms.

Negative eustatism/ change occurs when the sea level falls in relation to the land and produces emerged coasts and their related landforms.

Causes include; Climatic changes in form of Pluviation and desiccation/ prolonged drought Glaciation and deglaciation, Change in ocean temperatures, Influence of global warming Occurrence of earth movements/ tectonic movements, Deposition of sediments on the ocean floor and Isostatic readjustments.

🕮 **Remember to explain these causes.**

Landforms created a rise in sea level in submerged highland coasts include;

Rias, Dalmatian / longitudinal coast and peninsulas

Landforms created a rise in sea level in submerged low land coasts include;

Estuaries, creeks, mudflats and lagoons colonized by marshes and mangrove vegetation.

Emergent land forms in **highland coasts include;**

raised cliffs, raised terraces, raised beaches, raised caves, geos and blow holes.

Emergent land forms in lowland **coasts include;**

Coastal plains with no bays and headlands.

Exclude fiords and Fiards because they are not found in East Africa.

🕮 **Remember to explain the formation of these land forms**

WAVE ACTION

EFFECTS OF WAVES ON LAND FORM DEVELOPMENT IN EAST AFRICA

Waves are Oscillations or ripples on water caused by wind, earth quakes such as Tsunami, heavy marine vessels such as ships, whale e.t.c

Waves are effective agents of erosion hence create both erosional and depositional land forms.

WAVE EROSIONAL FEATURES

Discuss the processes responsible for the formation of erosional features on the coast of East Africa.

Approach

- **define waves**
- Identify and explain the processes of wave erosion
- Identify wave erosional features and explain their formation in relation to the processes identified above
- Draw diagrams and give relevant examples.

Answer guide

Waves are Oscillations or ripples on water caused by wind, earth quakes such as Tsunami, heavy marine vessels such as ships, whale e.t.c

Waves are effective agents of erosion. Waves erode through four major processes to create erosional landforms. That is hydraulic action, solution, attrition and abrasion.

Solution / corrosion -takes place on coasts dominated by limestone rocks which contain calcium carbonate which dissolves in water and carried away in solution.

Hydraulic action- takes place when breaking waves exert enormous pressure against jointed rock. As Waves hit the joints air is compressed.

As waves retreat, air expands rapidly. Eventually, repeated compression and expansion of air in rock joints break /shatter coastal rocks and enlarge joints deeper.

Abrasion/corrosion- takes place when waves use materials being carried such as pebbles, boulders and sand to scratch against and wear down coastal rocks.

Attrition-takes place when pebbles and rock fragments being carried by waves keep knocking against each other and eventually wear down by friction to smaller pieces.

Through these processes, wave create cliffs, wave cut plat forms, bays and headlands, caves, arches, stacks, stumps, blow hole and geos common along the shores of lake Victoria and the coast of East Africa

Wave erosional landforms are found between high and low tide level.

Cliffs. A cliff is a steep rock face along the sea coast or lake shore above high tide level. A cliff may be high or low in height.

Cliffs form when wave cut a notch in the coastal rock at high tide level through abrasion. Gradually, the notch is enlarged by hydraulic action and solution deeper inland. Eventually the land above the notch loses support and collapses into water and a steep rock face is left behind. Cliffs are found at Lutembe beach and Botanical gardens in Entebbe along the shore of Lake Victoria, Fort Jesus at Mombasa, Watamu at Kenyan coast and Dar es Salaam and Kilwa.

Wave cut plat form- is a surface of debris sloping seawards below the cliff formed between high and low tide level.

It forms when materials eroded from the cliff by abrasion and hydraulic action are deposited below the base of the cliff by breaking waves and accumulate seawards to form a bench like platform called a wave cut platform.

Wave cut platforms are exposed during low tide and submerged during high tides. They are found below fort Jesus at Mombasa and Gereza at Kilwa.

Headland is an elongated piece of land projecting into the sea. It is produced by differential wave erosion at the coast were hard and soft rocks alternate. Through wave abrasion and solution, soft rocks are eroded away to form bays while the hard rocks resist erosion and remain standing as head lands. For example Kibanga headland on Entebbe peninsular on Lake Victoria shores and Watamu headland on Kenyan coast.

Bays. A bay is extension of the sea or lake into coastland or an inlet of water projecting into the adjacent coastland. Formed when weak rocks are eroded away through wave abrasion and solution. For example Kavirondo Gulf in Kenya on Lake Victoria, Sango, Murchison and Napoleon bay on Lake Victoria in Uganda.

Caves. A cave is a huge hole in cliff face with a wide entrance and narrow end. Caves develop from waves enlarging joints, fault lines, cracks and other lines of weakness in coastal rock by abrasion and hydraulic action. For example limestone caves near Mombasa, Kiwi and Kilifi beaches in Kenya, Botanical and Lutembe beaches in Uganda.

Sea arches. A sea arch is a tunnel through a headland. Formed either when two caves from the opposite side of a headland join together due to prolonged wave abrasion, hydraulic action and solution from both sides and when waves erode the cave further and breaks through the headland through abrasion, hydraulic action and solution.

Stacks. A stack is an isolated pillar of rock rising from the sea cut from the headland. A stack is Formed when the roof of sea arch collapses into water due to prolonged wave erosion. For example stacks in Lake Victoria at Entebbe. Huge stacks form islands for example islands of Mafia, Zanzibar and Pemba.

Stumps are ruminants of eroded stacks. They are Formed due to prolonged wave abrasion and hydraulic action until stacks are reduced to the size of being submerged during high tides. For example Ssese stumps in Lake Victoria and Watamu on the Kenyan coast.

Blow holes. A blow hole is a cylindrical hole / opening drilled from the roof of a cave to surface or top of a cliff. Formed by wave abrasion, hydraulic action and solution usually by water splashing on the cave roof. They are Found at Malindi and Watamu, botanical gardens on Entebbe peninsular.

Geos. A geo is a deep and narrow steep sided inlet found in the cliff. Forms when the roof of a cave collapses into water due to prolonged wave erosion through solution. Found at Malindi and Watamu on the Kenyan coast.

LAND FORMS PRODUCED BY WAVE DEPOSITION

Account for the formation of wave depositional landforms in East Africa.

Approach

- Describe the process of wave deposition.
- Explain the landforms that are formed due to wave deposition
- Draw diagrams and give examples.

Answer guide

Deposition takes place when materials or debris are moved along the shores by waves and long shore drift, a mechanism by which waves transport eroded materials before they are deposited to form various landforms.

The major wave depositional landforms in East Africa include;

Beaches -such as barrier beach and Bay head beach,

Bars -such as bay bar, off shore bar, fore shore bar, barrier islands,

Spits -such as hooked spits, cuspate spit and winged spit

Tombolo and Mud flats.

Beaches- a beach refers to the accumulation of sand, mud, shingle, pebbles and other unconsolidated materials forming a gently sloping plat- form on a low-lying coast. Beaches are normally formed between the low tide level and high tide level on gentle sloping coastline.

- beaches are formed are formed when Constructive waves remove materials from the bottom of the sea and deposit them at the shore where they accumulate.
- The materials may be submerged or exposed by tides for example Nyeri beach in Kenya near Mombasa.

Types of beaches

Barrier beach- refers to a long shore ridge of sand deposits lying parallel to the coast and often separated from coast by a lagoon on gentle sloping coastline by long shore drift and waves breaking off shore (before reaching the coast).

- Barrier beach usually develops from Materials deposited on the continental shelf as off shore sand bars. More deposition increases the height of the bar until it appears above the sea level.
- High tides and wave action gradually move the deposition to the mainland to form barrier beaches for example at Mombasa.
- When the deposit is not joined to the coast is called **a barrier island**.

Diagram

Bay head beach- refers to a crescent of sand and shingle lying between headlands.

- Bay head beaches are formed when long shore drift and constructive waves deposit materials at the heads of bays between headlands. Bay head beaches do not extend to the headlands where wave erosion is dominant

Examples include Ggaba, Lutembe, and Lido beach in Entebbe on Lake Victoria.

Diagram

A spit -refers to a low, narrow ridge of sand or shingle joined/ attached to the mainland at one end with the other end extending in the sea.

- a spit develops where the river deposit large quantities of materials into an estuary and then long shore drift moves the materials to form a linear shape with one end joined to the mainland with the other extending in the sea or lake
- Spits exist at Kaiso and Tonya on Lake Albert, and Ras Luale north of Dar es Salaam.
- A spit May link the two headlands to form **a bay bar**.

Diagram

Types of spits

Hooked spit /curve spit - this is a narrow embankment of sand or shingle attached to land one end with the other end extending to the sea being curved across a bay or an estuary by the longshore drift.

- The hooked spit is formed when waves moving obliquely to the shore/ longshore drift tends to swing around the end of the spit extending to the sea and curves it toward the shore, or waves approaching the shore from several directions

For example Kaiso on the Eastern shore of Lake Albert and Ras Luale near Dar es Salaam.

Cuspate spit- this is applied to two spits converging off shore or when longshore drift recurve the hooked spit until it becomes attached/ joined to the shore at both ends.

- For example Tonya point on Lake Albert

Diagram

Winged headland spit- refers to spits attached at both sides of the headlands by longshore drift.

- Formed by long shore drift for example Kaiso spit and Tonya spit on Lake Albert.

Diagram

Bars- a bar refers to a ridge of sand, mud, gravel and shingle deposited off shore and lies parallel to the coast.

- Bars are formed on gently sloping coast and irregular shorelines.
- The Formation of a bar is related to formation of barrier beach where waves moving or drifting materials to the shore break off shore and drop the materials being carried under the water.
- Repeated deposition leads to accumulation and formation of an embankment of sand called a bar separated from the coast by a lagoon.

Types of bars

Bay bar –this is a ridge of sandy material joining the land at both ends in a bay.

- Bay bar is Formed where a spit is built across a bay continues to grow lengthwise until it is attached to two headlands enclosing a lagoon and marshes.
- For example Lake Nabugabo enclosed by Lwamunda swamp.

Diagram

Off shore sand bar- it applied to temporary submerged sandbar.

- Formed on gently sloping coasts where waves break off shore and back wash deposit materials off shore.
- Repeated deposition builds an embankment of sand off the coast called off shore sand bar found at Tanga along the coast of Tanzania and Lamu on the Kenyan coast.
- The expanse of sea water enclosed between the off shore bar and the main land is called a sound.

Diagram

Fore shore sand bar- formed by constant accumulation of sand causing off shore sand bars to rise above water surface.

Barrier islands applied to bars which gradually move inland by wave attack and enclose an area of shallow water (sounds) and have no connection to the mainland.

Tombolo -refers to the shingle or sand bar joining an island to the mainland.

- For example the Tombolo which used to connect Lambu islands to Masaka and Lambu to Bukakata.

Cuspate fore head - refers to triangular shaped deposit of sand and shingle projecting sea wards

- It is formed by convergence/ coalescence to an apex of two separate curved spits broadly at right angles or by two sets of constructive waves.

Gradually may get enlarged by additional materials forming beach ridges

Mud flats -are plat forms made of deposits of fine silt and alluvium deposited by rivers or waves. Continuous deposition of these sediments builds sand spits and bars. When the sea level rise, seawater is enclosed behind spits and bars to form a lagoon, colonized later by marshes and swamps. Found at Mombasa, Dar es Salaam e.t.c.

WEATHER AND CLIMATE

(a) Distinguish between weather and climate

(b) Explain how any two elements of weather are measured at a weather station.

Approach

- Define both concepts and give their elements
- Identify and select any two elements and describe how they are measured at a weather station.
- State the name of the apparatus used and the units used

Answer guide

- Weather is the state or condition of the atmosphere of a given place at a particular time.
- It is recorded over a short period of time.

●The weather elements include rainfall, temperature, wind speed and direction, humidity, atmospheric pressure, cloud cover and sunshine.
●Weather affects a small or localized area and may vary from time to time and from place to place.
●Weather elements can be observed and recorded.
●Weather can be described as being rainy, sunny, hot, cool, windy, foggy, frosty, misty e.t.c.

Where as

●Climate is the average weather condition of the atmosphere of an area recorded over a long period of time of atleast 30-35 years.
●Climatic conditions tend to remain relatively stable over a long period of time though with minor variations.
●Climate affects a large area or region
●Types of climate include, equatorial climate (hot and wet), tropical climate, montane climate, desert climate, Mediterranean climate, tundra climate e.t.c

Elements of weather and how they are measured

Rainfall

▪Rainfall is the amount of water droplets received at a particular point in time.
▪It is measured using a rain gauge, a metallic cylinder with a copper funnel placed at the top and a collecting jar inside the cylinder.
▪Rain falling in the funnel trickles into the jar below and at the end of a 24-hour period is poured into a graduated measuring cylinder marked in millimeters.
▪The readings are recorded in millimeters or inches.
▪A rain gauge is sunk into the ground so that 30 cm of it sticks up above the ground level to prevent rain drops from splashing into it from the ground, and also to prevent the sun's rays from causing excessive evaporation of the water already collected in the jar.
▪The rain gauge is also placed in an open space to prevent any run-off from buildings or trees from entering the collecting jar.

Diagram

Temperature

▪Refers to the degree of sensible heat or cold within the atmosphere.
▪ Air temperature is measured using a maximum and a minimum thermometer or the six's thermometer which detect the highest and lowest temperatures per day respectively.
▪Temperature is measured in degrees Celsius (^{0}c)
▪The six's thermometer consists of a u- shaped glass like tube with two scales containing mercury, alcohol, a vacuum and indexes inside.
▪When temperature rises the alcohol in the left-hand limb expands and pushes the mercury down this limb and up the right limb.
The alcohol in this limb also heats up and part of it is vaporized and occupies the space in the bulb.
▪As mercury expands, it pushes the metal index up-ward in the right limb and the metal index stays at the maximum level.
▪The end of the metal index nearest to the mercury gives the maximum temperature, recorded usually at 3:00 p.m and read from the scale on the right hand limb.
▪When the temperature falls, the alcohol in the vapor in the conical bulb liquefies, causing the mercury in the right hand limb to flow in the reverse direction, there by pushing the metal index in the left limb up high and the figure nearest the bottom side of the index is read usually at 9:00 a.m and the minimum temperature is recoded from the left hand limb.
▪The index metal is re-adjusted using a magnet.

Diagram

Atmospheric pressure refers to the force or weight pressing down on any object on the surface of the earth.
▪It is measured using a barometer, which could be mercury or an aneroid barometer.

▪It is expressed in millibars.
▪The mercury barometer consists of a tube about one meter long filled with mercury.
▪The glass tube scale is at the upper end and opens at the lowest end. The lower end is inverted in a container of mercury whose surface is exposed to air.
▪This causes the mercury to drop to approximately 760 mm high. The pressure of air on the mercury in the container balances the weight of mercury in the column.
▪As the pressure changes, the level of mercury in the tube rises or falls accordingly.
▪The pressure is then measured from a scale placed at the side of the glass tube.

Aneroid barometer.

▪It is an instrument which consists of a small metal box with very little air inside.
▪The top of this box bends slightly under the influence of any change in atmospheric pressure.
▪The movement of the box top is conveyed by a system of levers to a pointer which moves a cross a graduated scale.
▪When pressure rises, the top of the box bends inwards and when the pressure falls, the spring pushes the top outwards.

Sectional view of an aneroid barometer.

Humidity refers to the amount of water in gaseous form in the air.
▪It is measured using a simple hygrometer.
▪A simple hygrometer consists of a wet thermometer and a dry thermometer kept in a Stevenson screen.
▪The bulb of one is wrapped in a piece of muslin dipped in a container of water. ▪This is called the wet bulb thermometer. The other thermometer is not dipped hence called the dry bulb thermometer.
▪When air is not saturated, water evaporates from the muslin and cools the wet bulb and causes the mercury to contract.
▪The dry bulb thermometer is not affected in the same way hence the two thermometer show different readings
▪When air is saturated, there is no evaporation hence cooling hence the two thermometers show the same readings, an indication of humidity of the air.
▪When the readings on the thermometer show;

No difference---------air is saturated
Small difference-----high humidity
Large difference-----humidity is low

Diagram

Sun shine refers to the amount of solar radiations received at a particular place at a given moment in time.
▪It is measured using a sun shine recorder or the Campbell stokes apparatus and
▪Expressed in hours and minutes.
▪The Campbell stokes apparatus is a glass like sphere , partly surrounded by a metal frame on the inside with a sensitive card/ paper marked in hours and minutes from 1-12 when it is expected to shine.
▪As the sun moves, the glass concentrates the rays and a trace is burnt on the sensitive card while it is shining.
▪When it shines intermittently, the sensitive card shows a continuous burnt line. ▪However, when it's cloudy, the sensitive paper shows gaps of unburnt sections
▪At the end of the day, the lengths of all burnt parts are added to obtain the total hours of sunshine received at a location.

Diagram

Wind speed refers to the velocity of moving air in an environment.
▪It is measured using an anemometer which consists of 3-4 small cups attached to a rotating shaft by spokes

▪As the wind blows, it pushes against the cups hence generating a resisting force, which propels the movement of the rotating shaft.
▪As the shaft rotates, it generates a weak electric current which is calibrated on a speedometer in km/ hr.
▪However, the speed recorded is not absolutely accurate because, as the wind ceases, the rotation continuous under its own momentum.

Diagram

Wind direction is determined by using a wind vane.
▪It consists of a horizontal rotating arm pivoted on a vertical shaft.
▪The rotating arm has a tail at one end and a pointer at the other end.
▪ As wind blows, the arm swings until the pointer on the wind vane faces in the direction from which the wind blows and the wind is named after this direction.
▪The directions, North, East, South and West are fixed firmly on the pipe below the vertical shaft.

Diagram

Others include; cloud cover and visibility.

(a) Distinguish between solar radiation and terrestrial radiation
(b) Examine the factors which influence the amount of solar radiation received in a place.
Approach

- Define both terms
- State the differences between the two terms
- Explain the factors that cause a variation in solar radiation received.

Answer guide.
✓**Solar** radiation refers to the amount of heat energy that comes from the sun, travels through space and atmosphere to the surface of the earth.
✓It passes in the atmosphere inform of short waves with temperature estimated to be 6000^0c but only 45% of it is absorbed by the earth.
✓Solar radiation occurs only during the day and inform of light energy.
✓The amount of solar radiation received in a place varies from time to time and place to place depending on a number of factors.

While

✓**Terrestrial radiation** refers to the energy transferred from the earth's surface into the atmosphere after receiving solar radiation.
✓Terrestrial radiations are transferred back in form of long waves.
✓It's responsible for heating the atmosphere through radiation, conduction and convention and its measured and recorded at a weather station as temperature.
✓It occurs all the time both during day and at night.
✓The amount of terrestrial radiation varies with the type and nature of the surface.
For example, land emits a lot of terrestrial radiation than water surfaces such as oceans.

The amount of solar radiation received in a place varies due to the factors explained below.

Nature of the atmosphere. The atmosphere consists of permanent components such as nitrogen, oxygen, inert gases e.t.c and variable components like water vapor, dust, volcanic ash e.t.c
▪These components reduce the amount of solar radiation from reaching the earth's surface.
▪For example clouds through reflection cause about 30% heat loss, back scattering 10% while absorption by ozone cause a heat loss of 15%. Consequently the three processes cause a total loss of 55% and only 45% reaches the surface.
▪Therefore when the atmosphere has few variable components, a lot of solar radiation is received than when the atmosphere has a lot of components.

Cloud cover. Clouds influence the amount of solar radiation received through reflection and absorption which account for 45% energy loss.

▪Consequently areas with dense cloud cover such as equatorial regions receive low solar radiations while areas with clear skies such as desert and semi-desert areas receive a lot of solar radiations due to absence of obstacles.

Nature of the receiving surface for example;

●Bright surfaces like Snow have high albedo (the reflective ability of a body) hence reflect back a lot of solar radiation which results into low temperatures.

Dark surfaces like forests have low albedo hence high temperature.

●Plain land surface absorbs heat very fast than water surface. There fore solar radiation is high over the land during day and low over the sea.

Revolution of the earth and its tilt also cause differences in the amount of solar radiation received. For example;

●When the sun is over head tropic of Capricorn in December, the southern hemisphere receives high solar radiations in December, January and February while the northern hemisphere receives low solar radiation at the same period.

●When the sun is over head tropic of cancer in June, the northern hemisphere receives high solar radiation in June, July and August while the southern hemisphere receives low solar radiation.

●Both hemispheres receive the same amount of solar radiation twice a year when the sun is over head the equator. That is on 21st march and 23rd September.

●This is because the angle of incident and the distance traveled by Solar radiation change with the revolution and tilt of the earth.

The apparent movement of the sun due to revolution of the earth brings differences in the length of the day. That is; during summer, day light hours are longer than nights.

●Consequently, there is more insolation in summer than during winter where the nights are longer and days are shorter in temperate regions.

Latitudinal differences. The distance traveled by solar radiations varies according to latitudes. Solar radiations travel short distance to reach the surface at the equator but long distance at higher latitudes.

●Consequently the combination of short distance and influence of the over head sun at the equator leads to more solar radiations in low latitudes and low solar radiation at high latitudes like the northern and southern poles. High latitudes receive high solar insolation only when the sun is over head.

Increasing emission and concentration of green house gases such as carbon dioxide, methane e.t.c from industries, deforestation and other human activities have led to depletion of ozone layer and creation of large holes in the atmosphere for example over the Antarctica and arctic through which un filtered solar radiations pass hence increase temperatures on the surface and increase aridity.

Sun spot activity such as dead parts on the sun also contributes to variation in solar radiation.

Aspect refers to the direction of the slope in relation to the sun. Aspect influences solar radiation received mainly in temperate latitudes.

●In the northern hemisphere, the south facing slopes receive more solar radiations than north facing slopes. In the southern hemisphere, the north facing slopes receive more solar radiations than the south facing slopes.

●In low latitudes, aspect is relevant only in the mountainous areas of Atlas in North Africa, drankensberg in South Africa, mountain Kilimanjaro, Rwenzori and Kenya in East Africa.

(a) Differentiate between mini annual temperature and annual range of temperature

(b) Account for the variations in mean annual temperatures over the African continent.

Approach

- Define both concepts
- Explain the factors in details showing the existing variations in the mean annual temperatures over the African continent.

Answer guide

Mean annual temperature is the final figure obtained when the sum of mean monthly temperatures for 1 year is divided by 12 months.

Where as

Annual range of temperature is the difference between the highest and lowest mean monthly temperatures in a year.

Causes of variations in mean monthly temperatures are;

Apparent movement of the sun north and south of the equator. That is;

- An over head sun in the northern hemisphere causes high mean annual temperatures in July while at the same time causing low mean annual temperatures over tropic of Capricorn in the southern hemisphere.

- On the contrary, an overhead sun over the southern hemisphere in January ensures higher mean annual temperatures over Capricorn but low annual means over the cancer at the same time.

Latitudinal location .This determines the angle of incidence of solar isolation, distance traveled and areas heated by them. For example, near the equator solar radiations strike the earth's surface at a wider angle and not only travel over a short distance but also heats a smaller area. This ensures higher mean annual temperatures over the equator than areas a distance away.

Prevailing winds .these influence annual mean temperatures depending on their origin and fetch e.g.

- The North trade winds originate from the Arabian Desert and bring desiccating effects responsible for arid conditions characterized by high mean annual temperatures in North Eastern Uganda, North East North west and Northern Kenyan.

- The South East trade winds bring moist conditions from Indian Ocean hence cause low mean annual temperatures in the coastal regions of Tanzania e.t.c.

Large water bodies such as oceans, lakes, wet lands e.t.c also have a cooling or moderating effect on mean annual temperatures through the combined effect of breezes and on shore winds on the adjacent land masses consequently, areas near water bodies have low mean annual temperatures e.g. lake Victoria basin while those far from water bodies have high mean annual temperatures e.g. karamoja.

Ocean currents such as the warm Mozambique, Guinea and Aghulas have a warming effect which raises the mean annual temperatures of adjacent land masses. On the contrary cold ocean currents such as the Benguela and canaries tend to have low mean annual temperatures on coast lands adjacent to them.

Cloud cover. Presence or absence of cloud cover also affect mean annual temperatures. Thick cloud cover traps out going terrestrial radiations leading to high mean annual temperatures as the case with equatorial areas while arid and desert areas have clear skies which let all the outgoing radiations escape freely hence low mean annual temperatures.

Nature of the receiving Surface influence mean annual temperatures due to ability of such surfaces to reflect or absorb solar radiations. For example,

Snow capped mountains such as Kilimanjaro, Rwenzori and the Atlas experience low mean annual temperatures because snow has a higher albedo than bear land surface such as deserts.

Coastal areas have low mean annual temperatures because the effects of land and sea breezes while areas located far inland have high mean annual temperatures of absence of land and sea

breeze. e.g. ice surfaces such as on Rwenzori e.t.c reflect heat hence low mean annual temperatures whereas dark land surfaces absorb isolation leading to high mean annual temperatures.

Altitude. High altitude areas such as Drankenburg, Atlas Mountain, Rwenzori e.t.c have low mean annual temperature throughout the year because temperatures decrease with increase in altitude. Conversely, low altitude areas such as the rift valley areas and the coastal plains such as Mombasa have high mean annual temperatures.

Nature of vegetation .Equatorial regions such as Congo basin, Gabon e.t.c have low mean annual temperatures because of high rate of evapo-transpiration which has a cooling effect on temperature while arid and semi arid areas have high mean annual temperatures

Man's activities such as Industrialization, burning of fossils, bush burning, and deforestation have increased the concentration of Green House Gases in the atmosphere and depletion of ozone layer. This has resulted into global warming responsible for increasing mean annual temperatures.

TEMPERATURE INVERSION

(a) Examine conditions under which temperature inversion occurs
(b) Examine the influence of temperature inversion on weather and human activities.
Examine the causes and effects of temperature inversion in East Africa.
Approach

- Define and explain temperature inversion
- State and explain the types of temperature inversions
- Explain the effects of temperature inversion on weather and human activities.

Answer guide
Temperature inversion is an atmospheric condition in which air temperature increases with altitude /height from the ground level in the troposphere.
It's the reverse of the normal environmental lapse rate where temperatures decrease with altitude at a rate of 6.5^0C for every 1000metres of ascent.
With temperature inversion the higher you go, the warmer it becomes. However in the troposphere, the increase in temperature with altitude is up to a certain level referred to as the temperature inversion point or level. Beyond this level, the normal lapse rate applies.
In the atmosphere, temperature inversion is also a temporally phenomenon.
It is experienced in morning hours. As temperatures rise or as the sun warms up the air the condition later disappears.
There are basically two forms/ levels of temperature inversion. Namely
a) Low/ ground level inversion common in hilly areas due to rapid loss of radiation or when warm air is advected over a cold surface
b) High level inversion that occurs due frontal convergence.

Graph showing temperature inversion

Temperature inversion in East Africa occurs in mountainous/ hilly regions such as Kigezi in south western Uganda, chaaga land on the slopes of mountain Kilimanjaro, Uluguru area in southern Tanzania and areas of limited cloud cover marked by air stability or calm weather for example semi arid regions like Karamoja, northern and north eastern Kenya.

Conditions under which temperature inversion occurs in East Africa/ causes

- When there is rapid loss of heat from the earth's surface at night inform of terrestrial radiation in semi desert areas where cloud cover is absent or limited. This excessive loss of heat results into a cold surface that cools the air immediately above it meanwhile the air layers further above are warmer since some of the heat is retained by the green house gases (GHGs), water vapor and dust particles.

This type of inversion is some times referred to as nocturnal radiation temperature inversion and occurs in arid areas such as Karamoja, chaldt in northern Kenya e.t.c

- When there is subsidence of cold dense air from top of highlands down slope to the valley by gravity.
  - During night, hill tops and upper slopes lose heat by radiation. The air becomes cold and dense and descends down slope into the valley bottom by gravity; displacing the warm and light air from the valley bottom upwards to warm the upper slopes while the cold dense air creates cold conditions in the valley.
  - The subsidence of cold dense air resulting into temperature inversion is also referred to as katabatic effect or valley inversion common in the Kigezi highlands, Ankole hills e.t.c

Diagram

- Temperature inversion also occurs when a current of a warm air mass flowing horizontally blows over a cold surface. The lower layers of the warm air mass will be cooled by the cold surface while the overlying layer remains warmer. For example when warm trade winds flow over cold ocean current.

The air in contact with the cold surface may be cooled to form advection fog.

- This type of inversion is called advection inversion and occurs along coast lines washed by cold ocean currents.
- Occurs when two air masses of different characteristics meet at a front. That is, the meeting of a warm light air mass and a cold dense air mass at a frontal zone.

The warm air mass being lighter is lifted above the cold dense air mass leading to temperature increase with altitude.

- This is referred to as frontal / cyclonic temperature inversion and occurs within the inter tropical frontal zones in East Africa.
- Temperature inversion also occurs due to trade winds blowing at different altitude. That is trade winds blowing at a higher level or altitude tend to be warmer than the air close to the surface. This therefore results into a situation of temperature increase with altitude.
- Temperature inversion also occurs due to increase in altitude. It occurs in the stratosphere about 40-50km from the surface.
  - The presence of ozone in this layer absorbs ultra-violet materials from the solar radiations and therefore increases the temperature in this layer than in the troposphere below.
- Temperature inversion also occurs due to industrial pollution. The fumes discharged into the atmosphere are warm and rise faster than the cold air and spread horizontally to create smog- a dusty cloud leading to warm conditions at higher level and cool conditions below it.

Effects of Temperature Inversion on Weather

- Temperature inversion by advection and valley leads to formation of mist/ foggy conditions especially in the morning on the adjacent coast and highland regions respectively.
- Advection inversion prevents evaporation of warm moist air to condensation level which results into low rain fall and aridity.
- Fog and mist caused by valley and advection inversion results into invisibility for example in Kigezi.
- Valley inversion results into formation of frost in valley bottom
- Valley inversion leads to cold / cool conditions in valleys or low lands such as in Kigezi.
- Temperature inversion hinders vertical movement of air masses causing stability in the atmosphere.
- Temperature inversion causes air pollution in form of smog which keeps the upper layers of the atmosphere warmer than those below leading to cold conditions in countries like Britain, German, china, France and industrial cities in East Africa such as Hima, Kampala e.t.c
- Leads to warm conditions at higher altitudes.

Effects of Temperature Inversion on Human Activities

- **Very cold** or **F**rosty conditions discourage the growth of some crops such as bananas due to destruction of the flowers of such crops. Other crops destroyed in valleys include fruits and vegetables for example in Kigezi.
- The cold/ frosty conditions limit morning working hours for example in highland regions.
- Occurrence of cold related diseases such as pneumonia, cold, asthma e.t.c while smog- a form of air pollution is dangerous to the health of urban dwellers.
- Cold / frosty conditions discourage settlements in valley bottoms.
- **O**ver population and congestion on upper slopes due to warm rising air
- **F**og and mist reduces visibility hence affect transportation and pose a risk of accidents on land, water and air
- **Lo**w rain fall and aridity associated with advection inversion discourage settlement and agriculture.
- Foggy or cold conditions may favor the growth of crops such as pyrethrum, tea and sorghum
- Temperature inversion results into easy spread of industrial pollutants at higher levels for example smog.

HUMIDITY

(a) Distinguish between absolute humidity and relative humidity.
(b) Account for the variation in humidity in East Africa.
Approach

- ❖ Define both terms
- ❖ Give the characteristics of each concept
- ❖ In part (b) explain the factors responsible for the variation in humidity in East Africa.
- ❖ Give examples where possible

Answer Guide.
Absolute humidity refers to

- the actual amount of water vapor present in a given quantity of air at a given time.
- It's expressed in grams per cubic meter
- Absolute humidity varies according to temperature and pressure

While
Relative humidity refers to

- the actual amount of vapor present in a given volume of air expressed as a percentage or ratio of the maximum it could contain when saturated.
- Relative humidity depends on temperature and pressure.
- Relative humidity decreases as temperature rises and decreases as temperatures fall.
- It is high during day than night
- Its also high in the tropics than at the poles

The variation in humidity in East Africa is caused by the following factors;
Temperature. High temperatures encourage high rates of evaporation leading to high humidity while low temperature lead to low rates of evaporation leading to low humidity. Therefore areas with high temperatures and with water sources such as Lake Victoria basin experience high humidity than areas with low temperatures such as highlands like Kigezi, mountain Elgon, Kenya, Rwenzori, Kilimanjaro.
Influence of Water bodies. Water bodies such oceans, lakes, rivers and extensive swamps provide large amounts of moisture to the atmosphere through evaporation leading to high humidity. Therefore coastal areas, the northern shores of Lake Victoria basin and other areas near sources of moisture experience high humidity than areas with limited water bodies or far away from water bodies for example Miombo, Karamoja, Turkana, Marsabit e.t.c
Altitude. This is the height above sea level. Humidity reduces with increase in altitude. Consequently there is high humidity at low altitude because of

- high temperatures,

- being near sources of water vapor like water bodies and
- because water vapor molecules are pulled downwards by gravity.

On the other hand areas at high altitudes experience low temperatures which prevent evapo-transpiration resulting into low humidity for example Kigezi, mountain Elgon, Kenya, Rwenzori, Kilimanjaro.

Influence of Vegetation. Areas with forest vegetation experience high rate of transpiration leading to high humidity in the atmosphere for example Mabira, Bwindi e.t.c.

On the other hand areas with semi desert and desert vegetation such as scrub, bush and thickets give off inadequate moisture to the atmosphere through transpiration leading into low humidity For example Karamoja, Miombo, Rift valley areas, Ankole Masaka corridor, marsabit and wajir in north eastern Kenya.

Influence of Air masses or winds

Winds have the ability to transport water vapor from one area to another thus influencing amount of water vapor in a given place for example;

- The South East trade winds pick a lot of water vapor from the southern part of Indian Ocean and deposit it at the coast leading to high humidity on the East African coast such as Mombasa, Kilwa, Dar-es-Salaam and low humidity inland for where they get when they are dry for example the Miombo in Tanzania.
- The westeries pick a lot of water vapor from the southern part of Atlantic Ocean and the vast Congo forests leading to high humidity over highlands in western Uganda such as Rwenzori (Nyabirongo**),** Kigezi and some parts of Rukungiri.
- North East trade winds are dry after losing their moisture on the windward slope of Ethiopian highlands leading to low humidity in northern, north eastern Kenya and Karamoja region.

Influence of warm ocean current. The Mozambique warm current washing along the coast of East Africa raise temperatures of South East winds blowing over it leading to high evaporation and humidity in the coastal areas around Malindi, Mombasa, Tanga, Dar salaam, Kilwa e.t.c while areas far inland have low humidity for example Karamoja and marsabit.

Influence of Human activities. Environmentally friendly activities such as afforestation, re-afforestation, cloud seeding, protection of moisture sources e.t.c increase humidity through evapo-transpiration

On the other hand, areas where human activities degrade moisture sources reduce evapo-transpiration leading to low humidity. For example deforestation, swamp reclamation, sinking bore holes, bush burning, over grazing, industrialization e.t.c for example Karamoja.

Continentality effect or distance from the sea or ocean. Coastal areas in the path of trade winds experience high humidity than areas located far inland because they are near source of water vapor and winds carry humidity and deposit it to the coastal areas. For example Malindi, Kilwa, Tanga e.t.c

Influence of earth's revolution and tilt results into seasonal variation of humidity depending on where the sun is over head. That is, when the sun is over head a certain region, there are high temperatures which increase evapo-transpiration leading to high humidity. In addition high temperatures create a low pressure zone that attracts the North East and South East trade winds that bring humidity from their sources leading to high humidity. While areas where the sun is not over head experience low humidity.

Time of the day. Humidity is high during day because of high temperatures which cause high evaporation and evapo-transpiration from water bodies and vegetation respectively. At night there is no sun's heat hence no evaporation to increase moisture content in the atmosphere leading to low humidity.

Influence of relief. Windward sides of highlands have high humidity because of the influence of moist winds ascending over the mountain barrier and condense into orographical/ relief rainfall. The lee ward sides have low humidity because of the effect of dry descending winds.

RAIN FALL IN EAST AFRICA

East Africa experiences three types of rainfall. Namely, Relief/ Orographic rainfall, Convectional and frontal rainfall.

(a)Differentiate between Orographic rain fall and convectional rain fall

(b)Explain the factors leading to the formation of convectional rain fall in East Africa.

Approach

- Define Relief/ Orographic rain fall and convectional rain fall
- Describe how each type of rain fall is formed
- Draw diagrams
- Give examples of areas where each type of rainfall is experienced
- In part (b) explain the factors leading to the formation of convectional rain fall in East Africa

Answer guide

✓Orographic rain fall is a type of rain formed when moist moving air or wind meets a mountain.

✓Moist air is forced to rise up over the mountain and in the process is forced to cool at dry adiabatic lapse rate of 6.5^0c per 1000 meters of ascent until dew point is reached. The air continues to rise and cool at the saturated adiabatic lapse rate of 4.5 ^{0}c per 1000 meters.

✓The cooling releases latent heat which makes the atmosphere more unstable and this force the air to continue rising leading to formation of **Cumulo-nimbus clouds** resulting into rainfall received on the windward side of the mountain.

For example the south east facing slopes mountain Elgon, Kenya, Kilimanjaro e.t.c in the path of the south East trade winds.

✓The leeward side of the mountain lies in the rain shadow and dry due to desiccating effect of the dry descending winds For example Kasese and Semliki on the lee-ward side of Rwenzori Mountain, Karamoja, Northern and north eastern Kenya on the lee-ward side of Ethiopian highlands.

Diagram

While

✓Convectional rainfall is a type of rainfall which occurs when the ground surface is heated leading to upward movement of warm moist air.

✓ Warm moist air rises and cools to form **strato- cumulus** clouds. As condensation continues latent heat is lost and instability occurs. The rising air continues to rise and cools to form Cumulo-**nimbus clouds.**

✓These clouds result into rainfall accompanied by **thunder and lightening** if it has taken long without raining.

✓Convectional rainfall is received throughout the year at the equator and during summer in mid latitudes when there is intense heating.

✓ Convectional rainfall usually falls in the afternoon and characterized by unstable atmospheric conditions which occur due to heavy Cumulo-nimbus clouds.

✓Convectional rainfall is also experienced adjacent large water bodies and forested areas such as Mabira, Kalangala, Mukono, Kisumu and areas on the Northern shores of Lake Victoria basin

Diagram

FACTORS FAVOURING FORMATION OF CONVECTIONAL RAINFALL IN EAST AFRICA

The formation of convectional rainfall in East Africa is explained by the following factors

Latitude. East Africa lies astride the equator. As a result it experiences intense heat and temperature which spark off convectional currents in areas near the equator. Rising Air cools leading to formation of clouds resulting into torrential rain fall.

Presence of water bodies such as Indian Ocean, Lake Victoria, Kyoga, Tanganyika e.t.c provides large amounts of moisture/ humidity into the atmosphere through evaporation leading to formation of clouds resulting into rain fall.

Vegetation cover Vegetation- high evapo-transpiration rates from thick vegetation cover such as Mabira also recharges the atmosphere with water vapor that cools and form clouds resulting into rain fall.

The meeting of trade winds such as the North East and South East in the low pressure belt called the Inter Tropical Convergence Zone (I.T.C.Z) triggers off the up- ward movement of warm moist air which condenses into clouds resulting into rain fall.

Man's activities such as afforestation increase moisture emitted to the atmosphere from the planted forests. That is planted forests enhance evapo-transpiration, water goes to the atmosphere cools and forms clouds resulting into rain fall.

Study the table below showing mean monthly rain fall for selected stations in East Africa and answer the questions which follow:

STATION	J	F	M	A	M	J	J	A	S	O	N	D
MASAKA	52	61	112	180	167	46	36	52	87	100	97	88
VOI	34	31	76	97	32	09	03	09	12	23	96	130
IRINGA	120	104	126	72	20	02	-	-	02	06	32	154

Adapted from E.w and Mottam, B.H. (1985). A course in working Geography. **East Africa; Physical Regional and Human 3rd Edition page 76 -100**

(a)Describe how mean monthly rain fall is obtained at a weather station

(b) Explain the factors which have influenced the rain fall patterns at the three stations shown in the table above.

(a) The rain gauge is used to measure rain fall received in a place and units applied are **millimeters**. Rain fall is collected daily for one year. The total amount of rain fall for each month is recorded every year for a period of 30-35 years. The total amount of rain fall for each month is then divided by 35 years.

The mean monthly amount of rain fall is then obtained.

The factors responsible for variation of rain fall received include; water bodies, trade winds, I.TC.Z, continentality effect, relief and human activities as shown below.

MASAKA

- Has an equatorial location and the mean rain fall is high \heavy and well distributed thought the year.
- Bimodal distribution with peaks forming soon after passage of inter Tropical Convergence Zone
- Lake Victoria recharges the South East trade winds hence cause rain fall on the North western shores of Lake Victoria
- Influence of Lake Breeze cause rain fall
- Low rain fall amount in the middle of (July) caused by sun's location over the northern tropic
- Low amount in January when the sun is over the southern tropic
- Lower amount usually in June and July followed by heavy convectional rain fall
- Effect of vegetation cover. That is, tropical rain forests along the shores of Lake Victoria increase rain fall through the process of evapo-transpiration.

Voi

- Has a bimodal distribution due to equatorial location
- Low annual amount of rain fall caused by incursion of semi-desert conditions in North Eastern Kenya
- Very low monthly rains fall in middle of July- October. This is the prolonged dry season.
- Beginning of year has low mean monthly rain fall and end of year has heavy rain fall
- Drought is caused by incursion of North East dry winds from North Eastern Kenya

- Winds blow parallel to the coast hence low rain fall inland.
- Voi far inland than Mombasa.
- Human activities like deforestation, over stocking and over grazing e.t.c lead to limited humidity in the atmosphere hence low rain fall
- Rain shadow effect from the Kenyan highlands.

IRINGA

- Has low annual amount of rain fall
- Orographic uplift causes a little precipitation because of the high elevation
- Rain fall is seasonal / wet and dry
- Heavy rain fall from December – April caused by over head sun on southern tropic/ hemisphere
- Prolonged Dry season from May –October when the sun is over head the Northern Hemisphere
- Effect of continentality partly account for low amount of rain fall.

Convectional rain fall and frontal rain fall

(a)Differentiate between convectional rain fall and frontal rain fall

(b) Account for the variation in the rain fall received in East Africa.

Approach

- ❖ Define convectional rain fall and frontal rain fall
- ❖ Describe how each type of rain fall is formed
- ❖ Draw diagrams
- ❖ Give examples of areas where each type of rain is experienced
- ❖ In part (b) State the rain fall patterns experienced in East Africa and
- ❖ Explain the factors responsible for the variation in the rain fall received in East Africa

For convectional rain fall refer to the question above.

Frontal rain/ depression or cyclonic rain

✓Depression rainfall occurs when air masses of different characteristics in terms of temperature and humidity meet at a front. For example the warm moist air from the tropics and cold air mass from the poles.

✓When these two air masses meet, they don't mix easily due to differences in temperature and humidity instead remain separate with a gently sloping boundary surface called **a front.**

✓The warm air being light rises while the cold dense dry air descends below it.

✓The rising warm air under goes adiabatic cooling until it reaches the condensation level to form heavy **Cumulo-nimbus clouds** resulting into torrential rain fall and thunderstorms.

✓The condensation process releases a lot of latent energy which maintains a stormy cloud characterized by heavy rain fall accompanied by lightening and thunder storms and at times causing flooding

✓In East Africa, cyclonic rain fall occurs along the Inter Tropical Convergence Zone where the south East and North East trade winds meet such as the northern shores of Lake Victoria basin.

Diagram

Rain fall patterns in East Africa

▪East Africa experiences two major types of ran fall patterns. That is, **the double maxima pattern/ bimodal pattern** and **mono modal pattern.**

▪The bimodal pattern occurs on the northern shores of Lake Victoria basin and consists of two rainfall seasons.

▪The first season is short and starts from March to May while the second season starts from September to November.

▪It is associated with high temperatures and humidity throughout the year.

▪There is no marked dry season.

▪The mono modal type consists of one short wet season and one long dry season.

▪The wet season comes when the sun is over head the tropics in the northern and southern hemisphere.

Factors that influence rainfall patterns in East Africa

The apparent movement of the sun $23^1/_2$ north and south of the equator and revolution and tilt, creates low pressure zone called inter tropical convergence zone where trade winds converge forming clouds resulting into rainfall. That is;

Where the sun is over head, high temperatures create a low pressure zone which attracts the North East and South East trade winds to converge in the low pressure zone.

- The south east trades are recharged with moisture as they cross Lake Victoria.
- The hot ground heats the moist air; rising until dew point is reached and condenses into Cumulo-nimbus clouds resulting into convectional rain fall accompanied by lightening and thunder storms and comes mainly in the afternoon.
- When the sun is over head the equator in March and September, convectional rain fall is received in areas along the equator fore example in Entebbe and other areas on the Northern shores of Lake Victoria.
- When the sun is over head in the southern hemisphere, much of the southern and central Tanzania receive rain fall during December and January.
- When the sun is in the northern hemisphere, northern and North Eastern Uganda and northern Kenya receive rain fall in the months of June and August.

Difference in altitude. Highland areas of East Africa experience heavy rainfall as opposed to the areas of low altitude such as the coastal belt and the rift valley areas.

This is because high altitude causes adiabatic cooling of warm moist winds at dry adiabatic lapse rate of 6.5^0c per 1000 metres until dew point is reached to form Cumulo-nimbus resulting into relief rain fall on the wind ward side of the mountain such as Rwenzori, Kenya, Kilimanjaro, Muhavura e.t.c

Influence of relief. Areas with high relief such as mountains like Rwenzori, Kenya, Kilimanjaro, Muhavura and highlands such as Kigezi receive heavy relief rain fall because mountains act as barriers which force moist winds to rise over and in the process undergoes adiabatic cooling and condensation forming clouds which result into Orographic rainfall on the windward Side of the mountain.

On the other hand Areas without or limited mountains receive low rain fall less than 500mm per year because of absence of Orographic effect for example Karamoja, rift valley areas such as Albert flats, northern and north eastern Kenya. In addition these areas are affected by dry descending winds.

Influence of prevailing winds. Areas in the path of moist trade winds experience heavy rain fall than areas in the path of dry trade winds.

Fore example;

- The South East trade winds from the southern part of Indian Ocean deposit a lot moisture in form of heavy rain fall in the coastal areas, and the Northern, North Eastern lake shores of Victoria basin.
- The westeries from the southern part of Atlantic Ocean and the vast Congo forests bring heavy rain fall over highlands in western Uganda such as Rwenzori (Nyabirongo**) and** Kigezi highlands.
- On the other hand, **Areas in the path of** dry North East trade winds receive low annual rain fall for example Karamoja, Northern and North Eastern Kenya e.t.c

Influence of Water bodies. Areas adjacent large water bodies such as Indian Ocean, Lake Victoria and Tanganyika, rivers, and extensive swamps receive heavy rain fall because large water bodies provide large amounts of moisture to the atmosphere through evaporation, and recharging of trade winds resulting into convectional rain fall.

- On the other hand, Areas with limited water bodies or far away from water bodies are devoid of these effects leading to low rain fall for example Karamoja, Turkana, Marsabit e.t.c

Influence of Vegetation cover. Areas with dense vegetation cover receive heavy rain fall through the process of evapo-transpiration for example the tropical rain forests like Mabira, Kalangala islands, Bwindi and mangrove forests in the coastal areas.

On the other hand, **Areas** with semi and desert vegetation such as Bush and thickets receive low rain fall because of limited transpiration for example Karamoja, Rift valley areas, Ankole Masaka corridor, Marsabit and wajir in north eastern Kenya.

Influence of warm ocean current. The coast of East Africa is washed by the Mozambique warm current which recharges the South East winds blowing over it resulting into high temperatures, evaporation and heavy rainfall around Malindi, Mombasa, Tanga, Dar salaam, Kilwa e.t.c

Influence of Human activities. Areas where environmentally friendly activities such as afforestation, re-afforestation, cloud seeding, protection of moisture sources e.t.c receive heavy rainfall because such activities increase evapo-transpiration.

On the other hand, areas where human activities degrade moisture sources reduce evapo-transpiration leading to low rainfall. For example deforestation, swamp reclamation, sinking bore holes, bush burning, over grazing, industrialization e.t.c for example Karamoja.

Coastal configuration or alignment. This means the shape of the coast in relation to the direction of prevailing winds. The North Eastern coast of Kenya for example, lies parallel to North East winds which are forced to blow off-shore for a considerable distance leading to limited rainfall in the adjacent areas.

On the other hand, coastal areas in the direction of South East trade winds from the southern part of Indian Ocean experience heavy rainfall because the winds blow on-shore for example Mombasa, Kilwa, Malindi, Dar-es-Salaam e.t.c.

Continentality effect or distance from the sea or ocean. Coastal areas in the path of trade winds experience heavy rain fall than areas located far inland. This is because moist winds deposit moisture in the coastal areas for example Malindi, Kilwa, Tanga and continue loosing it as they travel inland leading to low rainfall for example Karamoja and Miombo in Tanzania.

Coriolis force effect. This is a deflecting force at the equator created by earth's rotation. The Coriolis Effect affects the south east trade winds in the southern hemisphere deflected to the left and recharged with moisture by lake Victoria leading to heavy rainfall on the northern and north eastern shores of lake Victoria basin.

-On the other hand, this deflection results into aridity on the North Western shores of Lake Victoria (Ankole-Masaka corridor)

Perturbation. This is the situation where low-pressure is created over the Indian Ocean and high pressure over the mainland. The low pressure created in Indian ocean attracts air/ wind from the interior to Indian ocean leading to heavy rainfall in islands such as Zanzibar and Pemba; leaving the main East African landmass especially Northern Eastern Kenya deprived of rainfall hence aridity.

To what extent does inter tropical convergence zone influence rain fall distribution in East Africa.

Approach.

- ❖ Define the term inter tropical convergence zone
- ❖ Explain how it is formed
- ❖ Give the 1^{St} evaluation and explain how I.T.C.Z influences rain fall distribution in East Africa.
- ❖ Give the 2^{rd} evaluation and explain other factors that influence rain fall distribution in East Africa.

Answer guide

- Inter tropical convergence zone is a low pressure belt associated with low equatorial latitudes.
- The I.T.C.Z is characterized by high temperatures and low pressure and its formation follows the apparent migration of the sun $23^1/_2$ north and south of the equator and it is responsible for rainfall distribution to a larger extent as explained below.
- Where the sun is over head, high temperatures create a low pressure zone which attracts the North East and South East trade winds to converge in the low pressure zone.
- The hot ground heats the moist air, rises and condenses into Cumulo-nimbus clouds resulting into convectional rain fall accompanied by lightening and thunder storms and comes mainly in the afternoon.

- The sun is over head the equator twice per annum in March and September.
- The first appearance occurs in March, creates the first rain season from March, April and may. The second appearance occurs in September, creates the second rain season from September, October and November. Fore example in Entebbe and other areas on the Northern shores of Lake Victoria.
- When the sun is over head in the southern hemisphere, much of the southern and central Tanzania receive rain fall during December and January.
- When the sun is in the northern hemisphere, northern and North Eastern Uganda and northern Kenya receive rain fall in the months of June and August.

Other factors that influence rain fall distribution in East Africa include; altitude, relief, ocean currents, water bodies, continentality effect, air masses, perturbation, human activities, coastal alignment e.t.c

📖 **Remember to explain these factors.**

☞Research question

To what extent has altitude influenced the distribution of rain fall in East Africa?

ATMOSPHERIC PRESSURE AND LAND AND SEA- BREEZES

(a)What is atmospheric pressure?

(b)Explain the causes of variations in atmospheric pressure in a particular region.

Approach

- ❖ Describe atmospheric pressure
- ❖ In part (b) explain the factors responsible for the variation in atmospheric pressure.

Answer guide

▪Atmospheric pressure is the force or weight exerted by air per unit area under the surface of the earth.

▪Mathematically, it's expressed as pressure= $\frac{\text{force}}{\text{Area}}$

▪It is measured at a weather station using an instrument called a barometer.

▪The standard units for measurement are called millibars (mb).

▪ It is often corrected to the average of 1013 millibars at sea level.

▪Lines drawn on the map to join places of equal pressure are called isobars.

▪The pressure varies with temperature. Areas of high temperature have low pressure and areas of low temperature have high pressure.

▪Pressure also varies with altitude. High altitude areas have low pressure while valleys have high pressure.

▪It also tends to be higher in cold air than in warm air. This is why it decreases with height in the atmosphere.

Factors that influence atmospheric pressure

Differences in temperature. High temperatures cause a fall in pressure while a low temperatures lead to high pressure. When air is heated, it expands, the pressure of its molecules spread outwards over a larger area and the pressure of the air decreases. When air is cooled, it contracts and the pressure of its molecules spread over a smaller area which leads to arise in the pressure of the air.

This is the reason why cold air masses and cold ocean currents flow from high pressure regions to tropical regions of low pressure.

Latitudinal differences. Atmospheric pressure is low in the tropics because of high temperatures caused by the over head sun and low at higher latitudes such as the poles because of low temperatures or cold conditions.

Altitudinal differences. The pressure of air at ground level is higher than that of air on mountain tops such as the Rwenzori, Kilimanjaro and Kenya.

▪This is because air descending down slope exerts greater weight on the air at the surface. Consequently, the molecules of the air at the ground push outwards over a larger area and its volume increases with a force equal to that exerted above.

▪In contrast, air at the top of a mountain has less weight exerted on it, its molecules spread over a smaller area, and its volume decreases.

Combined effect of earth's rotation and temperature create variation in pressure at different latitudes. For example, the rotation of the earth is very fast at the equator than at the poles. This combined with high temperatures create a low pressure belt at the equator.

The rising air from the equator is deflected, cools and sinks back to the surface to form a high pressure belt at horse latitudes 30^0 north and south of the equator e.t.c.

Differences in the heating capacity of water and land surfaces create different pressure zones between land and water. That is;

▪In temperate regions, land heats and warms faster in summer than ocean hence a low pressure zone on land and a high pressure zone over the sea or ocean. In winter, land cools very fast than the sea hence a high pressure zone over land and a low pressure zone over the sea.

▪In tropics, daily heating creates pressure zones in form of land and sea breeze. That is, land warms faster than the sea during day hence a low pressure zone over land and a high pressure zone over the sea.

▪At nigh, land cools rapidly than the sea hence a high pressure zone over land and a low pressure zone over the sea.

Change in seasons due to the apparent movement of the sun and revolution and tilt of the earth on its axis create variation in pressure. That is; where the sun is over, there is intense heating of the ground leading to high temperature hence low pressure, and low temperatures and high pressure where the sun is not over head .The sun is over head the tropics at different time of the year. For example;

▪When the sun is over head tropic of Capricorn in the southern hemisphere in December, its summer hence low pressure and its winter in the northern hemisphere hence high pressure

▪When the sun is over head tropic of cancer in the northern hemisphere in June, its summer hence low pressure and winter in the southern hemisphere hence high pressure.

Time of the day- influences variation in pressure during day and night in the tropics. That is, the earth is uniformly heated at 12:00 a.m .Therefore, from 9:00 a.m- 4:00 p.m pressure is low in low latitudes and high from 7:00 p.m – 6:00 a.m

Differences in the force of gravity- cause variation in pressure. Pressure is high in areas with high gravity such as mountain tops, Polar Regions and low in areas with low gravity such as valleys and equatorial regions.

Depressions and anticyclones. A depression is a mass of air whose isobars form circular shape, where pressure is low at the centre and increases towards the outside while an anticyclone is a mass of air with high pressure at the centre and decreases towards the out side.

▪Therefore, a depression creates low pressure where it is formed and a high pressure in the surrounding areas while an anticyclone creates high pressure where it is formed and low pressure in the surrounding areas.

LAND AND SEA BREEZES IN EAST AFRICA

(a)Account for the formation of land and sea breezes.

(b) Explain the effects of land and sea breezes on weather in East Africa.

Approach

- ❖ Define land and sea breezes
- ❖ Identify areas where they occur in East Africa
- ❖ Explain how each breeze is formed
- ❖ Draw diagrams showing the movement of winds in each case
- ❖ Explain the effects of each breeze on the weather.

Answer guide

▪A breeze refers to the air that blows from areas of low temperatures to areas of high temperatures.
▪Land and sea breezes are local winds developing as a result of temperature differences on land and sea (water bodies) during night and day respectively.
▪They blow on a daily basis and occur in areas where land is lying in close proximity to the water body for example;
around the northern shores of Lake Victoria basin, the coast of Kenya and Tanzania, and islands in Indian ocean such as Zanzibar and Pemba.

Causes of land and sea breezes

▪They are a result of diurnal differential heating of land and water.
▪Differences in the mobility of heat. That is, mobility of heat in water is greater than land which is solid. That's why water takes long to warm up.
▪Differences in heat transmission through water which is transparent as opposed to land which is opaque.
▪Differences in the reflecting capacities of heat between land and water.
▪They occur in a clear weather.

SEA-BREEZE (day time) - process of development

▪A sea breeze refers to a body of dense air that blows from a water body to replace the warm rising air on land.
▪It blows when there is intense heating of coastal land during day.
▪Land warms faster than the sea hence temperatures are high over land and colder over the sea.
▪Air above the ground heats up, forming convection currents of warm air rise over land and create low pressure at the surface.
▪The rising warm air condenses to clouds leading to occurrence of rainfall usually in the afternoon.
▪Cool and moist winds from the sea (sea-breezes) blow towards land to replace the warm rising air. That is from high pressure to low pressure.
▪on the Eastern shores of lake Victoria during day, the sea breeze and the evening prevailing Easterly winds cause a mild convergence leading to heavy showers in the late afternoon and evening.

Diagram

Effects of sea breeze on weather

▪Brings Cool temperatures on land in late afternoon and evening, for example around Lake Victoria (Kampala) That is, moderate temperatures are experienced.
▪Moist air may cause rain fall drizzles in the land adjacent to water bodies.

LAND BREEZE (night time) - process of development

▪A land breeze refers to dense air that blows during night to replace the warm rising air on the sea.
▪It blows during night when there is rapid Loss of terrestrial radiations in the coastal areas.
▪Land cools faster than the sea hence temperatures are cooler overland than over the sea which retains much of its heat absorbed before sun set.
▪Low pressure is created over the warm sea and high pressure over the cold land
▪Wind blows from land to the sea to replace the warm rising air. That is, from high pressure to low pressure. Hence formation of land breeze.
▪The rising warm air condenses into clouds leading to occurrence of rainfall usually in the afternoons.
▪Along the shores of Lake Victoria on the western side at night, the prevailing winds (Easterly winds) drift the clouds over the land where it may cause early morning showers.

Diagram

Effects of land breeze on weather

▪Cools temperatures over the sea because of the cool breeze from the land to the sea
▪Temperature inversion may occur over the sea leading to the formation of fog.
▪Land breeze results into light early morning showers.

MONSOON WINDS

(a)Explain the causes of monsoon winds over the Indian sub-continent.
(b)Describe the weather conditions associated with monsoon winds.

Answer guide

✓Monsoon winds are seasonal winds which blow across Asiatic continent in the northern hemisphere and the Indian ocean in the southern hemisphere at an interval of six months.
✓They occur on the Asian continent around china, Japan, Indian sub-continent and some parts of south East Asia.
✓Monsoon winds can be called land and sea breeze between Asiatic land mass and Indian ocean.
✓The word monsoon is derived from an Arabic word "mausim" which means seasons.

Monsoon winds are caused by;

✓Specific heating capacities between land and water, creates differences in pressure and subsequent wind movement.
✓During December-January, the Northern Hemisphere experiences winter. The low temperatures lead to creation of a high pressure zone in the Punjab region within the Asiatic landmass.
✓In the same period, the sun is in the southern hemisphere where its insolation effect (heat), leads to high temperatures and low pressure.
✓Difference in pressure caused by the apparent migration of the sun compels the wind movement from the cold regions (high pressure zone) in the Northern Hemisphere to drift towards the hot regions (low pressure zone) in the southern hemisphere.
✓This takes place in January and is called the January monsoon or North West monsoon.

DIAGRAM

✓During summer in the Northern hemisphere, and winter in the southern hemisphere, high pressure builds up in the southern hemisphere because of extreme cold conditions while a low pressure belt builds in the north because of high temperatures (summer)
✓Wind is compelled to move from the southern hemisphere towards the equator, it is deflected to the right and converges in the Punjab region within the Asian landmass across the Indian Ocean.
✓This is called the July monsoon or south East monsoon.

DIAGRAM

✓The differences in temperatures are thought to be brought about by the apparent movement of the over head sun over the tropic of cancer and Capricorn triggers the movement of trade winds across the Indian Ocean.

Weather associated with monsoon winds

▪Hot conditions as they originate from the tropical latitudes and blow over a warm ocean.
▪Humid conditions because winds blow over a warm ocean
▪Monsoon winds are associated with heavy torrential rainfall with thunder and lightening to many parts like Bombay in Asia. In East Africa, they bring some rain on the coast around Mombasa, Malindi, Kilwa and Dar es Salaam.
▪The rainfall on the Indian coast is due to the ascent of the monsoon winds over the Himalayas and Some times due to the collision with other winds especially cold ones from the north. For example Cherrapunji receives about 10,798mm per year making it the wettest place on earth.
▪Unfortunately, this rainfall is received in one short season (June-September), causing severe floods and destruction properties, leaving the rest of the year dry.
▪During the inter monsoon period; winds are light and variable, making morning skies clear leading to development of thunderstorm in the afternoons.
▪The winter monsoons bring clear dry weather, and winds that flow from land to the sea.

CLIMATE

(a)Differentiate between weather and climate

(b)Explain the factors which influence the climate of East Africa.

Approach

- Define both concepts and give their elements
- In part (b) identify the different types of climate of East Africa and where they occur
- Explain the factors influencing the climatic conditions in East Africa
- Give relevant examples.

Answer guide

▪Weather is the state or condition of the atmosphere of a given place at a particular time.
▪Weather is recorded over a short period of time for example hour/ day.
▪Weather elements include rainfall, temperature, wind speed and direction, humidity, atmospheric pressure, cloud cover and sunshine.
▪Weather affects a small or localized area and may vary from time to time and from place to place.
▪Weather elements can be observed and recorded at the weather station.
▪Weather can be described as being rainy, sunny, hot, cool, windy, foggy, frosty, misty e.t.c.

Where as

▪Climate is the average weather conditions of the atmosphere of an area recorded over a long period of time of atleast 30-35 years.
▪Climatic conditions tend to remain relatively stable over a long period of time though with minor variations.
▪Climate affects a large area or region for example Lake Victoria basin, northern Uganda e.t.c
▪Types of climate include, equatorial climate (hot and wet), tropical climate, montane climate, desert climate, Mediterranean climate, tundra climate e.t.c

FACTORS THAT INFLUENCE THE CLIMATE OF EAST AFRICA

Although East Africa lies astride the equator, it does not experience uniform climate.

TYPES OF CLIMATES IN EAST AFRICA

East Africa experiences varied climates fore instance;

Equatorial climate- experienced over the Northern shores of Lake Victoria basin, south western Uganda, parts of coastal areas in East Africa

Moist tropical / modified equatorial climate- experienced in most parts of central and western Uganda, slopes of mountain Rwenzori, Elgon, Kenya and Kilimanjaro, central and western Kenya and some coastal areas

Tropical savanna- experienced in most parts of Northern and central Uganda, southern Tanzania e.t.c

Semi desert/ desert/ arid climate or dry tropical climate experienced in northern Kenya (Chalbi desert), southern Kenya (Nyeri desert), southern Nyika plateau, Eastern and western Rift valley regions, north eastern Tanzania, Karamoja region in north eastern Uganda, Ankole – Masaka corridor,

Tropical monsoon/ moist tropical climate- experienced in coastal areas such as Mombasa, Eastern parts of Pemba and Zanzibar islands due to the monsoon / seasonal winds blowing from the Indian Ocean.

Montane / Alpine climate experienced on the mountain peaks of Elgon, Kenya, Meru, Kilimanjaro, Rwenzori, Mgahinga, Muhavura, Sabiniyo e.t.c due to high altitude

☞**Alternatively, the candidate may draw a sketch map of East Africa showing the climatic zones.**

FACTORS THAT INFLUENCE THE CLIMATE OF EAST AFRICA

The factors that influence the climate of East Africa are **physical and human** in nature for example; Altitude, latitude, relief, prevailing winds, distance from the sea, nature of vegetation, water bodies, coastal configuration, corioris force, perturbation, ocean currents, and human activities.

Altitude (height above sea-level). Areas at high altitude such as Mountain Rwenzori, Kenya e.t.c experience cooler / lower temperatures and heavy rainfall as opposed to the low altitudinal areas as

the coastal belt and the East African rift valley. This is because temperatures reduce with increase in altitude at a normal lapse rate of 6.5^{0}c for every 1000m of ascent. This is the reason why mountain peaks of Rwenzori, Kenya and Kilimanjaro over 4500 meters above sea level experience snowfall. In addition, high altitude areas experience low atmospheric pressure as opposed to low altitude areas.

Influence of relief. Regions composed of highlands experience cool temperatures and relief rain fall on the windward side as opposed to areas on the lee-ward side and areas composed of plateaus and low lying relief. This is because highlands/mountains act as barriers to moist winds; forcing them to rise over, cool and condense into clouds resulting into Orographic/ relief on the windward side. For example the south Eastern slopes of mountain Kilimanjaro, Elgon and Kenya, and arid conditions on the leeward side for example Northern Kenya on the leeward side of the Ethiopian highlands, Kasese and parts of Fort Portal on the lee-ward side of Mountain Rwenzori.

Latitudinal location. The low latitudinal position of East Africa explains the tropical nature of climate generally characterized by high temperatures since the sun is always near the earth at the equator; sun's rays travel short distance and hit small areas raising temperatures easily.

The high temperatures also create a low pressure zone called Inter Tropical Convergence Zone (I.T.C.Z); attracting air masses leading to formation of convectional rainfall received **over** the Northern shores of Lake Victoria basin, southern Tanzania and Northern Uganda when the sun is overhead the tropic of Capricorn and cancer respectively.

Influence of air masses/ prevailing winds. East Africa experiences moist and dry air masses which bring humid and arid conditions for example;

▪The south East air masses are moist because they originate from the southern part of Indian ocean; pick moisture and deposit it inform of heavy rain fall in the adjacent coastal areas around Malindi, Mombasa, Tanga, Dar salaam, Kilwa and the Northern shores of Lake Victoria basin after deflection at the equator.

They also bring arid/ dry conditions to central Tanzania and Ankole – Masaka corridor due to deflection at the equator by the Coriolis force.

▪The westeries also moist -originate from the southern part of Atlantic Ocean pass via the Congo basin; bring in heavy rainfall to south western Uganda in areas such as Nyabirongo, Rukungiri, Kabale and Bushenyi and dry conditions in Kasese e.t.c

▪Tropical Continental air masses such as North East and Harmattan are dry; bringing arid conditions over parts of northern Uganda, Karamoja region and northern, north eastern Kenya e.t.c

Distance from the sea / continentally effect or nearness to water bodies. Areas adjacent Large water bodies such as Indian Ocean, Lake Victoria and Lake Tanganyika experience heavy rainfall, moderate temperatures and small diurnal temperature range due to high evaporation and land and sea breezes, for example the northern shore of lake Victoria basin. On the other hand areas located far away in the interior of the continent don't experience such hydrologic processes leading to arid conditions for example Karamoja and Marsabit in Kenya.

Influence of Mozambique warm ocean current-The coast of East Africa is washed by the Mozambique ocean current which raises the temperature of the South East winds blowing over it resulting into high temperatures, humidity, heavy rainfall and high pressure in adjacent areas such as Malindi, Mombasa, Tanga, Dar salaam, Kilwa e.t.c

Influence of vegetation cover. Areas covered by forests experience high rates of evapo-transpiration resulting into heavy rainfall and cool temperatures for example Mabira, Budongo, Bwindi and the Mangrove forests at the coast. On the other hand areas covered by savanna grassland and semi –desert vegetation experience limited evapo-transpiration resulting into aridity for example Karamoja, Ankole-Masaka corridor, central Tanzania, Northern, and North Eastern Kenya e.t.c

Coastal configuration or alignment- it refers to the shape of the coast in relation to the direction of prevailing winds. The alignment of the coast North of Mombasa is parallel to North East winds which are forced to blow off-shore for considerable distance leading to aridity in north eastern Kenya.

On the other hand, the alignment of the coast south of Mombasa lies in the path of South East trade winds hence blow on-shore; bringing high humidity, heavy rainfall and high pressure in adjacent areas such as Malindi, Mombasa, Tanga, Dar salaam, Kilwa e.t.c

Coriolis force effect-coriolis force is a deflecting force at the equator created by the earth's rotation. It deflects winds in the Northern hemisphere to the right and to the left in the southern hemisphere. The Coriolis force deflects the south East trade winds to the left as they approach the equator; making them on-shore winds on the northern shores of Lake Victoria basin leading to high humidity, heavy rainfall and cloud cover. The deflection however deprives the south western part of Lake Victoria of moisture leading to aridity in areas such as Ankole – Masaka corridor.

Perturbation. This is the situation where low-pressure is created over the Indian Ocean and high pressure over the mainland. The low pressure created in Indian ocean attracts air/ wind from the interior to Indian ocean leading to heavy rainfall in islands such as Zanzibar and Pemba; leaving the main East African landmass especially Northern Eastern Kenya deprived of rainfall hence aridity.

Influence of human activities. Environmentally unfriendly human activities such as deforestation, bush burning, wetland reclamation, bore hole drilling, industrialization, over Grazing and other poor farming methods lead to desertification characterized by low humidity, rainfall and high temperatures. On the other hand, afforestation and other environmental conservation practices increase humidity, rainfall and moderate temperatures.

(a)Describe the characteristics of Equatorial type of climate.

(b) Explain the factors that have led to the occurrence of an Equatorial climate in East Africa.

Approach

- Identify areas that experience equatorial type of climate
- Describe the characteristics
- Explain factors favoring its occurrence.

Answer guide

Equatorial type of climate is experienced over the Northern shores of Lake Victoria basin , south western Uganda, parts of coastal areas in East Africa, Amazon basin in south America, parts of south East Asia such as Malaysia, Indonesia e.t.c

Equatorial type of climate is characterized by;

- Generally hot temperatures throughout the year
- Great uniformity of temperatures throughout the year ranging between 25^0c- 28^0c on average
- Maximum temperature is 38^0c while the minimum temperature is 15^0c depending on location
- The diurnal range of temperature is small and so is the annual range
- Convectional rainfall is usually received during afternoon and evenings, accompanied by thunderstorms and lightening
- Receives heavy rain fall and is well distributed throughout the year
- Two maxima rainfall with peaks in March and November (Bi-modal pattern)
- Rainfall totals range between 1000-2000mm per annum on average
- There is no clear / marked dry season
- Humidity is high over 80% due to high rate of evapotranspiration
- Cloud cover is thick throughout the year due to high rates of evapotransipiration and condensation
- Presence of low pressure belts in Areas dominated by air masses that converge at the I.T.C.Z hence a region of calmness-light winds.

Impression marking ……..max……..10mks

Factors that have led to the occurrence of an Equatorial climate in East Africa

Altitude- areas below 1000m above sea level tend to experience equatorial climate in terms of hot temperature. Generally the altitude of East Africa especially plateau are below 1000m a.s.l for example the coastal plains

Latitude- areas lying between O^0 to 5^0 N or S of the equator and below 1000m above sea level experience an equatorial climate due to high sun's insolation received

Vegetation cover-East Africa has tropical rain forests such as mabira which increase humidity, cloud cover and rain fall due to high evapotranspiration

Water bodies- East Africa has large water bodies such as Lake Victoria, Indian Ocean, rivers and extensive swamps which cause micro-climate effects through land and sea breezes and increased evaporation; leading to high humidity, cloud cover, rain fall and small diurnal range of temperature.

Influence of air masses/ winds where the south east trades are onshore, they maintain an equatorial type of climate for example at the coast around Malindi, Mombasa, Tanga, Dar salaam and Kilwa

Influence of the Inter Tropical Convergence Zone (I.T.C.Z) and the apparent movement of the over head sun influences insolation and rainfall pattern. The temperature and rainfall received varies with he position of the overhead sun

Cloud cover- thick cloud cover prevents heat loss in the space hence more heat is retained leading to a small range of temperature.

Relevant diagrams should be drawn to illustrate the answer

Impression marking…….15 marks

To what extent is the Lake Victoria type of climate equatorial?

Approach

- State the characteristics of the equatorial type of climate
- Explain how these characteristics conform to those of Lake Victoria basin
- Give the 1St evaluation and Identify and explain areas of Lake Victoria basin which don't conform to equatorial climate
- Give the 2rd evaluation and explain other factors that modify the climate of Lake Victoria basin.

Answer guide

Equatorial areas characterized by;

- Temperatures are uniformly high through out the year. That is, between 24^0C – 27^0 C.
- Heavy rain fall is received and well distributed through out the year averaging between 1500 mm-2500 mm
- The area is located astride the equator and receives a bimodal pattern of rain fall That is, March and November.
- The area is located where greatest insolation occurs with a small diurnal range of temperature of between 2^0C – 3^0 C.
- There is extensive and dense cloud cover.
- Relative humidity is usually high throughout the year over 80%
- The equatorial climate areas with no distinct dry season. So the area is almost wet through out the year.

Areas that conform to the above characteristics on Lake Victoria basin are;

- The Northern and north eastern parts of Lake Victoria have almost uniform high temperatures through out the year of about 27^0C
- Rain fall received in the northern and north eastern shores of Lake Victoria is heavy ranging between 1250mm - 2000mm per annum.
- Island areas of Lake Victoria such as Kalangala, Buvuma e.t.c receive about 2193 mm of rain fall per year.
- Bukoba receives 2030mm of rain fall per year.

Areas of Lake Victoria basin with little or don't conform to equatorial climate/ modified equatorial climate include;

- The northern parts of Lake Victoria basin receives less rain fall and has longer dry season. These areas experience high temperature ranges
- Mwanza in the south receives very little rain fall of about 989 mm a year. This characteristic of savannah type of climate
- The eastern parts of Lake Victoria don't reflect equatorial type of climate fore example Kisumu has rain fall of 1220 mm per year.

Therefore, it's to a small extent that the Lake Victoria basin has a true equatorial type of climate.

To a largest extent the climate of East Africa is not truly equatorial. It has been;

- Modified by altitudinal elevation since the basin lies 1200 meters above sea level
- Relief partly plays a role in modifying the climate of East Africa.
- Man's activities like deforestation, swamp reclamation, industrialization and urbanization, bore hole drilling over grazing, bush burning e.t.c has also modified the climate of the Lake Victoria basin.

EFFECTS OF MAN'S ACTIVITIES ON CLIMATE

The climatic anomalies in East Africa are a product of man's activities". Discuss.

Approach

- Define climate
- Show that East Africa is crossed by equator and therefore expected to have equatorial climate.
- However this is not the case
- Explain the anomalies
- Give the 1St evaluation and explain the role of man in causing these anomalies.
- Give the 2rd evaluation and explain the role of other factors.

Answer guide

East Africa is crossed by the equator and therefore expected to have equatorial climate characterized by;

- Generally hot temperatures throughout the year
- Great uniformity of temperatures throughout the year ranging between 25^0c- 28^0c on average
- Maximum temperature is 38^0c while the minimum temperature is 15^0c depending on location
- The diurnal range of temperature is small and so is the annual range
- Convectional rainfall is usually received during afternoon and evenings, accompanied by thunderstorms and lightening
- Receives heavy rain fall and is well distributed throughout the year
- Two maxima rainfall with peaks in March and November (Bi-modal pattern)
- Rainfall totals range between 1000-2000mm per annum on average
- There is no clear / marked dry season
- Humidity is high over 80% due to high rate of evapotranspiration
- Cloud cover is thick throughout the year due to high rates of evapotransipiration and condensation
- Presence of low pressure belts in Areas dominated by air masses that converge at the I.T.C.Z hence a region of calmness-light winds. However this is not the case.

There are numerous anomalies in the equatorial region brought about by physical and human activities. These anomalies include;

The Northern shores of Lake Victoria basin and highland areas such as Kigezi and Kenya highlands are the wettest in the region with high rain fall of above 1500mm per annum and high temperature of about 24^0C-28^0C other areas include Bukoba, Entebbe, Mukono, Jinja, Kalangala/ Ssese islands, Nyanza province in Kenya, e.t.c

Some areas experience alternate wet and dry seasons thus receive heavy rain fall during the wet season and a long dry spell characterized by high temperatures. Fore example central plateau and southern parts of Tanzania, Northern Uganda for example Gulu e.t.c

Some areas are experience semi desert climate characterized by low annul rainfall of less than 500mm, high temperatures ,low humidity and clear skies Fore example Karamoja, North western and north eastern Kenya, Ankole-Masaka corridor, e.t.c

Desert climate characterized by very low annual rain fall of less than 250mm, very high temperatures, clear skies e.t.c for example central northern areas of Kenya, Turkana and Marsabit (Chalbi desert).

Man through his activities is to a larger extent responsible for the above anomalies in the following ways;

Deforestation- it refers to the cutting down of forests without replanting them. Deforestation occurs because of the need for wood fuel, timber, land for settlement and agriculture, industrialization e.t.c. Deforestation leads increase in carbondioxide in the atmosphere which results into global warming. It also reduces the rate of evapo-transpiration leading to low humidity, cloud cover and rainfall. Deforestation is common in central Uganda, Kabale, Nyanza and Central Kenya e.t.c

Overstocking and overgrazing. Overstocking is the rearing of bigger number of animals on pastureland than what the pastureland can comfortably accommodate. Overstocking of livestock leads to overgrazing; responsible for destruction of vegetation cover and soil degradation which ultimately reduce the rate of evapo-transpiration leading to low humidity, low cloud cover and rainfall and high temperatures, for example in pastoral areas such as Karamoja, Masai, Turkana e.t.c

Repeated bush burning especially in pastoral communities so as to prepare for good pastures, kill pests and diseases, create and expand farms e.t.c leads to destruction of vegetation cover and soil degradation resulting into low rate of evapo-transpiration, low humidity, low cloud cover, low rainfall and high temperatures, for example in Karamoja, Mbarara, Turkanaland, Masai, Nakasongola, Miombo in Tanzania and other pastoral communities.

Sinking of boreholes and construction of valley dams especially in pastoral communities lowers the water table and affects the hydro-cycle leading to low humidity, low rainfall and high temperatures, common in semi-arid regions such as Karamoja, Miombo in Tanzania and other pastoral communities

Swamp reclamation for agriculture, dairying, settlement, industrial development e.t.c has led to disappearance of swampy vegetation, lowering of the water table and the hydro-cycle; leading to low humidity, low rainfall and high temperatures, for example Nakawa-Banda swamp , Nalukolongo-Natete swamp and swamps in eastern, central and western and Uganda.

Industrial development- has led to increased emission of heat trapping gases such as Carbondioxide in the atmosphere, depletion of ozone layer leading to global warming; responsible for climate change. In addition, industrial has led to degradation of moistures sources such as swamps and forests resulting into low humidity, low rainfall and high temperatures. For example Namanve industrial park

mining and quarrying- involves destroying vegetation cover and soil structure which ultimately reduce the rate of evapo-transpiration leading to low humidity, low cloud cover and rainfall and high temperatures, for example in Mwandui (Diamond), Tororo (limestone and vermiculite), Kilembe (Cobalt), Bamburi (cement), Gold, Tin, Wolfram in south western Uganda, murrum, sand, e.t.c

Settlement/ urbanization and other construction works such as road construction in areas of Kampala, Lugazi, Mukono, Nairobi, Kisumu, Jinja, Dodoma and other towns in central, Eastern and south western Uganda, Kenya and Tanzania has increased degradation of moisture sources such as swamps and forests resulting into low humidity, low rainfall and high temperatures.

Burning of fossil fuels such as oil increase carbondioxide and other heat trapping gasses in the atmosphere leading to global warming and climate change

Physical factors are also responsible for climatic anomalies in East Africa also to a large extent for example;

Trade winds, Influence of relief, Rotation of earth / Coriolis Effect, Poor vegetation cover, Absence of water bodies, Nature of relief, Coastal configuration, Continentality effect/ distance from the sea, Latitudinal location / influence of I.T.C.Z and Perturbation.

🕮 **Remember to explain these factors**

ARIDITY IN EAST AFRICA

Examine the causes of aridity in East Africa

Approach

- Define aridity
- Identify arid areas in East Africa
- Explain the physical and human conditions that have caused aridity

Answer guide

Aridity is a climatic condition characterized by persistent lack of moisture, low seasonal and unreliable rainfall, low humidity, high temperature and high diurnal temperature range, clear and cloudless skies and scorching sun

Arid areas in East Africa include Northern, North Western and North Eastern Kenya, central Tanzania, Karamoja region (North Eastern Uganda); and the leeward side of major mountains such as Kenya, Kilimanjaro, Rwenzori e.t.c

Aridity in East Africa is a result of physical and human factors for example latitude, relief, prevailing winds, distance from the sea, nature of vegetation, water bodies, coastal configuration, corioris force, perturbation and human activities.

PHYSICAL CAUSES

Nature of relief. Most arid areas in East Africa are generally flat and lack major highlands such as mountains to cause Orographic lifting of moist winds to form relief rainfall.

In addition the flat relief limits condensation of moist winds leading to aridity for example Albert flats, Karamoja e.t.c

The rain shadow effect- Most arid areas in East Africa lie on the leeward side of major highlands experiencing dry descending winds incapable of forming relief rainfall. In addition, the dry descending winds under go adiabatic expansion; absorbing moisture instead of releasing it, lead to aridity. For example Kasese and Albert flats lie on the leeward side of mountain Rwenzori. Karamoja, Northern and North Eastern Kenya lie on the leeward side of Ethiopian highlands and Ankole Masaka corridor is partly dry because of leeward effect of Kigezi highlands, Masai land is partly dry because of the leeward effect of mountain Kilimanjaro.

Long distance from the sea/ continentality effect. Most arid areas are located far away from large water sources such as Indian Ocean, Lake Victoria e.t.c hence do not experience land and sea breezes and evaporation which contribute to rainfall formation and moderate temperatures. In addition, moist winds travel long distance; lose moisture to adjacent areas leading to arid conditions to distant places far inland for example Karamoja, Marsabit, Ankole-Masaka corridor, central Tanzania e.t.c

Absence or presence of limited sources of moisture- for example lakes, extensive swamps, and permanent streams to increase moisture in atmosphere through evaporation, recharging of winds and activation of land and sea breezes. This results into hot temperatures, low moisture, rainfall and clear skies. For example Karamoja, Marsabit, Ankole-Masaka corridor e.t.c

Influence of prevailing winds bring arid conditions inform of hot temperatures, low rainfall and cloud cover. For example

The North East trade winds and Harmattan winds are hot and dry; causing aridity over northern, north eastern and north Western Kenya and North-Eastern Uganda.

The South East trade winds cause aridity over Northwestern shores of Lake Victoria (Ankole Masaka corridor) after being deflected by Coriolis force caused by earth's rotation.

Lastly, the westeries from the southern part of Atlantic Ocean and the Great Congo forests bring aridity on the leeward side of mountain Rwenzori, western rift valley and Albert flats where they descend and cause hot, dry and rainless conditions.

Coastal configuration or alignment. That is, the shape of the coast in relation to the direction of prevailing winds. The alignment of the East African coast North of Mombasa is parallel to North East winds which are forced to blow off-shore for considerable distance leading to aridity in north eastern Kenya.

Presence of poor natural vegetation cover such scrub, shrubs and thickets cannot release enough moisture to the atmosphere through evapo-transpiration for rain formation; results into low humidity, cloud cover, rainfall and hot temperatures, for example Northern Kenya, North Eastern Uganda e.t.c

Latitudinal location .some arid areas are located far away from the equator and in areas out side inter tropical convergence zone (I.T.C.Z. consequently regions such as Karamoja, northern and north

eastern Kenya, faraway from the equator receive rainfall only once in a year when the sun is overhead and dry conditions dominate most of the year.

Coriolis force effect. Coriolis force is a deflecting force at the equator created by the earth's rotation. It deflects winds in the Northern hemisphere to the right and to the left in the southern hemisphere. The deflection of the South East trades brings aridity to North West shores of Lake Victoria (Ankole-Masaka corridor)

Perturbation. This is the situation where low-pressure is created over the Indian Ocean and high pressure over the mainland. The low pressure created in Indian ocean attracts air/ wind from the interior to Indian ocean leading to heavy rainfall in islands such as Zanzibar and Pemba; leaving the main East African landmass especially Northern Eastern Kenya deprived of rainfall hence aridity.

Influence of human activities. Environmentally unfriendly human activities such as deforestation, bush burning, wetland reclamation, bore hole drilling, industrialization, over Grazing and other poor farming methods lead to desertification characterized by low humidity, rainfall and high temperatures. On the other hand, afforestation and other environmental conservation practices increase humidity, rainfall and moderate temperatures.

To what extent are Trade winds responsible for aridity in East Africa?

Approach

- ❖ Define aridity
- ❖ State the arid areas in East Africa
- ❖ identify the trade winds which cause aridity in East Africa and their source
- ❖ Give the 1St evaluation (large extent) and explain the influence of trade winds
- ❖ Give the 2rd evaluation (larger extent) and explain other factors responsible for aridity in East Africa

Answer guide``

Aridity is a climatic condition characterized by persistent lack of moisture, low seasonal and unreliable rainfall, low humidity, high temperature and high diurnal temperature range, clear and cloudless skies and scorching sun

Arid areas in East Africa include Northern, North Western and North Eastern Kenya, central Tanzania, Karamoja region (North Eastern Uganda); and the leeward side of major mountains such as Kenya, Kilimanjaro, Rwenzori e.t.c

Trade winds are prevailing tropical winds that blow from sub-tropical high pressure cells toward the equatorial low pressure cells from the North East in the northern hemisphere or from the southern hemisphere.

Those that blow in the Northern Hemisphere are veered to the right of their path to form the North East trades.

The ones that blow from the Southern Hemisphere are veered to the left of their path to form South East trades.

Trade winds are notable for their constancy of force/ speed and direction and f or this, they used to aid traders hence the name trade winds.

▪East Africa experiences 3 types of trade winds namely; North East trades, South East trades and westeries.

▪North East trades are hot and dry because they originate in the Arabian Desert to East Africa via Abyssinia or Ethiopia.

▪South East trades originate from the southern part of Indian Ocean, which makes them warm and moist. They keep changing as they blow over the main land areas.

▪The westeries blow from the Congo basin hence are moist laden and affect much of western Uganda.

Trade winds are responsible for aridity of East Africa to a greater extent as explained below;

▪The North East trades because of their origin and fetch/, bring hot and desiccating conditions over North Eastern Uganda, Northern, North Eastern and North Western Kenya. And at the time, they bring similar conditions in Eastern Kenya where they blow off-shore.
▪The South East trades bring aridity to North West shores of Lake Victoria (Ankole-Masaka corridor) when they are deflected by earth's rotation.
▪The westeries from Congo basin bring aridity over lee-ward sides of Mountain Rwenzori, Rift valley and Albert flats where they descend and bring hot, dry and rainless conditions.

Other factors that have contributed to aridity in East Africa include;

Low altitude, absence of mountains and other barriers to moist air, Latitude, distance from the sea, nature of vegetation, limited water bodies, coastal configuration, corioris force, perturbation and man's activities.

🕮 **Remember to explain these factors**

To what extent is man responsible for aridity in East Africa?

Approach

- Define aridity and Identify arid areas in East Africa.
- Give the 1St evaluation (larger) and Identify and explain the human activities that have increased aridity in East Africa.
- Give the 2r d evaluation (large) and explain the role of physical conditions.

Answer guide

Man is largely responsible for aridity through his activities like;

Deforestation- it refers to the cutting down of forests without replanting them. Deforestation occurs because of the need for wood fuel, timber, land for settlement and agriculture, industrialization e.t.c. Deforestation leads increase in carbondioxide in the atmosphere which results into global warming. It also reduces the rate of evapo-transpiration leading to low humidity, cloud cover and rainfall. Deforestation is common in central Uganda, Kabale, Nyanza and Central Kenya e.t.c

Overstocking and overgrazing. Overstocking is the rearing of bigger number of animals on pastureland than what the pastureland can comfortably accommodate. Overstocking of livestock leads to overgrazing; responsible for destruction of vegetation cover and soil degradation which ultimately reduce the rate of evapo-transpiration leading to low humidity, low cloud cover and rainfall and high temperatures, for example in pastoral areas such as Karamoja, Masai, Turkana e.t.c

Repeated bush burning especially in pastoral communities so as to prepare for good pastures, kill pests and diseases, create and expand farms e.t.c leads to destruction of vegetation cover and soil degradation resulting into low rate of evapo-transpiration, low humidity, low cloud cover, low rainfall and high temperatures, for example in Karamoja, Mbarara, Turkanaland, Masai, Nakasongola, Miombo in Tanzania and other pastoral communities.

Sinking of boreholes and construction of valley dams especially in pastoral communities lowers the water table and affects the hydro-cycle leading to low humidity, low rainfall and high temperatures, common in semi-arid regions such as Karamoja, Miombo in Tanzania and other pastoral communities

Swamp reclamation for agriculture, dairying, settlement, industrial development e.t.c has led to disappearance of swampy vegetation, lowering of the water table and the hydro-cycle; leading to low humidity, low rainfall and high temperatures, for example Nakawa-Banda swamp , Nalukolongo-Natete swamp and swamps in eastern, central and western and Uganda.

Industrial development- has led to increased emission of heat trapping gases such as Carbondioxide in the atmosphere, depletion of ozone layer leading to global warming; responsible for climate change. In addition, industrialization has led to degradation of sources moistures such as swamps and forests resulting into low humidity, low rainfall and high temperatures. For example Namanve industrial park

mining and quarrying- involves destroying vegetation cover and soil structure which ultimately reduce the rate of evapo-transpiration leading to low humidity, low cloud cover and rainfall and high

temperatures, for example in Mwandui (Diamond), Tororo (limestone and vermiculite), Kilembe (Cobalt), Bamburi (cement), Gold, Tin, Wolfram in south western Uganda, murrum, sand, e.t.c

Settlement/ urbanization and other construction works such as road construction in areas of Kampala, Lugazi, Mukono, Nairobi, Kisumu, Jinja, Dodoma and other towns in central, Eastern and south western Uganda, Kenya and Tanzania has increased degradation of sources moisture such as swamps and forests resulting into low humidity, low rainfall and high temperatures.

Burning of fossil fuels such as oil increase carbondioxide and other heat trapping gasses in the atmosphere leading to global warming and climate change

Physical factors are to a large extent are also responsible for aridity in East Africa for example, latitude, relief, prevailing winds, distance from the sea, nature of vegetation, limited water bodies, coastal configuration, corioris force, and perturbation.

🕮 **Remember to explain these factors.**

AIR MASSES

(a)Describe the characteristics of an air mass

(b)Explain the formation of air masses.

Approach

- Define air masses
- Give the characteristics of air masses
- Identify the major air masses
- Explain how air masses form.

Answer guide

An air mass is a large body of air with uniform horizontal temperature and humidity conditions.

Characteristics of air masses

▪They have definite source region/ latitudes for example tropical region, high latitude (Polar), Arctic/ Antarctic

▪They have uniform temperature conditions. That is warm (Tropical), cold (Polar), very cold (arctic / Antarctic)

▪They have Uniform humidity conditions

▪They blow from high pressure to low pressure regions .That is, from the Polar regions towards the Equator

May blow either over land (Continental) or over sea (Maritime) depending on the path

▪Have common or defined direction of movement from a defined source region

▪Converge at fronts/ Zones

▪Air masses may modify completely or partially conditions of areas they blow over.

Formation of air masses

Differences in temperature at the source region and surrounding areas lead to differences in pressure triggering off air movement.

The direction of the air mass is determined by the barometric gradient. In addition, Earth's rotation creates the Coriolis force that drags the air mass from the source region

The Path taken by air that is, water surface or land determines the final character of the air mass.

An Air mass develops over an area which is extensive and uniform in build and shape fore example desert surface such as Sahara and ocean surfaces.

Surface air mass may be caused by stagnation of air fore example areas of high and low pressure.

EFFECTS OF AIR MASSES ON THE CLIMATE OF EAST AFRICA

(a)What is an air mass?

(b) Explain the influence of air masses on the climate of East Africa.

Approach

- Define air mass
- Briefly explain how air mass is formed

- ❖ Give the characteristics of air masses
- ❖ Identify the air masses that affect the climate of East Africa
- ❖ Explain the climatic conditions associated with them
- ❖ Give examples of areas affected.

Answer guide

An air mass is a large body of air with uniform horizontal temperature and humidity conditions.
Air masses form when stationary air settles over a large uniform area for long, enabling it to acquire uniform conditions in terms of temperature and humidity of that particular region.

Air masses have the following characteristics

▪They have definite source region/ latitudes for example tropical region, high latitude (Polar), Arctic/ Antarctic
▪They have uniform temperature conditions. That is warm (Tropical), cold (Polar), very cold (arctic / Antarctic)
▪They have Uniform humidity conditions
▪They blow from high pressure to low pressure regions .That is, from the Polar Regions towards the Equator
▪They May blow either over land (Continental) or over sea (Maritime) depending on the path
▪Have common or defined direction of movement from a defined source region
▪Converge at fronts/ Zones
▪Air masses may modify completely or partially conditions of areas they blow over.

Air masses that affect East Africa include;

Tropical Maritime (South East trades) Tropical continental (North East trades and Westeries)
They influence the climate of East Africa in terms of temperature, humidity, cloudless, rain fall e.t.c as explained below;
The Tropical Maritime (South East) air masses originate from Indian Ocean and blow on shore the adjacent coast. They have high humidity and cause the following **characteristics;**
▪Bring high humidity modified (warm) temperatures, cloudy conditions and heavy rain fall in the adjacent coastal areas.
As they traverse main land Tanzania, they lose their moisture, there by bringing **hot, rainless, clear skies and dry conditions.**
Over Lake Victoria, however, they are recharged with moisture and deflected rightwards at the Equator, thereby ▪bringing **high humidity, cloudy and wet conditions** over the Northern, North Eastern lake basin/ shores.
However, because of this deflection, they blow off Ankle – Masaka corridor, bringing arid conditions characterized by **▪low humidity, high temperatures, clear skies, low and unreliable rain fall.**
Tropical Continental (North East) originates from the Asian land mass. As they blow over the Ethiopian highlands, moisture in them is lost, rendering them hot and dry.
▪They bring Low humidity, high temperature, clear skies, low and unreliable rain fall over Northern, North Eastern Uganda and Kenya.
After some time, the Tropical Maritime and Tropical Continental air masses meet at the Inter Tropical Converge Zone (I.T.C.Z). In the process, the warm moist Tropical Maritime air mass is forced to rise, giving rise to towering ▪cumulonimbus clouds, light variable winds and frequent thunderstorms / convectional rain fall**.**
Tropical Continental (westerly) winds originate from the southern part of Atlantic Ocean and blow over the Congo basin.
▪They are warm and moist. During their Eastward journey, they blow over highlands in western Uganda (Rwenzori), bringing heavy relief rain fall for example Nyabirongo, Kigezi e.t.c
▪On descending on the lee-ward sides of the mountain, winds are characterized by low humidity, clear skies, hot and rainless conditions in areas of Kasese, Ankole – Masaka, Lake Albert flats e.t.c

(a)What is an anticyclone?

(b) Describe the weather characteristics associated with anticyclones.

Approach

- Define anticyclones
- Give the characteristics of anticyclones
- Explain the weather associated with anticyclones.

Answer guide

An anticyclone is a system of atmospheric pressure associated with the horse latitudes (sub-tropical highs) in which there is high pressure at the centre and low pressure towards the periphery of the system.

Characteristics of anticyclones

▪The movement of anticyclones is clock wise in the Northern Hemisphere and anti -clock wise in the Southern Hemisphere.

▪Their general direction of movement is to the Eastern direction due to earth's rotation.

▪Anticyclones may remain stationary or move slowly

▪Anticyclones affect a larger area on continent

▪Winds in anticyclones blow outwards from the centre.

Diagram showing the movement of an anticyclone

Weather conditions associated with anticyclones

✓Anticyclones are associated with light winds

✓**The** weather in an anticyclone tends to be dry, warm and sunny during summer.

✓**During t**he winter season, the anticyclone is associated with light cloudy, cold, frosty and clear (day) weather conditions.

✓**It** is associated with radiation surface cooling.

✓**Anticyclones** are associated with descending air which is warmed adiabatically and dried thereby leading to stability in the atmosphere.

✓**Clouds** in an anticyclone don't give rise to rain in summer. Only fog and clouds are formed in winter.

✓**Fog** and smog formed during an anticyclone are associated with temperature inversion

✓**Prolonged** droughts occur when rains are expected

✓**Hazy** conditions occur due to the blowing of cold anticyclones over the Sahara towards the low latitude.

OCEAN CURRENTS

There are two types of ocean currents, namely; warm current and cold current **WARM OCEAN CURRENTS**

(a)Describe the characteristics of a warm ocean current.

(b) With reference to specific examples, explain the influence of warm ocean currents on the climate of adjacent land masses.

Approach

- Define ocean current and a warm ocean current
- state the causes and characteristics of a warm ocean currents
- Show the distribution warm ocean currents descriptively or by using a sketch map
- Explain the effects of warm ocean currents on climate with examples of different warm ocean currents.

Answer guide

Ocean currents are general movements or drifts of the surface water of the ocean in a defined direction.

Oceans currents are caused by differences in density / salinity of the ocean water, winds, earth's rotation and the shape of the adjacent landmasses.

A warm ocean current refers to the drift which has relatively high temperature than the surrounding areas.

Types of warm ocean currents

Mozambique/ Agulhas- on the Eastern coast of Africa
Guinea current- on the coast of Guinea
Brazilian current- on the coast of Brazil,
North Atlantic drift- on the western coast of Europe such as U.K and Norway
Gulf Stream current- flows north East ward along the coast of North America, Newfound land and the coasts of the British Isles
Kuroshio- along the coast of Japan in western Pacific Ocean and the **A**ustralian current

CHARACTERISTICS OF WARM OCEAN CURRENTS

▪Warn ocean currents have high temperatures than the surrounding water
▪flow from low latitude near the equator to high latitude. That is, from the tropics to the poles.
▪They generally move in clockwise direction in the Northern Hemisphere fore example the Kuroshio and the Gulf Stream drift. And anti-clock wise in the southern hemisphere fore example Brazilian current and Australian
▪They generally flow on the Eastern side of continents in low latitudes fore example the Brazilian current, Mozambique current , East Australian except for Guinea current.
▪In the mid latitudes and the high latitudes, they generally flow on the western side of the continent. Fore example the Pacific current and the North Atlantic drift and Kuroshio.
▪They are characterized by low density due to high salinity in the water
▪They flow on the surface but loose temperatures and become under water towards the poles.

🕮 **Towards the poles, they gradually cool, become dense and sink down to form cold ocean currents.**

EFFECTS OF WARM OCEAN CURRENTS ON CLIMATE

✓Warm ocean currents tend to raise the temperatures of the adjacent landmasses. When on-shore winds blow over the warm water, its temperatures are raised and in turn raises temperatures of the adjacent landmasses.
✓For example the North Atlantic drift raises the temperatures of coasts of Portugal, France, Netherlands, Britain, Norway and the ports remain ice- free in winter.
✓Durban on the East coast of South Africa washed by warm Mozambique has temperatures of 24.4. ^{0}C compared to Port Nolloth on the west coast on the same latitude, has 15.5 ^{0}C because of the cold Benguela current.
✓They increase the humidity of the adjacent land masses because high temperatures increase evaporation from the oceans and the coastal areas. Fore example Natal, coast of Mozambique, Dar es Salaam and Mombasa e.t.c due to the Mozambique current, Western Europe washed due to the North Atlantic drift.
✓They increase cloud cover of the adjacent land masses. As winds blow over a warm current, they absorb the moisture over that current and become moisture laden. As the winds reach the shore, the vapor is cooled down to condensation level leading to formation of thick Cumulo-nimbus clouds.

✓They facilitate the formation of heavy rain fall over the adjacent land because the on shore winds carry a lot of moisture from the warm ocean current. Fore example Natal on the East coat of South Africa, Mozambique coast, Dar es Salaam and Mombasa washed by the warm Mozambique.
For example Beira gets 1521 mm per annum while Durban receives 1008 mm per annum.
✓In Western Europe, warm ocean currents lead to Formation of cyclonic rain fall when warm moist laden air rises over cold dry air.

COLD OCEAN CURRENTS

(a)Describe the characteristics of a cold ocean current.

(b) With reference to specific examples, explain the influence of cold ocean currents on the climate of adjacent land masses.

Approach

- Define ocean currents and a cold ocean current
- Give the causes and characteristics of a cold ocean current
- Show the distribution cold ocean currents descriptively or by use of a sketch map
- Explain the effects of cold ocean currents on climate with examples of different cold ocean currents.

Answer guide

Ocean currents are general movements or drifts of the surface water of the ocean in a particular direction.

Oceans are caused by differences in density / salinity of the ocean waters, effect of winds and earth's rotation and the shape of the adjacent landmasses.

A cold ocean current refers to a drift which has relatively low temperature than the surrounding areas.

Types of cold ocean currents

The Canary- off the coast of North west Africa along the Moroccan coast,
Benguela current- off the coast of south West Africa along the Namibian coast,
Peruvian / Humboldt- off the coast of Chile and the west coast of Peru
Californian current- flows south wards on the western coast of North America
Oyashio/ kuril current

Characteristics of cold ocean currents

▪They are characterized by low temperatures
▪Cold ocean currents flow from high latitudes to low latitudes. That is, they flow towards the equator from the regions of low temperatures.
▪They generally flow on the western sides of landmasses for example Benguela, Peruvian, canary e.t.c in the low latitudes and
▪In the middle latitudes, they flow on the Eastern sides for example Labrador and Oyashio.
▪They are characterized by high density because of low temperature.
▪They are also characterized by up-welling along the coast.
🕮**A**s they flow towards the equator, they gradually become warm, light and up-well to form warm ocean currents.

Effects of cold ocean currents on climate

✓Cold ocean currents tend to lower the temperatures along the adjacent coast due to the influence of land and sea breezes. For example the Benguela current flowing north wards along the coast of Namibia, lowers the temperature of the Walvis Bay to an average temperature of 16 ^{0}C compared to Durban's 25 ^{0}C although both places are at the same latitude.

✓They are associated with off winds and cause condensation leading to the development of desert conditions fore example Sahara, Kalahari and Californian desert adjacent to the canary, Benguela and Californian cold ocean currents respectively.
✓They are characterized by advection fog on the surrounding areas, formed when warm wind passes over the cold ocean currents. Fore example the frequent fog at San Francisco in California and North East Canada because of the Labrador Current, Namibian coast as warm south trades cross the Benguela current.
✓They are associated with low humidity due limited evaporation
✓Low cloud cover because of limited evaporation resulting from condensation of moist winds.

CAUSES OF OCEAN CURRENTS AND EFFECTS ON HUMAN ACTIVITIES

Examine the causes and effects of ocean currents on human activities on the adjacent areas.

Approach

- ❖ Define ocean currents
- ❖ Identify the types of ocean currents
- ❖ Give examples of ocean currents and where they are located
- ❖ Give the characteristics of each type briefly.
- ❖ Explain the effects of ocean current on man's activities.

Answer guide

📖**Refer to the questions above for the introduction**

Causes of ocean currents

Ocean currents are caused by wind, differences in density, differences in temperature, earth's rotation and shape of the landmass.

Wind is the major cause of ocean currents. As wind blows over the surface of the ocean, friction is generated between the wind and the top water layers. Energy is transferred from wind to water causing the water to move in the same direction as the wind. Fore example the westerly winds produce the North Atlantic drift.

Differences in density of water. Sea water is salty/ saline and the salinity varies from one part of the ocean to another. Salty water is dense and tends to sink while less saline water is light and up-wells.

Differences in temperature- cause variation in water density. Water in the Polar Regions is cold due to low temperatures hence dense, sinks to the bottom of the ocean and flows towards the equator.

Water in equatorial regions is warm due to hot temperatures, light and tends to flow on the surface towards the poles.

Earth's rotation due to Coriolis Effect. Besides affecting the direction of the winds, the earth's rotation also tends to deflect ocean currents obliquely to the right in the Northern hemisphere and to the left in the southern hemisphere. Fore example the Mozambique current, the Brazil current and North Equatorial current.

Land masses. When ocean current moves towards a land mass, the current is deflected and some times splits into two. Fore example the North Atlantic drift and the south Equatorial ocean current.

Effects of ocean currents on human activities

✓The upwelling of cold water brings rich nutrients such as nitrates and phosphates vital for the growth of planktons while the mixing of cold and warm ocean currents creates conducive conditions which favor growth of planktons and fish breeding; leading to development of fishing industry.
Fore example along the coast of South Africa, Morocco, Namibia e.t.c.

✓Fish canaries provide a wide range of employment to the people hence source of **income** and foreign exchange from fish exports.

✓Warm ocean currents increase temperatures and induce heavy rainfall in the adjacent areas which encourage plantation agriculture.

Fore example Sugar plantations in Natal due to presence of warm Mozambique currents while Guinea warm current favor cocoa and palm oil plantations in West Africa, cloves in Zanzibar, market gardening around ports of Mombasa, Dar-es-Salaam and port Durban.

✓Trade and commerce due to accessibility and ice free conditions of the ports. Fore example ports in Western Europe.

✓Aridity along the coast washed by cold currents has encouraged nomadic pastoralism. Fore example pastoral groups like the Fulani in the Sahel and Hontentos of Namibia. There is also ranching inland.

✓Heavy rainfall along the coast of warm ocean currents supports equatorial rain forests hence **forestry** and lumbering. Fore example lumbering in Rainforests in Gabon, Ghana, Nigeria, Liberia, and Cote devour due to presence of Guinea currents. Forestry on the wind- ward side of the Drankenburg.

✓The warm ocean currents washing along the East African coast create ideal conditions for coral reef development; exploited for cement production. Fore example Bamburi cement.
✓There is also development of tourism due to warm conditions on the beaches of adjacent coast washed by warm ocean currents fore example coral reefs at Mombasa and Dar es Salaam, beaches in Durban e.t.c.
✓Irrigation agriculture is carried out enabling viticulture and market gardening fore example in Namibia and in parts of Ghana.
✓Warm ocean currents create ideal conditions which facilitate urbanization. Fore example Durban, Mombasa, e.t.c
✓North Atlantic drift facilitates water transport through accelerating the speed of ships. Consequently, there is reduction in time taken by ships to reach to their destinations.

SOIL IN EAST AFRICA

(a)What is soil?
(b)Examine the processes of soil formation in East Africa
Approach

- Define soil
- Give and explain briefly components of good soil.
- Describe the processes that lead to formation of soil in their order.

Components/ Constituents of Soil

Soil is a thin layer of the earth crust composed of naturally weathered rocks, water, organic matter and living organisms capable of supporting plant life.
Good soil consists of;
Tiny mineral particles derived from weathering of parent rock. For example phosphorus, magnesium, potassium, calcium, sulphur, iron, copper and zinc
Humus derived from decaying Organic matter. Humus is broken down by micro-organisms to enrich the soil with nitrogen, phosphorus, calcium and potassium which plants absorb through roots. Humus increases soil fertility, soil texture and water retention for example in sandy soils.
Living organisms such as earth worms, termites and bacteria such as "rhizobium" (nitrogen fixing bacteria in legumes). Living organisms decompose organic matter physically and chemically to form humus. The number of living organisms in the soil depends on the aeration of soil.
Air- for example oxygen and nitrogen to support living organisms in soil. The amount of air present in the soil depends on drainage. Therefore waterlogged places have limited air and biological activity.
Water derived mainly from rainfall and varies from nil in deserts to logging in equatorial regions. Water moves down in the soil by infiltration and to sub-layers by percolation and upwards to the surface by capillarity.
Water dissolves minerals taken up by plant roots. It also acts as a medium for chemical weathering processes that take place within the soil for example leaching and eluviation.

PROCESSES OF SOIL FORMATION

Processes of soil formation refer to activities that take place to produce soil from parent material, organic and inorganic matter. These processes include weathering, leaching, Eluviation, Illuviation, Humification, Mineralization, Calcification, Calcification, Laterisation, Gleization and Podzolisation; and have to be presented in order.
Weathering- refers to the physical disintegration and chemical decomposition of rocks in situ by natural agents on or near the earth surface.
Weathering of the parent rock produces tiny mineral particles or colloids which are worked on by other soil forming processes to produce mature soil.

High weathering rates for example in hot humid (equatorial regions) produce deep and mature soil while slow weathering rates for example in arid and semi arid regions produce shallow and immature soil.

Leaching- this is the process by which soluble minerals are washed out/ removed by water from the upper layer of the soil profile (A' Horizon) to the underlying layer (B' Horizon). Leaching washes out soluble minerals like silica, potassium, magnesium, sulphate, and calcium carbonates from top layer.

Leaching leaves the A' horizon impoverished forming poor soil especially in humid regions where vegetation cover has been cleared.

Eluviation- is the removal of insoluble compounds or colloids such as iron and aluminum from the top soil to the sub-soil in solution or suspension from one place to another within the soil.

The movement may be vertical or horizontal depending on the movement of soil water. Eluviation leads to complete loss of soil nutrients from top soil and impoverishment of A 'horizon of soil profile.

This process is mainly influenced by climate and the nature of the parent rock.

Illuviation- is the deposition and accumulation of both leached and eluviated materials in the B'horizon of the soil profile. It's responsible for the development of the $\mathbf{b_2}$ layer (dark colored zone) due to maximum accumulation of colloids.

Humification is the process by which organic matter is decomposed by bacteria and earth worms in soil to form humus. Humification is more rapid in equatorial regions than dry and cold areas because of hot and humid conditions, dense foliage on the ground e.t.c

Humification influences the development of A_0 and A_1 zones of the top soil and determines the soil fertility.

Mineralization- takes place when humus is broken down farther into basic parts such as carbon oxide, water and silica. Mineralization influences the development of A' horizon due to presence of high organic matter.

Calcification- (named after calcium salts) involves the movement of calcium salts from the sub-soil (B'horizon) upwards to the surface by capillarity caused by hot high temperatures. Calcification is common in dry / arid areas where high daily temperatures encourage capillarity and evaporation of water containing dissolved calcium bicarbonates. As water evaporates, calcium is deposited on the surface where it accumulates to form a calcite layer and soils rich in calcium known as **pedocols;** with a shallow soil profile. This process is common in the karst regions of East Africa.

Salinisation (salt) - this is the process by which salts from the sub-soil accumulate to the surface. It is common in semi arid areas composed of salt rock. Hot temperatures pull salt solution to the surface by capillarity and as water evaporates, salt evaporites such as **sulphates, sodium and chlorides** are left on or near the surface.

Salinisation leads to formation of saline soil with a shallow soil profile, poor and toxic to plants hence unsuitable for agriculture. Saline soils are found around Lake Magadi in Kenya, Lake Katwe south western Uganda and other parts of rift valley.

Laterization- occurs in hot humid regions where heavy rainfall and humic acid form decaying organic matter remove silica and other soluble substances completely from the top layer and leave behind iron and aluminum; which are oxidized to form latosols and lateritic soils which are non nutritious hence unsuitable for agriculture.

Gleization (comes *from glej; a polish name for muddy soil***) -** occurs in cool and water logged environment such as swamps. In such places Permafrost and water logging conditions slow down chemical weathering; resulting into formation of semi decomposed soils called peat/ grey with poorly developed soil profile.

Peat/ grey soil is usually acidic and oxygen poor hence unsuitable for agriculture.

Podzolization *(comes from podzol; a Russian word for something like ash*) - takes place in temperate region particularly in areas experiencing cold temperatures and heavy rainfall through out the year (coniferous forest region) in mid and high latitudes.

Cold temperatures and heavy rainfall reduce the rate of chemical weathering; resulting into formation of semi decomposed soils called podzol.

Podzodic soils are ash like, light gley in color and shallow. They are also very acidic due to accumulation of decomposed and semi decomposed organic matter in 'B' horizon due to leaching and eluviation in the top soil brought about by the heavy rainfall hence unsuitable for agriculture.

Factors That Influence Soil Formation

Account for soil formation in East Africa

Approach

- Define soil
- Explain the factors and show the type of soil formed

Answer guide

Soil is a thin layer of the earth crust composed of naturally weathered rocks, water, organic matter and living organisms capable of supporting plant life.

The type and nature of soil formed depends on; climate, nature of the parent rock, relief, living organism and time.

Climate Facilitates soil formation through its elements of rainfall and temperature which determine the rate and type of weathering and vegetation type for formation of humus as explained below.

●Hot humid climates experience rapid and deep chemical weathering leading to formation of deep and fertile soil for example the northern shores of Lake Victoria.

●Hot dry climates (semi arid and desert regions) physical weathering dominates producing thin/ skeletal soils/ Azonal soils with poorly developed profiles.

Influence of vegetation type present

Thick and luxuriant vegetation cover decays; producing high humus added into 'A' horizon of the soil profile. In addition plant roots disintegrate rocks easily leading to soil formation. Forested areas therefore tend to have deep soils with well developed profiles while areas with thin vegetation cover such as scrub have thin skeletal soils.

Nature of the parent rock

This is the original rock weathered to produce mineral particles. The nature of the parent rock in terms of hardness, jointing, color and permeability facilitates soil formation in the following ways;

●Hard and resistant parent rock such as granite and gneiss take long to weather hence produce shallow soil such as sand while Soft rock like limestone and chalk weather down very fast to produce deep soil.

●rocks with joints and cracks such as granites and limestone weather easily under humid and hot conditions to form deep and mature soil compared to those with out for example gneiss and quartzite; take long to weather under similar conditions hence form coarse textured and shallow soils.

●Mineral composition of the parent rock. Rocks rich in calcium such as limestone and chalk and rocks rich in feldspar, mica and silicates for example basalt; weather easily under hot humid conditions leading formation of deep fertile soil while rocks rich in rich in quartz such as granites take long to weather leading to formation of poor and swallow soils.

●**Rock color**. Dark colored rocks such as basalt absorb a lot of heat hence weather easily to form deep and mature soil for example volcanic soils in Kigezi while brightly colored rocks such as granites reflect back much heat hence take long to weather leading to formation of shallow and poor soils such as sandy.

●Permeable/ porous rocks such as Loess, chalk and limestone weather easily by chemical processes to produce deep but dry soil while impermeable rocks such as Gneiss limit chemical weathering leading to swallow soil.

Relief or topography determines the rate soil formation through erosion and deposition of weathered materials and the rate of chemical weathering through percolation of water.
Consequently:
●On steep slopes, soils form very fast because erosion exposes fresh rocks to physical weathering. However, high rate of soil erosion removes weathered materials producing shallow and poor soils for example scree soils on the steep slopes of Aberdare and Kipengere ranges, mountain Rwenzori and Kilimanjaro.
●Very steep slopes and cliffs discourage soil formation since rock debris break down physically without undergoing chemical change.
●Gentle slopes- percolation of water encourages chemical weathering and the rate of deposition of weathered materials from steep slopes exceeds erosion; leading to development of deep and mature soil.
●Valleys or lowlands - extensive deposition and percolation of water lead to deep chemical weathering hence formation of deep and mature soil.
However where water logging conditions exist for example swampy areas , poor and immature soils such as peat are formed because water logging conditions limit deep chemical weathering.

Drainage

Well drained areas allow percolation of water leading to deep chemical weathering and formation of deep and mature soil while poorly drained or waterlogged areas limit biological activities and chemical weathering hence formation of poor and swallow soils for example peat soil common in swampy areas.

Influence of living organisms for example termites, earth worms, bacteria and moles facilitate the rate of soil formation and the depth of the soil formed in the following ways;
●bacteria and roots of growing plants excrete nitric acid and ammonia which react with rock minerals hence decompose to form deep soil.
●Plants and animals produce organic matter or humus and other nutrients that increase soil fertility.
●Termites, earth worms, moles**, rodents** and other organisms in soil break down rocks into smaller particles, improve on drainage and aeration by creating underground tunnels hence facilitate chemical weathering leading to formation deep and mature soil. In addition they churn out materials and transport this material from one layer to another leading to formation of deep soil.
Therefore soil with numerous living organisms have deep and well developed soil profile than soil with few living organisms.

Influence of man's activities. Human activities such as agriculture, mining and quarrying and construction lead to break down of rocks and formation of deep soils characterized by well developed profiles.
However human activities such as Overstocking, overgrazing, deforestation and uncontrolled construction expose soil to agents of erosion leading to development of swallow soil.

Time. Soil forming processes need ample time to interact with factors that influence soil formation to produce mature and deep soils called Zonal soils. Short interaction leads to formation of young soils called Azonal soils.

To what extent has the nature of the parent rock influenced soil formation in East Africa?
Approach

- Define soil,
- Give the 1St evaluation and explain the role of the parent rock. That is, (jointing, hardness, color, permeability and mineralogy)
- Give the 2$^{r\,d}$ evaluation and explain other factors that influence soil formation

To what extent has climate influenced soil formation in East Africa?
Approach

- Define soil,

- Give the 1St evaluation and explain the role of climate. That is, rainfall and temperature in different climatic regions.
- Give the 2r d evaluation and explain other factors that influence soil formation.

To what extent has relief influenced the process of soil formation in East Africa?

Approach

- Define soil,
- Give the 1St evaluation and explain how relief influences soil formation on different slopes,
- That is, steep slopes, Very steep slopes, Gentle slopes, Valleys or lowlands
- Give the 2r d evaluation and explain other factors that influence soil formation.

General classification of soils

Globally soils are classified into three major groups due to variation in climate, parent material, vegetation and impact of man's activities. That is; Zonal soils, Intra-zonal soils and Azonal soils.

Intrazonal soils

These are intermediate soil types with distinct profiles largely influenced by relief / topography and the nature of parent rock, exerting strong contribution to the soil forming processes than climate and vegetation.

They are mainly common on flat lands and have poor drainage for example peat soils formed in swamps, terra rossa formed in semi- arid limestone areas and saline soils.

(a)Distinguish between Zonal and Azonal soils.

(b) Account for the formation of azonal soils in East Africa.

Approach

- Define each soil type , state its characteristics,
- factors that influence the formation each soil type,
- Example and where they occur.
- In part (b) explain the factors that limit the development of a complete or mature soil.

Answer guide.

Zonal soils-

▪These are soil types largely resulting from the climatic factors which contribute to the soil forming processes.

▪Zonal soils are mature soils with well developed soil profiles due to prolonged action of climate which influences weathering and vegetation cover present in a particular region.

▪Zonal soils develop under conditions of good drainage hence they are well drained soils and develop on gentle slope and flat landscapes.

▪Zonal soils are divided into two groups depending on the mineral content present. That is; pedocals and pedafers.

▪Pedocals contain high content of calcium carbonate and develop under condition of low rainfall which prevents leaching out of soluble minerals. Pedafers are rich in aluminum and iron hydroxide and develop under conditions heavy rainfall which leaches out soluble minerals to form acidic soils.

▪Zonal soils are found in different regions of the world depending on climate that influences the type of weathering in that particular region. That is;

▪In low latitudes (tropics), the hot humid conditions give rise latosols and tropical black earths/basisols (formed from deep physical and chemical weathering of basaltic rocks).

▪In mid latitude / temperate region, cool and humid conditions a give rise podzols and brown earth soils that are heavily leached and very acidic. They are associated with cool temperate forests.

▪In areas receiving seasonal rainfall, chernozem soils / black earth soils develop and are rich in humus. They are associated with grasslands of sub humid temperate climates for example the Canadian prairies, North Dakota in USA and parts of Argentina's Pampas.

▪Semi arid and arid conditions give rise to chestnut colored soils.

▪High latitude climates, zonal soils occur in form tundra and artic brown soils because of low annual temperatures, permanently frozen sub- soil and limited weathering.

While

AZONAL SOILS

▪These are young soils without a clear soil profile. They are newly formed soils hence lack complete soil profile.

▪They are soils which have not been exposed to soil forming processes long enough to develop characteristics of mature soil.

▪They are skeletal soils. That is, soils which contain only mineral particles derived from weathered parent material without humus.

▪Azonal soils are divided into two groups. That is lithosols and regosols.

▪Azonal soils are derived from unconsolidated materials such as alluvium, sand and volcanic ash.

Examples of Azonal soils include;

▪Scree soils on mountain slopes,

▪Mud flat soils/ marine clays,

▪Fluvial- glacial soils such as tills, outwash sands and gravel, and resorted clays laid down in glacial lakes,

▪Wind blown soils especially sand dunes and loess soils,

▪Volcanic soils such as Lava/ ash soils cinder and pumice.

(b) Azonal soils have developed in East Africa because of the following factors.

Hard and resistant parent rock prevents deep chemical weathering and other soil forming processes which results into skeletal soils For example scree soil on the mountain slope of Rwenzori.

Violent volcanic eruption produces lava/ ash soils, cinder and pumice.

Agents of erosion such as running water, waves glaciers and wind transports and deposit materials else where to form different azonal soils as below;

▪Wave erosion and deposition produces marine deposits which form mudflat soils/ marine clay soils

▪Wind erosion and deposition produce wind-blown soils such loess, sand sheets and dunes.

▪Glacial action (fluvio-glacial erosion) produces fluvio-glacial soils such as tills, out wash sands and gravels, and resorted clays (deposited in glacial lakes)

▪River erosion and deposition produces alluvial soils common along river valleys, deltas and low lying plains.

Climate influences formation of azonal soils through its elements of rainfall and temperatures which accelerate weathering and erosion as shown below;

▪Heavy rain fall such as El-Nino causes river floods that increase river erosion and deposition of alluvium in the lower course.

▪In addition, heavy rainfall causes high rate of erosion on the steep slopes and deposition of materials in lowlands to form alluvial soils.

▪Temperature changes in glaciated highlands cause frost weathering to form scree soils on mountain slopes.

The nature of relief influences the formation of azonal soils by accelerating erosion of weathered screes on the mountain slopes and their subsequent deposition to form new soils.

Influence of human activities influence formation of azonal soils in the following ways;

▪Mining and quarrying lead to breaking of parent rock into tiny particles which form skeletal soils.

▪Deforestation, bush burning and over grazing expose the parent rock to physical weathering processes that lead to formation of young soils.

Time lapse. Azonal soils are newly formed soils which have not been exposed to soil forming processes for so long to produce characteristics of mature soil. Therefore require more time.

Soil Profile

(a)What is a soil profile?

(b)Explain the factors or conditions that have influenced soil profile development of in various parts of East Africa.

Approach

- Define soil profile
- Explain the components of a fully developed soil profile, characteristics and
- Draw a diagram of a fully developed soil profile.
- In part (b) explain the factors in details. That is, (climate relief, parent rock, living organisms and time)

Answer guide

Soil profile is a vertical section through the soil from the surface of the earth down to the bed rock. Soil profile is composed of soil layers called horizons which are differentiated in terms of color, depth, texture and mineralogy.

Soil profiles differ from place to places however an idealized soil profile is composed of four horizons: A, B, C, D or A' horizon (top soil), B' horizon (sub soil), C' horizon (weathered parent materials) and D' horizon (unweathered parent rock/bed rock).

A Diagram Showing an Idealized Soil Profile with Four Distinct Horizons

Description of the diagram

Horizon A is the top most soil layer and is subdivided into, A_{00} –A_3.

A_{00} consists of undecomposed litter of dead leaves, leaves and vegetation and is followed by A_0

A_0 is made of decomposing organic matter and is followed by A_1 which has high humus content which gives it a dark color.

The quantity of humus present depends on the density of foliage and living organisms to decompose organic matter to humus.

A_1 is followed by **A_2** which is poor in nutrients because of the effect of leaching and eluviation which wash out soluble mineral nutrients to the sub-soil; leaving it bleached, light colored and impoverished.

A_2 is followed by a transition zone called **A_3**

Horizon B is the soil layer below horizon A and is some times called the sub-soil. It is the horizon where nutrients washed out from horizon A are deposited and accumulate by the process known as illuviation; making this horizon richer in nutrients and dark in color than A' horizon above it. It's some times characterized by a hard pan caused by the accumulation of large quantities of clay and other nutrients.

N.B Horizon A and B form what is regarded as mature soil.

Horizon C lies beneath the subsoil and located far from the surface hence experiences partial weathering to produce partially weathered materials which form immature soil.

Horizon D is the last layer of the soil profile and consists of solid parent rock. There is no soil formed because the parent rock is located deep in the crust and therefore not affected by weathering and other soil forming process.

Impressional marking……10 mks

Factors Influencing the Development of a Complete Soil Profile

Climate

Climate Facilitates soil profile development through its elements of rainfall and temperature which determine the rate and type of weathering and vegetation type for humus formation as explained below.

- Hot humid climates experience rapid and deep chemical weathering leading to formation of well developed/mature soil profile for example the northern shores of Lake Victoria.
- Hot dry climates (semi arid and desert regions) physical weathering dominates producing thin/ skeletal soils/ Azonal soils with poorly developed profiles.

Influence of vegetation type present

Thick and luxuriant vegetation cover decays; producing high humus added into 'A' horizon of the soil profile. In addition plant roots disintegrate rocks easily leading to soil formation. Forested areas therefore tend to have deep/ well developed profiles while areas with thin vegetation cover such as scrub have thin skeletal soils and poorly developed profiles.

Nature of the parent rock

This is the original rock weathered to produce mineral particles. The nature of the parent rock in terms of hardness, jointing, color and permeability facilitates the development of soil profile in the following ways;

●Hard and resistant parent rock such as granite and gneiss take long to weather hence form poorly developed soil profiles while Soft rocks like limestone and chalk weather down very fast to produce deep soil profile.

●rocks with joints and cracks such as granites and limestone weather easily under humid and hot conditions to form deep and mature soil compared to those with out for example gneiss and quartzite; take long to weather under similar conditions hence form coarse textured and shallow soils.

●rocks with joints and cracks such as granites and limestone weather easily under humid and hot conditions to form deep and mature soil profile compared to those with out for example gneiss and quartzite under similar conditions.

●Mineral composition of the parent rock. Rocks rich in calcium such as limestone and chalk and rocks rich in feldspar, mica and silicates for example basalt; weather easily under hot humid conditions leading to well developed profile while rocks rich in rich in quartz such as granites take long to weather leading to poorly developed soil profiles.

●Rock color. Dark colored rocks such as basalt absorb a lot of heat and weather easily to form deep and mature soil profile while brightly colored rocks such as granites reflect back much heat hence take long to weather leading to poorly developed soil profiles.

●Permeable/ porous rocks such as Loess, chalk and limestone weather easily by chemical processes to produce deep soil profile while impermeable rocks such as Gneiss limit chemical weathering leading to swallow soil profile.

Relief or topography determines the rate soil profile development through erosion and deposition of weathered materials and the rate of chemical weathering through percolation of water. Consequently:

●steep slopes tend to have thin, stony and poorly developed soil profiles because excessive run off removes weathered materials as soon as they are formed hence limiting soil profile development for example on the steep slopes of Aberdare and Kipengere ranges.

●Gentle slopes- percolation of water encourages deep chemical weathering and the rate of deposition of weathered materials from steep slopes exceeds erosion; leading to development of mature soil profiles.

●Valleys or lowlands - extensive deposition and percolation of water lead to deep chemical weathering hence development of deep and mature soil profile.

However where water logging conditions exist for example swampy areas , poor and immature soil profiles develop because water logging conditions limit deep chemical weathering and complete decomposition of organic matter.

Drainage

Well drained areas allow percolation of water leading to deep chemical weathering and formation of deep and mature soil profile while poorly drained or waterlogged areas limit deep chemical weathering and complete decomposition of organic matter hence poorly developed soil profiles for example peat soil common in swampy areas.

Influence of living organisms for example termites, earth worms, bacteria and moles facilitate the development of a complete soil profile by;

▪**decomposing organic matter** physically and chemically to humus and other nutrients found in **A** horizon

▪facilitate weathering of rocks physically and chemically by creating underground tunnels where air and water pass and react with rock minerals, excrete acids like humic acid which weather the rock chemically

▪Plants and animals produce organic matter or humus and other nutrients that increase soil fertility.
▪Termites and earth worms in soil mix up humus and weathered particles from one horizon to another hence increase the depth of the soil profile.
Therefore soil with numerous living organisms have deep and well developed soil profile than soil with few living organisms.
Influence of man's activities. Human activities such as agriculture, mining and quarrying and construction lead to break down of rocks and formation of deep soils characterized by well developed profiles.
However human activities such as Overstocking, overgrazing, deforestation and uncontrolled construction expose soil to agents of erosion leading to development of swallow soil.
Time. The development of complete soil profile requires ample time to develop. Therefore soils exposed to weathering and other soil forming processes for a very long time have deep and mature profile than newly formed soils (Azonal).
Impression marking……15marks

SOIL CATENA

Soil catena is the horizontal sequencing or differentiation of soils along the slope from hill-top to the valley bottom
Soil catena displays the different soils along the slope formed under similar climatic conditions but the characteristics are different because of topography and drainage
Soil catena usually displays 4-5 different soil types in respect to texture, color and water retention as they succeed each other right from the hill top to the valley down the slope.
Soil catena is more pronounced in regions with relief composed of hills with steep slopes alternating with valleys. For example hills in the southern part of Buganda, Busoga region, shores of Lake Victoria and Kigezi in south western Uganda.
Diagram showing a well developed soil catena in Buganda region
The soil catena on Buganda's hills is arranged in a way that;
The top is composed of lateritic pan or cap due to excessive leaching. This pan is weathered to form thin reddish lateritic soil; supporting poor scrub vegetation.
Below the lateritic pan is **a steep slope known as free face** composed of bare rock and very thin soil because of excessive soil erosion and mass wasting due to high gravity.
Below the free face is **a convex or waxing slope** of thin and skeletal coarse stony sandy soils used for grazing in Masaka and Ankole.
The waning or concave slope follows and fairly gentle, with deep and well drained fertile loam soil derived from materials deposited by erosion and wasting from upper slopes, best for cultivation of crops/ agriculture.
Lastly, valleys contain clay soil with grey color due to water logging conditions and very acidic, for example peat.
Distinguish between soil profile and soil catena
Approach

- Define soil profile, show the different layers/ horizon, and draw the diagram showing a well developed soil profile.
- Define soil catena, show its components from the top down the valley bottom, and draw a diagram showing a complete soil catena
- Then give the differences. That is;

Soil profile is a vertical section through the soil from the surface of the earth down to the bed rock, showing horizontal layers called horizons while soil catena is the horizontal sequencing or differentiation of soils along a slope from hill-top to the valley bottom.
The development of the soil profile is mainly influenced by climate which causes weathering, leaching, eluviation and illuviation while the development of soil catena is mainly influenced by drainage and relief which cause soil erosion and creep.

Soil profile focuses on vertical changes of soil in terms of color, texture and mineralogy but soil catena focuses on change in surface soil types in terms of texture, color and water retention as they succeed each other right from the top to the valley down the slope.

Differentiate between soil profile and soil catena

Explain the causes of soil catena in East Africa.

Approach

Refer to question ….for part (a)

FACTORS INFLUENCING THE DEVELOPMENT OF SOIL CATENA IN EAST AFRICA

The type of weathering, That is;

Hill tops and steep slopes experience physical weathering resulting into deep soil, which creeps down slope due to gravity, and washed down by soil erosion. This eventually produces thin soil, for example lateritic soil.

On gentle slopes, weathering, erosion and deposition take place in almost equal proportion leading to the formation of fairly deep soils.

In valleys, the dominance of chemical weathering due to water logging conditions, gives rise to clay and peat soil which is very acidic.

Influence of Relief of the area. That is;

Hill tops and steep slopes have thin/ skeletal soil because the rate of erosion exceeds deposition.

Gentle slopes have fairly deep soil because weathering, erosion and deposition take place in almost equal proportion.

Lower slopes have deep soil because chemical weathering and deposition exceed erosion.

Valleys have highly weathered clay and peat soil due to water logging conditions.

Drainage. That is;

Valleys encourage water logging conditions leading to deep clay soil. Hill tops and steep slopes have skeletal soil because of low water retention.

Influence of vegetation cover. That is;

Hill tops and steep slopes have poor scrub vegetation which gives rise to skeletal lateritic soil.

Gentle slopes and valleys have luxuriant vegetation which give rise well developed soils rich in humus content.

Influence of human activities. For example mining and quarrying, agriculture, settlement and grazing of animals on gentle slopes and valleys results into highly weathered laterites in the middle slopes and valleys compared to hill tops where there is limited or no human activities at all.

Explain what is meant by the following terms;

(a) Soil structure

(b) Soil acidity

(c) Soil texture

(a) Soil structure

Soil structure refers to how soil particles are aggregated or clustered into large pieces of various shapes and sizes. Each aggregate is separated from the adjoining aggregates by cracks that appear naturally on the surface of soil.

Soil particles are held together by tiny particles of organic and mineral substances in solution called colloids and by internal cohesion.

Aggregates pack together into large and fairly regular shaped units called peds.

Soil structure is described in terms of shape, size, and stability of peds within the soil. A soil without clusters is said to be structure less.

There are four main types of soil structure: platy, prismatic, blocky and Spheroidal.

Soil structure is greatly determined by climatic conditions, nature of the parent rock from which soil particles are obtained, and living organisms to break organic matter into humus and minerals.

Soil structure is important because: it determines soil resistance to erosion, degree of permeability, percolation and capillarity ,the ease of cultivation and a good balance between soil, water, air and nutrients.
The best soil structure is the one that has a high water retention and aeration.

(b) Soil acidity

Soil acidity refers to the degree of acidity and alkalinity of the soil is expressed in the pH value.
It is determined by concentration of hydrogen ions (H+) held by the soil colloids. If the concentration is high, the soil will be acidic and if it is low, soil is alkaline.
Hydrogen ions increase in soil due to poor aeration which retards the rate of decomposition of organic matter by microorganisms.
The degree of soil acidity is measured using the pH value scale, numbered from 1-14.
A pH value of 7 is considered neutral. If the pH is below 7, then the soil is said to be acidic. Acidic soils are common in hot humid regions, industrialized and irrigated areas.
If the pH value exceeds 8.0, then the soil has excess salts or is said to be very alkaline, common in desert areas due to absence of organic matter or humus.
The best soil for agriculture has neutral value. Soil pH is lowered by leaching, and use of fertilizers containing sulphur or nitrogen.
High acidity in soil can be reduced by adding lime (calcium hydroxide) to improve on its productivity.
Alkanity can be reduced by adding humus or gypsum to make the soil productive.
Soil pH value is important because it helps to determine the soil color, availability of nutrients, amount of ions present in soil, solubility of all materials in soil and the activities of micro bacteria in soil.

(c) Soil texture

Soil texture is concerned with different sizes of the smaller mineral particles, or grains that make up soil.
Particles are measured in terms of their diameter, ranging from 2 millimeters to less than 0.002 mm.
Soil particles are graded into three major types: Sand, silt and clay.
Soils with large particles such as gravel and sand are said to be having a coarse texture while those with small particles like clay are said to have fine texture.
Gravel has soil particles measuring 2 .0+ millimeters in diameter.
Coarse sand has particles ranging between 2 .0 – 0.2 mm in diameter
Fine sand has particles ranging between 0.2 – 0.02 mm in diameter.
Silt has particles ranging between 0.02 – 0.002 mm in diameter
Clay has particles measuring below 0.002 mm in diameter.
Soil texture is important because it determines the degree of water retention, permeability, leaching and aeration.
Soils with a coarse texture such as sand and gravel are well aerated , very permeable, have a high rate of leaching of nutrients in the soil, have poor water retention, loose when dry and are easily washed away by agents of erosion.
Soil with a fine texture such as clay, have high water retention, impermeable, poor aeration, retards leaching of nutrients, sticky when wet and resilient to agents of erosion.
Silt grains are fine, sticky under wet conditions, have limited permeability and high capillarity during the dry season.

LATERITIC SOILS IN EAST AFRICA

Account for the formation of lateritic soils in East Africa.

Approach

- Define laterite soils
- Identify and describe the formation of lateritic soils
- state areas where lateritic soils are found

- Explain the process of formation and the factors that facilitate their formation.

Answer guide

Lateritic soils are red or black residual deposits, created from weathering of rocks bearing iron and aluminum under humid and hot tropical conditions in the low latitudes.

Laterite soils consist of either iron or aluminum oxides, and are found either as hard pans (duricrust) or soft clays (clay pan).

Lateritic soils form through the processes;

Heavy rain fall and high temperatures cause decay of vegetation and other organic materials, and deep chemical weathering of rocks.

Through the chemical process of leaching, silica and other soluble minerals are removed from rocks and A-horizon by water and transferred to B- horizon of the soil profile.

The insoluble material compounds of iron and aluminum are also moved to B- horizon of the soil profile through the eluviation and illuviation processes.

When temperatures exceed rain fall, iron and aluminum compounds are carried to the surface of the soil profile by evaporating water and fuse together.

Continuous fusion and accumulation of these compounds gradually harden to form a layer known as duricrust, or may remain under moist conditions at the surface to form soft clays known as Kaolin.

Weathering of the duricrust produces laterites or lateritic soils, with a greyish color derived from aluminum or reddish –brown color derived from iron compounds.

Laterites are sticky when saturated with rain water, hard, and drain quickly when dry.

In East Africa, laterites are found in various areas such as savannah and equatorial forests. For example central Uganda around mukono, lugazi, Mpigi and on hill tops, Nyanza province in western Kenya e.t.c

Factors favoring formation of lateritic soils in East Africa

Relief. Laterite soils form under conditions of low and gentle relief. This allows percolation of water, leaching in A- horizon and illuviation in B- horizon.

Chemical weathering by oxidation, solution change the color and transports the cementing silicate materials respectively.

High temperature. This is required for increasing the rate of chemical reactions.

Vegetation cover. This helps to hold the soils and allow weathering in situ.

Nature of the parent rock. The parent rock should not be extremely hard and should contain a lot of iron and aluminum compounds for oxidation to take place.

Nature of the slope. Very steep areas are prone to soil erosion which does not allow the formation of Laterite soils.

Drainage. Poorly drained soils don't allow the formation of laterites. Lateritic soils form on well drained areas or soils.

Human activities. The formation of lateritic soil is interrupted by human activities such as agriculture, construction and mining.

Geological time. The formation of laterites requires long time to allow the formation and accumulation of oxides. For example many laterites in East Africa are relics of tertially weathering process.

Examine the formation of laterites in East Africa and their effects on human activities.

Approach

- Define laterite soil
- Identify and describe the formation of lateritic soils
- Give areas where lateritic soils are found
- Explain the process of formation and effects of laterites on human activities.

Refer to the question …. Above for the introduction

EFFECTS OF LATERITE SOILS ON HUMAN ACTIVITIES

Deeply weathered laterites form murrum, used in constructing roads.

Laterites also form firm foundation for construction of settlent structures such as storied buildings, schools, houses, water tanks e.t.c.
Erosion on lateritic duricrust produces beautiful dissected flat topped hills called mesa and butte for example in hill tops in Buganda region, used for settlement and forestry.
Laterites support mining of murrum, hence source of employment and income to different people for example on Mutundwe hill.
Laterites are unproductive in terms of agriculture because they are heavily leached and lack humus.
Lateritic soils support growth of poor scrub and grass vegetation used for grazing animals because they are palatable to cattle and sheep and goats.
Laterites hinder mechanization because the lateritic duricrust is hard and lead to break down of machines such as ploughs or wear down easily.
Kaolin clay is used as a raw material in making building materials such as bricks, tiles and maxi pans.

SOIL EROSION IN EAST AFRICA
CAUSES AND EFFECTS

Examine the causes and effects of soil erosion in East Africa

Approach

- Define the term soil erosion; identify the types /processes of soil erosion.
- State areas where soil-erosion is taking place in East Africa.
- Explain the causes of soil erosion
- Explain the positive and negative effects of soil erosion.

Answer guide

Soil erosion is the washing away/ removal of top soil by running water, wind, glaciers and animals. The processes involved include splash, rill, sheet and gully.
Splash / rain drop erosion-is the removal of soil particles by the beating action of heavy rain drops usually on bare ground.
Sheet erosion -is the uniform removal of thin layers of soil by wind and running water over a wide area usually on gentle slopes.
Rill erosion- involves creation of small channels called rills normally in areas where the rate of rainfall exceeds the rate of infiltration. It's common on slopes where the vegetation has been cleared.
Gulley erosion- occurs where erosion forms deep and wide channels /grooves through which soil is taken down slope by running water. It's common in highland areas and on gentle slopes where the vegetation has been cleared.

CAUSES OF SOIL EROSION IN EAST AFRICA

Soil erosion in East Africa is caused by both physical and human factors as explained below;
Heavy rainfall such as relief and El-Niño leads to high surface run off that washes away the top soil. Heavy rainfall is responsible for soil erosion in highland areas such as Kigezi, Kenya high land, windward slopes of mountain Elgon, Kenya, Rwenzori, the northern shores of Lake Victoria basin and Kondoa .
Nature of topography. steep slopes /hilly areas where vegetation cover is cleared experience rapid soil erosion by because steep slopes increase the erosive power of running water than gentle slopes and low lying areas ,for example Kigezi, Kondoa, Kenyan high lands, slopes of mountain Elgon, Kenya, Rwenzori, Meru and Kilimanjaro.
Occurrence of ferocious wind especially in arid areas leads to washing away of top loose soil in suspense, for example Karamoja region, North Western Kenya, Northern and North Eastern Kenya and North Eastern Tanzania.
Presence of weak and loose soils for example Volcanic and sandy soils, soak easily and carried away by the destructive forces of wind and running water. For example in the volcanic highlands of Kigezi, Kipengere, Elgon e.t.c, and sandy soils in arid Areas like Karamoja and Northern Kenya and Machakos in Kenya e.t.c

Presence of Biotic factors, for example harvester ants, termites and locusts especially in arid areas. These insects eat all the grass leaving the surface bare and exposed to agents of erosion especially during the dry season/ spell. Wind and water get a clear sweep of bare land; carrying away soil for example Machakos, Ankole - Masaka ranching areas, Nakasongola and Karamoja, Turkana e.t.c.
Deforestation on steep slopes for more cultivable land, space for, settlements, road construction, wood fuel and lumbering e.t.c deprives soil of protective cover from splash and wind erosion. Deforestation also deprives soil of the binding effect of plant roots; making soil weak hence easily carried away, for example northern shores of Lake Victoria basin, Kigezi, Elgon, Kenya highlands, Karamoja and areas near urban centers.
Over stocking and over grazing. The keeping of large herds of livestock in as small areas of land leads to trample on land, breaking the loose particles weakens the soil and makes it susceptible to erosion. In addition large herds of cattle eat and uproot vegetation thus leaving the soil exposed. This practice is common in pastoral areas of East Africa such as Rakai, Nakasongola, Masaka –Ankole cattle corridor, Karamoja, Masai land, Turkana land and Kondoa district in Tanzania.
Over cropping/over cultivation -the repeated cultivation of crops on a fixed plot of land without rest or little rest weakens the soil thus making it vulnerable to erosion, for example Kigezi and Kenyan highlands, banana plantations in Masaka e.t.c
Monoculture-the cultivation of one type of crop every season on the same plot of land leads to loss of soil nutrients; weakens soil structure and texture; making it vulnerable to agents of erosion, for example Irish and sweet potatoes 'Ebitakuri' in Kabale, sorghum and millet in Baringo- Kenya, banana and coffee in Buganda region.
Mining and quarrying for example, limestone and vermiculite in Mbale, wolfram in Kabale and Kigezi, cobalt recycling in kasese, diamond in shinyanga, sand, clay, murrum e.t.c weakens the soil and deprives the soil of protective cover thus exposing the soil to the agents of erosion.
Repeated bush burning especially in pastoral communities during the dry season so as to prepare for good pastures, kill pests and diseases e.t.c deprives soil of protective cover thus leaving the soil bare and vulnerable to wind and sheet erosion for example in Karamoja, Mbarara, Turkanaland, Masai, Nakasongola, Miombo in Tanzania and other pastoral communities.
Planting of Poor cover crops such as maize, sorghum, cotton, onions and finger millet leave the soil exposed to splash erosion and wind erosion, for example in Karamoja, Kigezi, Kondoa, Machakos, Baringo e.t.c.
Land fragmentation in highland regions involves creating boundaries which encourage high surface run off leading to rill and gully erosion for example in Kigezi and Kenyan highlands.
Up and downward ploughing on hill slopes encourage increased soil erosion as water finds it easy to flow down slope in cannels leading to rill and gully erosion during the wet season for example in Kigezi, Kondoa and Kenyan highlands.
Construction works such as road networks, settlements e.t.c reduce vegetation cover which protects the soil thus exposing it to agents of soil erosion.
Herds of grazing animals in protected areas such as National game parks for example, buffaloes, elephants e.t.c destroy the vegetation cover through over grazing, browsing and trampling especially near water sources creates bare patches leading to soil erosion. For example Kabalega, Queen Elizabeth, Masai Mara, Para and Serengeti National game parks e.t.c.
High illiteracy rates especially in pastoral areas such as Karamoja, Mbarara corridor, Kondoa e.t.c has led to persistent soil erosion because the local people tend to be ignorant about the effects of overstocking, overgrazing, bush burning and deforestation which expose the soil to agents of soil erosion.
Rapid urbanization has facilitated destruction of vegetation cover to create more space thus leaving the soil exposed to the agents of soil erosion for example Kampala, Mukono, Jinja, Nairobi, Dar-es-salaam e.t.c
Increased use of heavy machinery on farms and other surface compacts soil and sealing of pores

which makes infiltration and percolation difficult thus high surface run-off which increase soil erosion

Effects of soil erosion in East Africa

(b) **Soil erosion has devastating effects than positive effects as shown below**;

NEGATIVE EFFECTS

Soil erosion leads to **Loss of top fertile soils** thus leaving poor and less productive soils which results into low crop yields for example in Kabale, Kondoa and Kenya highlands.

Wind and water erosion can carry away the entire soil cover **creating bare ground/ waste land** with low agricultural productivity. For example some parts of Karamoja, Nakasongola e.t.c

Low crop yields caused by loss of top fertile soil has resulted into persistent **famine** in some regions of East Africa for example Karamoja and Turkana land.

Soil erosion facilitates **aridity and desertification** because the poor vegetation cover cannot give-off adequate moisture into the atmosphere to facilitate formation of rain fall.

Soil erosion lowers **water table** due to limited infiltration. This leads to crop failure and low crop yields for example in Karamoja, Turkana land, Nakasongola e.t.c

Discharge of soil particles/ sediments leads to **pollution of water bodies** such as lakes, streams valley dams and wet land.

Discharge of soil particles/ sediments causes **silting of water bodies**. This reduces the storage capacity of these water sources and low hydro-power generation for example Lake Bunyonyi, Victoria, Mutanda, Murehe, Kyahifi and Masinga dam on river Masinga respectively .

Discharge of soil particles/ sediments leads **eutrophication** (a situation where water bodies become fertile and encourage growth of algae) which affects marine organisms especially fish. In addition, silting of culverts and other drainage systems **increases maintenance Costs** through dredging for example Lake Victoria, Turkana and Bunyonyi and Mutanda.

High surface run-off and silting leads **to flooding in low-lying areas/ valleys and destruction and property** such as gardens, houses, livestock, infrastructures and some times death of people for example in Bwaise, Natete, Kigezi, slopes of mountain Elgon, Teso and Turkana. The section of River Kagera from Mbarara to Tanzania experiences high rate of silting leading to floods during the wet season.

Rills and Gullies make **development of transport and communication net works difficult**; making such areas remote/ inaccessible for example Kitui, Machakos and Kondoa in Tanzania and some parts of Karamoja.

Wind erosion produces dusty storms which cause **poor visibility and accidents** especially in arid areas such as Karamoja

Water and air pollution facilitates the **spread of air and water borne diseases** such as Cholera, bilharzias, dysentery and flue.

Soil erosion facilitates physical weathering inform of pressure release thus exposing hard rocks underneath which **hinders agricultural mechanization** for example in Kigezi.

Soil erosion in highland areas weakens soil structure **leading to landslides** causing massive destruction of property and loss of lives for example in Kigezi, slopes of mountain Elgon, Rwenzori, Kilimanjaro and Kondoa.

Soil erosion produces azonal soils which are less productive because they lack humus and other vital soil ingredients.

POSITIVE EFFECTS

Soil Erosion facilitates pressure release thus exposing the fresh rocks to gents of weathering and formation of fresh or new soils.

Soil erosion produces alluvial fertile soils in low lands and valleys, support crop cultivation for example Irish and sweet potatoes, vegetables e.t.c in Kigezi, lower slopes of mountain Elgon, Kenya and Rwenzori.

Soil erosion exposes Inselbergs, volcanic plugs, batholiths, arenas e.t.c which create beautiful

scenery for the tourism industry and earning of foreign exchange used for economic development, for example Karamoja
Soil Erosion exposes minerals like gold, diamond, limestone rocks hence reducing cost of mining. For example Diamond in Shinyanga, volcanic plugs in Tororo e.t.c.

(a)Differentiate between sheet erosion and gulley erosion.

(b) Explain the causes of soil erosion in the highland areas of East Africa.

Approach

- ❖ Define sheet and gulley erosion
- ❖ Give the characteristics of each type of soil erosion
- ❖ Identify the highland areas in East Africa affected by soil erosion descriptively or by use of a sketch map
- ❖ Explain the physical and human causes of soil erosion.

Answer guide

▪Sheet erosion is the uniform removal of thin layers of soil by wind and running water over wide area usually gentle slopes.
▪It involves slow movement of thin layers of soil and not easy to notice.
▪This movement covers a wide area / extensive areas especially on gentle slopes.

WHILE

▪**Gulley erosion** occurs where erosion forms deep and wide channels /grooves through which soil is carried down slope by running water.
▪It's common in areas receiving heavy rain fall. **And**
▪on steep to gentle slopes where the vegetation has been cleared
▪Gulley erosion creates degraded /wasteland.

(b) Soil erosion is the removal or detachment of soil material from one place to another.

● highland areas of East Africa where soil erosion is rampant include Kigezi in south western Uganda, Uluguru, Kondoa, Usambara and Kipengere in Tanzania, Kenyan highlands, Slopes of mountain Elgon, Rwenzori, Kenya, Aberdare, Kilimanjaro, and Meru.

CAUSES

▪Heavy and torrential rain fall received leads to high surface run- off that carries away the top soil
▪Steep slopes in highland areas such as Kapchorwa, Bundyibugyo, Kenyan highlands encourage high surface run- off ▪presence of weak soils such as volcanic soak are weak, porous, unstable and easily washed away by running water and wind when vegetation cover is cleared.
▪Deforestation on slopes- the cutting of trees without replanting them due to need for agriculture, settlement e.t.c weakens the soil structure and exposes the soil to splash and wind erosion
▪Overstocking of livestock such as cattle, goats, pigs, sheep e.t.c leads to over grazing and depletion of vegetation cover; exposing the soil to agents of soil erosion
▪Over cropping/over cultivation -the continuous cultivation / planting of crops on a fixed plot of land with little or no rest, weakens the soil; making it vulnerable to erosion, for example Kigezi and Kenyan highlands.
▪Monoculture-the cultivation of a single crop year after year on the same plot of land leads to loss of soil fertility,
weakens soil structure and texture; making soil vulnerable to agents of erosion, for example Irish and sweet potatoes 'Ebitakuri' in Kabale, sorghum and millet in Baringo, Kenya e.t.c
▪Mining and quarrying for example, limestone and vermiculite in Mbale, wolfram in Kabale and Kigezi, cobalt recycling in kasese, diamond in shinyanga, sand e.t.c weakens the soil and reduces the vegetation that protects the soil; hence expose the soil to the agents of erosion.
▪Repeated bush burning in highland areas so as to prepare for good pastures, kill pests and diseases, create e.t.c leads to destruction of vegetation cover leaves the soil bare and vulnerable to wind and sheet erosion.
▪Planting of Poor cover crops like maize, sorghum, cotton, onions and finger millet leave the soil

exposed to splash erosion and wind erosion, for example in Kigezi
▪Land fragmentation in highland regions involves creating boundaries which encourage high surface run off leading to rill and gully erosion for example in Kigezi and Kenyan highlands.
▪Up and downward ploughing on hill slopes encourages high surface run off leading to rill and gully erosion during the wet season for example in Kigezi, Kondoa and Kenyan highlands.
▪Construction works such as roads, motorable trucks, railways, settlements e.t.c reduce vegetation cover which protects the soil hence exposing the soil to agents of soil erosion.
▪Herds of grazing animals such as cattle, buffaloes, elephants e.t.c destroy the vegetation cover through over grazing, browsing and trampling especially near water sources hence create bare patches which expose the soil to agents of soil erosion, for example on the slopes of mountain Elgon, Kenya, Kilimanjaro e.t.c.
▪High illiteracy rates has led to persistent soil erosion because the local people tend to be ignorant about the effects of overstocking, overgrazing, bush burning and deforestation which expose the soil to agents of soil erosion.
▪Rapid population growth in highland regions such as Kabale, Mbale, Kapchorwa, Kenya highlands e.t.c has facilitated destruction of natural vegetation cover hence exposing the soil to the agents of soil erosion.

To what extent is man been responsible for soil erosion in East Africa?

Approach

- Define soil erosion and give the processes/ types of soil erosion in occurring in East Africa.
- State areas in East Africa experiencing soil erosion
- Give the 1St evaluation (larger extent) and explain the human activities that accelerate soil erosion on in the areas stated above.
- Give the 2$^{r\,d}$ evaluation (large extent) and explain the physical factors.

Answer guide

Man is largely responsible for soil erosion through his activities such as;

Deforestation on steep slopes for more cultivable land, space for, settlements, road construction, wood fuel and lumbering e.t.c deprives soil of protective cover from splash and wind erosion. Deforestation also deprives soil of the binding effect of plant roots; making soil weak hence easily carried away, for example northern shores of Lake Victoria basin, Kigezi, Elgon, Kenya highlands, Karamoja and areas near urban centers.

Over stocking and over grazing. The keeping of large herds of livestock in as small areas of land leads to trample on land, breaking the loose particles weakens the soil and makes it susceptible to erosion. In addition large herds of cattle eat and uproot vegetation thus leaving the soil exposed. This practice is common in pastoral areas of East Africa such as Rakai, Nakasongola, Masaka –Ankole cattle corridor, Karamoja, Masai land, Turkana land and Kondoa district in Tanzania.

Over cropping/over cultivation -the repeated cultivation of crops on a fixed plot of land without rest or little rest weakens the soil thus making it vulnerable to erosion, for example Kigezi and Kenyan highlands, banana plantations in Masaka e.t.c

Monoculture-the cultivation of one type of crop every season on the same plot of land leads to loss of soil nutrients; weakens soil structure and texture; making it vulnerable to agents of erosion, for example Irish and sweet potatoes 'Ebitakuri' in Kabale, sorghum and millet in Baringo- Kenya, banana and coffee in Buganda region.

Mining and quarrying for example, limestone and vermiculite in Mbale, wolfram in Kabale and Kigezi, cobalt recycling in kasese, diamond in shinyanga, sand, clay, murrum e.t.c weakens the soil and deprives the soil of protective cover thus exposing the soil to the agents of erosion.

Repeated bush burning especially in pastoral communities during the dry season so as to prepare for good pastures, kill pests and diseases e.t.c deprives soil of protective cover thus leaving the soil bare and vulnerable to wind and sheet erosion for example in Karamoja, Mbarara, Turkanaland, Masai, Nakasongola, Miombo in Tanzania and other pastoral communities.

Planting of Poor cover crops such as maize, sorghum, cotton, onions and finger millet leave the soil exposed to splash erosion and wind erosion, for example in Karamoja, Kigezi, Kondoa, Machakos, Baringo e.t.c.

Land fragmentation in highland regions involves creating boundaries which encourage high surface run off leading to rill and gully erosion for example in Kigezi and Kenyan highlands.

Up and downward ploughing on hill slopes encourage increased soil erosion as water finds it easy to flow down slope in cannels leading to rill and gully erosion during the wet season for example in Kigezi, Kondoa and Kenyan highlands.

Construction works such as road networks, settlements e.t.c reduce vegetation cover which protects the soil thus exposing it to agents of soil erosion.

Herds of grazing animals in protected areas such as National game parks for example, buffaloes, elephants e.t.c destroy the vegetation cover through over grazing, browsing and trampling especially near water sources creates bare patches leading to soil erosion. For example Kabalega, Queen Elizabeth, Masai Mara, Para and Serengeti National game parks e.t.c.

High illiteracy rates especially in pastoral areas such as Karamoja, Mbarara corridor, Kondoa e.t.c has led to persistent soil erosion because the local people tend to be ignorant about the effects of overstocking, overgrazing, bush burning and deforestation which expose the soil to agents of soil erosion.

Rapid urbanization has facilitated destruction of vegetation cover to create more space thus leaving the soil exposed to the agents of soil erosion for example Kampala, Mukono, Jinja, Nairobi, Dar-es-salaam e.t.c

Increased use of heavy machinery on farms and other surface compacts soil and sealing of pores which makes infiltration and percolation difficult thus high surface run-off which increase soil erosion

On the other hand, physical factors are responsible for soil erosion to a large extent through**;**

Heavy rainfall such as relief and El-Niño leads to high surface run off that washes away the top soil. Heavy rainfall is responsible for soil erosion in highland areas such as Kigezi, Kenya high land, windward slopes of mountain Elgon, Kenya, Rwenzori, the northern shores of Lake Victoria basin and Kondoa .

Nature of topography. steep slopes /hilly areas where vegetation cover is cleared experience rapid soil erosion by because steep slopes increase the erosive power of running water than gentle slopes and low lying areas ,for example Kigezi, Kondoa, Kenyan high lands, slopes of mountain Elgon, Kenya, Rwenzori, Meru and Kilimanjaro.

Occurrence of ferocious wind especially in arid areas leads to washing away of top loose soil in suspense, for example Karamoja region, North Western Kenya, Northern and North Eastern Kenya and North Eastern Tanzania.

Presence of weak and loose soils for example Volcanic and sandy soils, soak easily and carried away by the destructive forces of wind and running water. For example in the volcanic highlands of Kigezi, Kipengere, Elgon e.t.c, and sandy soils in arid Areas like Karamoja and Northern Kenya and Machakos in Kenya e.t.c

Presence of Biotic factors, for example harvester ants, termites and locusts especially in arid areas. These insects eat all the grass leaving the surface bare and exposed to agents of erosion especially during the dry season/ spell. Wind and water get a clear sweep of bare land; carrying away soil for example Machakos, Ankole - Masaka ranching areas, Nakasongola and Karamoja, Turkana e.t.c.

▪Presence of poor vegetation cover fore example scrubs, bushes, shrubs e.t.c offer less protection to soil leading to soil erosion, for example in Karamoja

MEASURES / STEPS TAKEN TO CONTROL/ COMBAT SOIL EROSION

NATURAL VEGETATION IN EAST AFRICA

Major vegetation types in East Africa and factors influencing their growth and distribution.

With specific reference to East Africa, examine the factors that influence the growth and distribution of natural vegetation.

Approach

- Define natural vegetation
- Identify the various natural vegetation types in East Africa and areas where they occur
- Describe the characteristics of each vegetation type
- Explain the factors that have favored each vegetation type/zone identified.

Answer guide

Natural vegetation refers to that type of plant life that grows naturally in a particular physical environment without man's influence or interference. It can be a forest, grassland or scrub.

East Africa has different types of natural vegetation grouped into; natural forests, savanna wood land and grass land, scrub (semi desert) and swampy vegetation.

Natural forest vegetation Includes the tropical rain forests, mangroves and montane forests.

They are common in areas of mabira, kalangala, Budongo, East African coast, Kakamega, slopes of mountain Kilimanjaro, Rwenzori, Kenya and other major mountains.

Forest vegetation is characterized by;

▪ever green trees with broad leaves
▪tall trees of up to 50 meters high
▪trees have buttress roots to support the huge and straight trunks
▪trees appear in mixed stand for example mahogany, iron wood, ebony
▪trees form 2-3 canopy layers
▪there many climbing plants for example lianas

Savanna vegetation is subdivided into savanna wood land and grassland depending on the annual rainfall received and the duration of the dry season.

Savanna woodlands and grasslands cover areas of Northern Uganda, western and southern Tanzania e.t.c

Savanna vegetation is characterized by;

▪dominance of medium height trees in the woodland and tall grass in the grassland
▪trees have small waxy needle like leaves,
▪trees are drought and fire resistant,
▪trees are deciduous
▪trees are umbrella shaped at the top to reduce water loss,
▪dominant tree species are acacia and baobab,
▪grass dries during the dry season and become brown or yellow, and green during the wet season.

Scrub or semi desert vegetation in northern, north western and north eastern Kenya, north eastern Uganda (Karamoja), Ankole – Masaka corridor, northern Tanzania and some parts of Rift valley due to low annual rainfall between 250mm-500mm.

Scrub vegetation is characterized by;

▪bushy thorny trees of 5- 10 meters tall with shrub growing between them
▪trees are drought and fire resistant for example acacia,
▪very poor and short tuft grasses with bare ground between the scattered thorny bushes,
▪grass dries up and turns yellow / brown during the drought period and roots become dormant in soil
▪some plant species have twisting leaf system to prevent direct sunshine and high transpiration
▪Trees have small waxy needle like leaves to reduce transpiration

Swampy vegetation found in poorly drained areas and includes

●Mangrove swamps in the salty waters along the coastal plains for example Lamu and Rufijj delta.
●Papyrus swamps in water logged areas such as shores of Lake Kyoga and Victoria; valleys in central and western Uganda and river valleys such as katonga, kagera and Rwizi.

Characteristics of swampy vegetation

▪dominance of papyrus, palm trees and sedge grass in papyrus swamps,

▪Mangrove swamps have Medium height trees of about 12 meters,
▪trees have aerial roots for breathing because of mud,
▪trees have short and twisted trunks,
▪trees have ever green broad leaves
▪trees are of tropical hard wood.

Factors responsible for vegetation growth and distribution in East Africa

PHYSICAL FACTORS

These include climate, type of soil, drainage, altitude, relief and biotic factors.

Climate- Influences vegetation growth and distribution through its elements of rainfall, temperature and humidity

▪Heavy, reliable and well distributed rainfall over 1500 mm per annum and hot temperatures of about 22^0-27^0 C encourage the growth of natural forests.
▪Moderate to heavy rainfall of about 760 mm -1200 mm annually and distributed in one season and hot temperatures of about 24^0c - 30^0 c encourage growth of savannah woodland while moderate annual rain fall of about 500mm-760 and hot temperatures over 30^0 c encourage grass lands.
▪Low and seasonal rain fall of about 250mm- 500 mm per annum and very hot temperatures over 30^0 C encourages the growth of scrub vegetation.
▪High humidity over 80 % encourages equatorial vegetation; moderate humidity savanna and low humidity for scrub vegetation.

Altitude refers to the height above sea level. Different vegetation types thrive at different altitude because the conditions that influence vegetation growth like climate, soil and drainage change with altitude For example;

▪Low and high altitude about 1000m-2500m above sea level encourage forest vegetation while savanna, scrub and swampy vegetation thrive well at low altitude of less than 1000m above sea level.

Nature of the soil present. The Type of soil in terms of; fertility, depth and texture influence vegetation growth and distribution in the following ways;

▪deep and fertile soils such as volcanic on gentle slopes of volcanic highlands, loamy and alluvial soils in low lying areas such as lake shores and valleys have encouraged growth of forest and swampy vegetation.
▪fairly fertile soils with low water retention capacity have favored the growth of woodlands with soils of moderate fertility for example latosols and laterites have favored grass lands
▪Poor sandy soils for example in Karamoja and rift valley regions have encourage growth of scrub vegetation

Drainage of the area influences the moisture in the soil. That is;

▪Well drained areas for example gentle slopes of major highlands and basins with adequate supply of steams have favored the growth of forest vegetation
▪Water logged areas have favored swampy vegetation
▪Well drained areas without or very limited surface water and streams have encouraged the growth of savanna and scrub vegetation

Influence of relief- determines depth and moisture in the soil for example;

▪Gentle slopes and lowlands such as the coastal plains, lake shores and river valleys have encouraged the growth of both swampy and forest vegetation
▪Low lying plateau areas have favored savanna wood lands while flat lowlands have favored both savanna grass lands and scrubs

Biotic factors for example;

▪Termites, locusts, and elephants have led to destruction of the original vegetation types which are replaced with scrubs or other poor forms.

▪Animal grazing through nomadism, ranching and dairying leads to disappearance of forests, woodlands and grasslands and swamps

▪Man's activities such as deforestation, construction, cultivation and mining have led to the destruction of the original forests, woodlands, swamps and grasslands and replacing them with secondary vegetation types.

●On the other hand, human intervention through environmentally friendly activities such as afforestation, re-afforestation and agro forestry, creation of national parks and forest reserves has led to regeneration of formally degraded natural vegetation such as forests and protection of the existing ones.

To what extent has climate influenced vegetation distribution in East Africa?

Approach

- Define natural vegetation,
- Identify vegetation types in East Africa descriptively or drawing a sketch map,
- Give the 1St evaluation and explain the role of climate
- Give the 2$^{r\,d}$ evaluation and explain other factors that influence vegetation distribution in East Africa. That is; altitude, type of soil, relief, biotic factors and drainage

Answer guide

Natural vegetation refers to that type of plant life that grows naturally in a particular physical environment without man's influence or interference. It can be a forest, grassland or scrub.

East Africa has different types of natural vegetation grouped into; natural forests, savanna wood land and grass land, scrub (semi desert) and swampy vegetation.

Natural forest vegetation Includes the tropical rain forests, mangroves and montane forests.

They are common in areas of mabira, kalangala, Budongo, East African coast, Kakamega, slopes of mountain Kilimanjaro, Rwenzori, Kenya and other major mountains.

Savanna vegetation is subdivided into savanna wood land and grassland depending on the annual rainfall received and the duration of the dry season.

Savanna woodlands and grasslands cover areas of Northern Uganda, western and southern Tanzania e.t.c

Scrub or semi desert vegetation in northern, north western and north eastern Kenya, north eastern Uganda (Karamoja), Ankole – Masaka corridor, northern Tanzania and some parts of Rift valley due to low annual rainfall between 250mm-500mm.

Swampy vegetation found in poorly drained areas and includes

●Mangrove swamps in the salty waters along the coastal plains for example Lamu and Rufijj delta.

●Papyrus swamps in water logged areas such as shores of Lake Kyoga and Victoria; valleys in central and western Uganda and river valleys such as katonga, kagera and Rwizi.

Climate has to a largest extent Influenced vegetation growth and distribution through its elements of rainfall, temperature and humidity as explained below;

Heavy, reliable and well distributed rainfall over 1500 mm per annum and hot temperatures of about 22^0 C-27^0 C encourage the growth of natural forests characterized by;

.▪ever green trees with broad leaves

▪tall trees of up to 50 meters high

▪trees have buttress roots to support the huge and straight trunks

▪trees appear in mixed stand for example mahogany, iron wood, ebony

▪trees form 2-3 canopy layers

▪there many climbing plants for example lianas

Moderate to heavy rainfall of about 760 mm -1200 mm annually and distributed in one season and hot temperatures of about 24^0c - 30^0 c has encouraged growth of savanna woodland while moderate annual rain fall of about 500mm-760mm and hot temperatures over 30^0 c encourage grass lands.

Savanna vegetation is generally characterized by;

▪dominance of medium height trees in the woodland and tall grass in the grassland

▪trees have small waxy needle like leaves,
▪trees are drought and fire resistant,
▪trees are deciduous
▪trees are umbrella shaped at the top to reduce water loss,
▪dominant tree species are acacia and baobab,
▪grass dries during the dry season and become brown or yellow, and green during the wet season.

Low and seasonal rain fall of about 250mm- 500 mm per annum and very hot temperatures over 30^0 C have encouraged the growth of scrub vegetation characterized by;
▪bushy thorny trees of 5- 10 meters tall with shrub growing between them
▪trees are drought and fire resistant for example acacia,
▪very poor and short tuft grasses with bare ground between the scattered thorny bushes,
▪grass dries up and turns yellow / brown during the drought period and roots become dormant in soil
▪some plant species have twisting leaf system to prevent direct sunshine and high transpiration
▪Trees have small waxy needle like leaves to reduce transpiration

High humidity over 80 % has encouraged growth of natural forest and swampy vegetation; moderate humidity savanna and low humidity for scrub vegetation.

Other factors that have influenced the growth and distribution to a large extent apart from climate include type of soil, drainage, altitude, relief and biotic factors.

Explain these factors.

To what extent has altitude influenced the distribution of natural vegetation in the highland areas of East Africa?

Approach

- Define natural vegetation
- Identify the highland areas of East Africa where altitude controls or influences vegetation distribution.
- Explain the vegetation zonation with a clear diagram
- Explain the characteristics of each vegetation zone
- Give the 1^{St} evaluation (to a large extent) and explain how attitude influences natural vegetation.
- Give the $2^{r\,d}$ evaluation (other factors) that is; Climate, type of soil, nature of relief, biotic factors, drainage and human activities.

Answer guide

Altitude refers to the height above sea level and influences vegetation distribution in Highland areas like mountain Kilimanjaro, Kenya, Rwenzori, Elgon, Meru, Muhavura and other highlands above 3500m above sea level.

In highland regions, Altitude controls climate, soil and drainage which influence Vegetation zonation from the foot of the mountain to the top (summit) as explained below.

Areas lying below **1800 meters** above sea level have savannah vegetation, sub-divided into three depending on the annual rainfall and the duration of the dry season.

At its lowest level is **dry savanna** (dry bush and thicket) characterized by;
▪short bushy thorny trees with shrub growing between them
▪thorny trees have small waxy needle like leaves to reduce loss of water through transpiration
▪Poor and short tuft grasses with bare ground between them
▪trees are drought and fire resistant
▪growth of thickets
▪some plants have twisting lea system

The dry savanna merges into grassland characterized by;
▪dominance of tall grasses of about 3-5 m such as spear and elephant
▪few scattered short trees growing within the grasses for example acacia
▪trees have tiny leaves and are deciduous
▪trees are fire and drought resistant

▪grasses dry during the dry season and turns brown or yellow and green during the wet season
As altitude increases to **about 1800m** above sea level, savanna grasslands change into woodland characterized by;
▪dominance of trees forming a continuous cover towards the margin of the rain forest and less grass
▪trees are of tropical hard wood and appear in mixed stands
▪trees are umbrella shaped to reduce loss of water through transpiration
▪trees are of medium height of about 16- 18 meters
▪trees are deciduous in nature
▪they are also drought and fire resistant with tap roots to reach the water table deep in the ground and thick barks
▪trees also have small leaves to reduce loss of water through transpiration
▪dominant tree species include acacia and baobab
▪thick under growth of tall grasses, shrubs and bushes growing under scattered trees because adequate sun light reaches the ground easily than in the tropical rain forests
▪grasses dry during the dry season and turns brown or yellow and green during the wet season
▪some trees such as baobab have swollen trunks to resist drought and fire
At an altitude of **about 1800 – 2500** meters above sea-level, savanna woodland gradually merges into tropical rain forests characterized by;
.▪ever green trees with broad leaves
▪tall trees of up to 50 meters high
▪trees have big and straight trunks
▪trees have buttress roots to support the huge and straight trunks
▪trees appear in mixed stand for example mahogany, iron wood, ebony
▪trees form 2-3 canopy layers
▪there many climbing plants for example lianas
▪limited under growth because the canopies block sunlight from reaching the ground
▪trees are of tropical hard wood species
At an altitude **of about 2500- 3000 meters** above sea-level, equatorial forests gradually merge into temperate forests characterized by;
▪dominance of coniferous soft wood trees species like cedar, podocarp and camphor.
▪trees are ever green,
▪trees have straight trunks,
▪trees have thick barks,
▪trees have needle shaped leaves and no under growth.
▪Trees are shorter towards the bamboo forest.
At an altitude of about 3000 - 3500 meters above sea-level, temperate forests gradually merge into bamboo forest characterized by;
▪trees which appear in single layer,
▪trees grow in pure stands
▪have segmented or reed like stems with hollows inside to minimize water consumption which is relatively scarce at this altitude,
▪have small, tough pointed leaves,
▪trees are ever green,
▪they have prop roots to anchor firms in the thin soil layer
At an altitude of about **3500 - 4500metres** above sea-level, bamboo forest gradually merges into heath and moorland characterized by;
▪short grasses, shrubs and Alpine flowers
▪Plants include lobelia and giant groundsel.

DIAGRAM SHOWING NATURAL VEGETATION ZONATION IN MOUNTANEOUS AREAS IN EAST IN RELATION TO ALTITUDE

On the other hand, vegetation distribution is influenced by climate, type of soil, drainage, relief and biotic factors

Account for the differences in the natural vegetation zonation in one mountainous area in East Africa.

Approach

- identify any one mountainous area in East Africa with different natural vegetation
- identify the different natural vegetation zones existing on it
- describe the characteristics of each vegetation type
- explain the factors that have favored each vegetation type/zone identified.
- Draw the diagram showing the arrangement of vegetation types from the top to the base

Answer guide

Vegetation zonation refers to the arrangement of vegetation along the slope from the summit to the base. It is dictated by altitude hence limited to mountainous regions such as Kilimanjaro, Kenya, Rwenzori, Elgon, Meru and Muhavura.

Altitude influences vegetation zonation because rain fall, temperature, soil and drainage change with altitude as explained below.

The vegetation zones vary from mountain to mountain depending on the height of the mountain. In addition the zones don't have clear margins instead overlap.

Diagram showing natural vegetation zonation in mountainous areas in East Africa

Generally the following zones can be identified

Areas lying below **1800 meters** above sea level have savanna vegetation, sub-divided into three depending on the annual rainfall and the duration of the dry season.

At its lowest level on the drier margins is **dry savanna** (dry bush and thicket) characterized by;

▪scrub, bush and thicket with stunted trees **due to;**
▪moderate to low annual rainfall of about 500 mm-250mm supports dry bush.
▪Low humidity in the atmosphere supports growth of drought resistant plants
▪very hot temperatures of over 30 ^{0}C support growth of drought resistant plants
▪poor sandy soils with low water retention capacity support growth of drought resistant plants
▪fair drainage hence limited moisture in the soil
▪flat low lying relief/ lower slopes
▪low altitude less than 1000m above sea level- the lower slopes of the mountain

The dry savanna merges into **grassland characterized by**;

▪dominance of tall grasses of about 3-5 m such as spear and elephant
▪few scattered short trees growing within the grasses for example acacia
▪trees have tiny leaves and are deciduous
▪trees are fire and drought resistant
▪grasses dry during the dry season and turns brown or yellow and green during the wet season

Savannah grass exists at this level because of;

▪Moderate annual rain all of about 500mm-760mm encourages growth of tall grasses and short trees
▪Alternate short wet and long dry seasons encourage growth of deciduous trees and drying of grasses
▪Low humidity in the dry season and high in the wet season
▪Hot temperatures above over 27 ^{0}C support growth of drought resistant plants
▪Fairly fertile soils encourage growth of tall grasses and short scattered trees
▪Fairly good drainage especially in the wet season increases moisture in the soil and growth of tall grasses
▪Relatively flat lowland relief favors growth of grasses and short trees
▪Low altitude of less than 1000m above sea level minimizes moisture in the soil for growth of grasses

As altitude increases to **about 1800m** above sea level, savanna grasslands change into woodland towards the rain forest with the following characteristics;

▪dominance of trees which are umbrella shaped with less grass
▪trees are of tropical hard wood and appear in mixed stands
▪trees are of medium height of about 8- 16 meters
▪trees are deciduous in nature to reduce water loss through transpiration
▪they are also drought and fire resistant with tap roots to reach the water table deep in the ground.
▪Trees have thick barks to resist water loss and destruction from animals and wild fire,
▪trees also have small leaves to reduce loss of water through transpiration
▪dominant tree species include acacia and baobab
▪thick under growth of tall grasses, shrubs and bushes growing under scattered trees because adequate sun light reaches the ground easily than in the tropical rain forests
▪some trees such as baobab have swollen trunks to resist drought and fire

Savanna woodland exists at this level because of;

▪Moderate to heavy rain fall of about 760mm – 1200 mm annually supports the growth of medium height trees and thick under growth.
▪Rainfall is seasonal and concentrated in one peak hence growth of deciduous and drought resistant plants such as acacia and baobab
▪Fairly high humidity in the wet season encourages growth of deciduous trees, tall grass and shrub.
▪hot temperatures above 24^0c encourage high transpiration hence growth of deciduous and drought resistant plants.
▪Fairly fertile soils with low water retention capacity favor growth of and drought resistant plants
▪low lying plateau relief favors the growth of short trees intermixed with shrubs
▪Fairly good drainage with limited surface water favors growth of deciduous and drought resistant plants

Rain forests exist at **an altitude of about 1800- 2500 meters** above sea-level. They are characterized by;

▪tall trees of up to 50 meters,
▪trees are ever green with broad leaves,
▪trees form 2-3 canopy layers. That is, upper layer of very tall trees, middle and lower layer.
▪Trees have huge and straight trunks
▪trees have buttress roots to support the huge and straight trunks,
▪trees appear in mixed stand, for example mahogany, iron wood, ebony e.t.c
▪Little or no under growth because of the canopies which block sunlight,
▪there many climbing plants for example, lianas and epiphytes like Ferns, mosses and orchids,
▪trees have thick barks and provide hard wood for example, mahogany, iron wood, rose wood, green heart and ebony.

Tropical rain forests exist at this level because of;

▪Heavy and well distributed rain fall over1500mm annually provides adequate water for growth of tall trees with buttress roots
▪High humidity over 80 % contributes to formation of heavy rain fall
▪hot temperatures of about 22^0c- 28^0c increases humidity and rain fall formation through evapotranspiration
▪Deep fertile soils such as volcanic provide adequate nutrients for growth of tall trees
▪Low and high altitude of about 1000m- 2500m above sea level encourages growth of tall trees
▪Good drainage with adequate supply of streams increases moisture in the soil.
▪In terms of relief, rain forests thrive on gentle slopes of major highlands

Temperate forests exist at an altitude of about 2500 - 3000 meters above sea-level. They are characterized by;

▪dominance of coniferous soft wood trees species like cedar, podocarp and camphor.
▪trees are tall near the tropical rain forests due to heavy rain fall
▪trees are ever green,

▪trees have straight trunks,
▪trees have thick barks,
▪trees have needle shaped leaves and no under growth.
▪Trees are shorter towards the bamboo forest.

Temperate forests exist at this level because of;

▪Low rain fall
▪Low humidity
▪Low temperatures below 20^0C
▪Shallow soils

Bamboo forests exist at an altitude of about 3000m – 3500m above sea. Bamboo plants have the following characteristics;
▪they appear in single layer,
▪grow in pure stands
▪have segmented or reed like stems with hollows inside to minimize water consumption which is relatively scarce at this altitude,
▪have small, tough pointed leaves,
▪they are ever green,
▪have prop roots to anchor in the swallow soil.

Bamboo forests exist at this level because of;

▪low rain fall
▪cool temperatures
▪thin and skeletal soils.

Heath and moorland exists at an altitude of about **3500m – 4500** meters above sea- level and have the following characteristics;
▪They consist of short grasses, shrubs and Alpine flowers
▪Plants include lobelia and giant groundsel.

Heath and moorland exist at this level because of;

▪low rain fall
▪cold or Low temperatures
▪thin soils such as scree soils due to high rate of erosion on steep slopes and limited chemical weathering

Other factors that influence vegetation zonation include;

▪**Aspect of relief**. That is, forest vegetation exists on the wind ward side while savanna and scrub vegetation exists on the leeward due to arid conditions
▪Occurrence of Natural disasters such as landslides have led to the destruction of the original vegetation in highlands; replacing them with secondary vegetation types.
▪Wild fires have led to the destruction of the original vegetation in highlands; replacing them with secondary vegetation types.

Influence of biotic factors for example;

▪Termites, locusts, and animals in game parks such as elephants have led to destruction of the original vegetation types which are replaced with scrubs or other poor forms.
▪Animal grazing through nomadism, ranching and dairying led to destruction of the original vegetation types which are replaced with scrubs or other poor forms.
▪Man's activities such as deforestation, construction, cultivation and mining have led to the destruction of the original forests, woodlands, swamps and grasslands and replacing them with secondary vegetation types.
●On the other hand, human intervention through environmentally friendly activities such as afforestation, re-afforestation and agro forestry, creation of national parks and forest reserves has led to regeneration of formally degraded natural vegetation such as forests and protection of the existing ones.

●Favorable Government policy of gazetting highlands as national parks and game reserves has protected and preserved natural vegetation

To what extent has the natural vegetation of East Africa been modified by human activities?

Approach

- ❖ define natural vegetation
- ❖ Identify and describe the characteristics of natural vegetation types modified by human activities
- ❖ State areas where human activities have modified natural vegetation
- ❖ Give the 1St evaluation (to a large extent) and explain the activities that have modified natural vegetation
- ❖ Give the 2r d evaluation (physical factors)

Answer guide

Natural vegetation is that type of plant life that grows naturally in a particular physical environment.
The natural vegetation types modified greatly by human activities include:
Natural forests, savanna wood land and grass lands and scrub.
Natural forests include tropical rain forests, mangroves and montane Forest. They are common in areas of mabira, kalangala, Budongo, East African coast, mountain Kilimanjaro, Rwenzori, Kenya and other highlands above 3500 m above sea level.

Forest vegetation is generally characterized by;

▪ever green trees
▪trees are tall
▪trees have broad leaves,
▪ trees have buttress roots to support the huge trunks,
▪trees appear in mixed stand for example mahogany, iron wood, ebony e.t.c
▪trees form 2-3 canopy layers. That is, upper layer of very tall trees, middle and lower layer.
▪trees have thick bark and provide hard wood for example, mahogany, iron wood, rose wood, green heart and ebony.

Savanna woodlands and grasslands cover areas of Northern Uganda, western and southern Tanzania e.t.c
They are characterized by;

▪dominance of medium height trees in the woodland and tall grass in the grassland
▪trees have small waxy needle like leaves,
▪trees are drought and fire resistant,
▪trees are deciduous
▪trees are umbrella shaped at the top to reduce water loss,
▪dominant tree species are acacia and baobab,
▪grass dries during the dry season and become brown or yellow, and green during the wet season.

Scrub or semi desert vegetation in northern Kenya, north eastern Uganda (Karamoja), Ankole – Masaka corridor, northern Tanzania and some parts of Rift valley due to low annual rainfall below 500mm.
Scrub vegetation is characterized by;

▪bushy thorny trees of 5- 10 meters tall with shrub growing between them
▪trees are drought and fire resistant for example acacia,
▪very poor and short tuft grass with bare ground between the scattered thorny bushes,
▪grass dries up and turns yellow / brown during the drought period and roots become dormant in soil
▪some plant species have twisting leaf system to prevent direct sunshine and high transpiration.

The natural vegetation types identified above have been modified by man's activities mainly in areas of Kenya highlands, Kigezi highlands, Lake Victoria basin, north eastern Uganda, northern and western Kenya, slopes of mountain Kilimanjaro, parts of central Tanzania and central Uganda e.t.c
The areas stated above have witnessed the following human activities that have to a largest extent modified natural vegetation as explained below;

●steady destruction and clearing of forests and swamps to expand cultivable land either for commercial or subsistence for example sugar cane in lugazi , coffee, Banana plantations, tea on the fringes of Mabira forest, palm oil in Kalangala, islands, yams ,rice; millet and sorghum in savanna and semi desert areas.
The original vegetation cover has been replaced by planted crops.
●He burns vegetation to provide new pastures for nomadic pastoralism, dairying and ranching for example in Nakasongola, Teso, Kikuyu, Karamoja and Miombo in Tanzania.
●clearing of forests and grasslands and swamps for settlement/ urbanization in areas of Kampala, Lugazi, Mukono, Nairobi, Kisumu, Jinja, Dodoma and other towns in central, Eastern and south western Uganda, Kenya and Tanzania
●lumbering in tropical rain forests have been replaced by woodland and scrubs for example Imaragambo, Budongo, Kibaale, Kalangala islands, Miombo woodlands e.t.c
●cutting down of trees for fuel (fire wood and charcoal) for industrial and domestic use for example Budongo, Kibaale, Kalangala islands, Miombo woodlands , Karamoja, central Uganda, south western Tanzania e.t.c .Trees have been replaced by secondary forms of vegetation.
●Swamp reclamation for agriculture, dairying, settlement, industrial development e.t.c has led to disappearance of swampy vegetation in most areas such as Nakawa-Banda, Nalukolongo-Natete and other swamps in western and central Uganda
●mining and quarrying in Mwandui (Diamond),Tororo (limestone and vermiculite),Kilembe(Cobalt), Bamburi (cement), Gold, Tin, Wolfram in south western Uganda, murrum, sand, e.t.c destroys the original forests, grasslands and swamps ;replacing them with secondary vegetation types.
●animal grazing through nomadism, ranching, and dairying leads to disappearance of original forests, grasslands and swamps; replacing them with secondary vegetation types for example in Karamoja, Ankole – Masaka corridor, Kigezi and Kenya highlands a Miombo in Tanzania e.t.c.
●repeated bush burning in Karamoja, Mbarara, Turkanaland, Masai, Nakasongola, Miombo in Tanzania and other pastoral communities to prepare for good pastures, kill pests and diseases e.t.c has led to the destruction of the original vegetation types which are replaced with scrubs or other poor forms.
●Man also clears natural vegetation for setting up and expanding industries for example Namanve industrial park destroys the original forests, grasslands and swamps ;replacing them with secondary vegetation types.
●Cutting down of trees for timber and building materials have modified forest, grasslands and swamps; replacing them with secondary vegetation types.
●Human interference through afforestation, re-afforestation and agro forestry has led to the introduction of exotic tree species such as p pine, eucalyptus, Robusta, Grevilleea e.t.c replacing the former grasses and natural vegetation types
To a least extent, natural vegetation has been modified by physical factors such as;
Harsh climatic conditions/ unreliable rain fall/ desertification e.t.c has changed the natural vegetation characteristics fore example Karamoja, northern Kenya, Miombo e.t.c
Occurrence of landslides has removed the original vegetation cover; exposing rock layers for example on Mount Elgon slopes Kigezi highlands, Rwenzori slopes, Rwampara hills e.t.c
Overgrazing by wild game, browsing, debarking and over trampling have changed the original natural vegetation in National parks such as Queen Elizabeth, Masai-Mara e.t.c
Living organisms such as termites, ants, locusts e.t.c in Nakasongola e.t.c have destroyed savanna grasslands; changing it to scrub. Aphids and Tsetse flies in Masindi, Bunya, and Mayuge e.t.c prompted man to clear forests changing to savanna woodland and grassland
Continued deposition of sediments on flood plains leads to gradual successions of vegetation types and growth of new types.
To what extent has man influence the distribution of natural vegetation of East Africa?

Approach

- define natural vegetation
- Identify and describe the characteristics of natural vegetation types in East Africa.
- State areas where human activities have influenced/ modified natural vegetation in East Africa
- Give the 1St evaluation (to a large extent) and explain the activities that have influenced natural vegetation
- Give the 2r d evaluation (physical factors)

Answer guide

Refer to the question above for answers

Human activities that have influenced vegetation distribution in East Africa include;

●steady destruction and clearing of forests and swamps to expand cultivable land either for commercial or subsistence

●He burns vegetation to provide new pastures for nomadic pastoralism, dairying and ranching

●clearing of forests and grasslands and swamps for settlement/ urbanization in areas of Kampala, Lugazi

●lumbering in tropical rain forests have been replaced by woodland and scrubs

●cutting down of trees for fuel (fire wood and charcoal) for industrial and domestic use

●Swamp reclamation for agriculture, dairying, settlement, industrial development

●mining and quarrying in Mwandui (Diamond), Tororo (limestone and vermiculite), Kilembe (Cobalt), Bamburi

●Human interference through afforestation, re-afforestation and agro forestry has led to the introduction of exotic tree

●repeated bush burning in Karamoja, Mbarara, Turkanaland, Masai, Nakasongola, Miombo in Tanzania

●Man also clears natural vegetation for setting up and expanding industries for example Namanve industrial park

●Cutting down of trees for timber and building materials have modified forest, grasslands and swamps;

●animal grazing through nomadism, ranching, and dairying leads to disappearance of original forests, grasslands

To a least extent, man has influenced vegetation distribution through;

●afforestation, re- afforestation and agro forestry for example planting pine, eucalyptus, Robusta, Grevilleea

●Favorable Government policy of conserving natural vegetation in form of forest reserves and national parks has led to the existence of natural forests, savanna and swamps for example Mabira, Budongo, Bugoma, IMaramagambo, Bwindi impenetrable forests, Elgon forests, Tsavo National parks e.t.c

On the other hand, vegetation distribution is influenced by physical factors like;

Climate, altitude, type of soil, nature of relief, biotic factors and Drainage

Remember to explain these factors.

NATURAL FOREST VEGETATION IN EAST AFRICA

Account for the distribution of natural forest vegetation in East Africa.

Approach

- Define natural forest vegetation.
- Identify the types of natural forests in East Africa
- State the characteristics of each type of forest and where it is found descriptively or by drawing a sketch map.
- Explain the factors influencing the growth of each type of forest

Answer guide

Natural forest vegetation refers to the community of a dense cover of trees growing naturally in a particular physical environment
Natural forests in East Africa are grouped into three types. Namely; equatorial forests/ tropical rain forests, montane forests, mangrove and riverine forests
Equatorial tropical rain forests are common in areas of mabira, kalangala, Budongo, Kibaale, Imaramagambo and on the foot hills of Mount Elgon, Rwenzori, Kenya, Kilimanjaro and Meru.
Tropical rainforests are characterized by;
▪ever green trees
▪trees are tall
▪trees have broad leaves,
▪trees have huge and straight trunks
▪ trees have buttress roots to support the huge trunks,
▪trees appear in mixed stand for example mahogany, iron wood, ebony e.t.c
▪trees form 2-3 canopy layers. That is, upper layer of very tall trees, middle and lower layer.
▪trees have thick bark and provide hard wood for example, mahogany, iron wood, rose wood, green heart and ebony.
▪Limited or no under growth because of the canopies which block sunlight from reaching the ground
Montane forests- sub divided into temperate and Bamboo.
Temperate forests exist at an altitude of about 2500m- 3000meters above sea –level and characterized by;
▪dominance of coniferous soft wood trees species like cedar, podocarp and camphor.
▪trees are tall near the tropical rain forests due to heavy rain fall
▪trees are ever green,
▪trees have straight trunks,
▪trees have thick barks,
▪trees have needle shaped leaves and no under growth.
▪Trees are shorter towards the bamboo forest.
Bamboo forests exist at an altitude of about 3000m – 3500m above sea. Bamboo plants have the following characteristics;
▪they appear in single layer,
▪grow in pure stand
▪have segmented or reed like stems with hollows inside to minimize water consumption which is relatively scarce at this altitude,
▪have small, tough pointed leaves,
▪they are ever green,
▪have prop roots to anchor in the swallow soil.
Mangrove forests in the salty waters along the coast of East Africa between 5^0 north and 5^0south of the equator for example Rufiji delta, areas near Mombasa, Lamu e.t.c
▪Mangrove contain Medium height trees of about 12 meters,
▪trees have aerial roots for breathing in mud,
▪Have tap roots for filtering salts from the blackish water
▪Have buttress roots to anchor firmly in the unstable mud flats
▪trees have short and twisted trunks,
▪trees have ever green broad leaves
▪trees are of tropical hard wood.
▪trees form a dense cover due to water logging conditions,
Factors favoring the growth and distribution of natural forests
The growth and distribution of natural forests in East Africa is influenced by; climate, type of soil, drainage, altitude, relief and biotic factors as explained below.

Climate- has influenced the growth and distribution of forests through its elements of rainfall, temperature and humidity. That is;

▪hot and wet/ humid conditions have encouraged the growth of tropical rain forests.

▪cool and wet conditions in highland areas have encouraged the growth of montane forests.

▪hot and moist conditions in the coastal areas of East Africa have encouraged the growth of mangrove forests.

Altitude: refers to the height above sea level and affects temperate and rainfall.

▪Low and high altitude about 1000m-2500m above sea level encourages tropical rain forest

▪High altitude of about 2500m-3500m above sea level has encourage growth of montane forest vegetation

▪Coastal areas of about 0-200m above sea level have encouraged the growth of mangrove forests

Nature of the soil. The Type of soil in terms of; fertility, depth and texture has influenced the growth of forests in the following ways;

▪deep and fertile soils such as volcanic on gentle slopes of volcanic highlands, loamy and alluvial soils in low lying areas such as lake shores and valleys have encouraged growth of rain forests.

▪shallow and fairly fertile soils on mountain slope have encouraged the growth of montane forests

▪deep, muddy and saline soils have encouraged the growth of mangrove forests.

Drainage of the area influences the moisture in the soil. That is;

▪Well drained areas such as gentle slopes and steep slopes have encouraged the growth of both rain and montane forests.

▪poorly drained or water logged areas such as salty marshes in the coastal areas and deltas have encouraged the growth of mangrove forests.

Influence of relief. That is;

▪lowlands and gentle slopes have encouraged growth of rain forests

▪fairly steep slopes or hilly areas have encouraged the growth of montane forests

▪low lying coastal plains have encouraged the growth of Mangrove forests.

Influence of relief biotic factors for example;

▪Bird have helped in dispersing seeds form which trees thrive

▪Human intervention through afforestation, re-afforestation and agro forestry has facilitated the existence of natural forests,

▪Favorable Government policy of conserving natural forests in form of forest reserves and national parks has facilitated the existence of natural forests for example Mabira, Budongo, Bugoma, IMaramagambo, Bwindi impenetrable forests, Elgon forests, Tsavo National parks e.t.c

▪Absence of serious diseases and pests such as elephants and giraffes which would have other wise destroyed and change the quality and quantity of forest vegetation. For example Mabira and Bwindi forests.

EQUATORIAL FORESTS / TROPICAL RAIN FORESTS

(a) describe the characteristics of tropical rain forests in East Africa

(b) Explain the conditions which have favored the growth of tropical rain forests in East Africa.

Approach

- Identify areas covered by tropical rain forests in East Africa
- Give and describe the characteristics of tropical rain forests
- Identify and explain the factors favoring the growth of tropical rain forests

Answer guide

Tropical rain forests exist in equatorial climatic region in areas such as mabira, kalangala, Budongo, Kibaale, Imaramagambo, Kakamega western Kenya, parts of central Uganda; and on the foot hills of Mount Elgon, Rwenzori, Kenya, Kilimanjaro and Meru.

Tropical rain forests are characterized by;

▪tall trees that grow to height of 60 meters due to competition for sun light

▪Hard wood tree species such as mahogany, musizi, mvule, ironwood, Ebony e.t.c due to availability of adequate water and nutrients
▪Trees form dense canopies usually in 3 layers. That is; upper layer of very tall trees, middle and bottom layer due to growth of trees at different intervals or age and sprawl to form canopies
▪Ever green trees, shedding leaves at different intervals throughout the year due to constant rain fall hence continuous growth of trees
▪They have little or no undergrowth due to thick canopy preventing sunlight from reaching the ground
▪Trees have broad leaves that allow evaporation to get rid of excess water
▪Trees have many climbing plants for example lianas and epiphytes such as ferns, mosses that get support from the tall and huge trees
▪Trees grow in mixed stands/ have a variety of plants growing profusely such as mahogany, palms, iron wood, ebony e.t.c
▪Trees have straight trucks and buttress roots due to ample water supply
▪Most trees have buttress roots that give support to the huge and tall trees
▪ Trees have a long gestation period to mature of about 30 years

Impression marking……..10 marks

Tropical rain forests are largely favored by physical factors for example;

Climate. Equatorial forests grow well in areas;
▪Receiving heavy and reliable rainfall above 1500mm annually.
▪Rain fall is distributed through out the year with a bi-modal pattern
▪Have hot to warm temperatures of about 22^0c- 28^0c throughout the year; increase humidity in air and formation of heavy rainfall that encourages the growth of tall trees
▪Have high humidity levels of about 80% that promotes luxuriant tree growth
▪Presence of adequate sun light for plants to manufacture food promotes plant growth

Altitude-affects temperature and rainfall. Consequently tropical rain forests thrive at an altitude of about 1000m-2000m above sea level where rainfall is abundant and temperatures range from hot to warm in lowland and highlands respectively

Soil-tropical rain forests grow in areas with deep fertile soils along mountain slopes, gently sloping areas, alluvial soils along river valleys and loamy soil near shores of lakes.

Drainage. Tropical rain forests grow in well drained areas especially along gentle slopes of major highlands and lowlands
▪Water logged areas especially those containing numerous streams and rivers favor riverine forests

Aspect of relief. Equatorial rain forests thrive on the gentle slopes on the windward side of major mountains due to moist winds that facilitate the formation of relief rain fall

Influence of biotic factors for example;

▪**Favorable government policy** of conserving/ gazetting forest reserves for ecological functions has ensured the growth and continuous existence of rain forests in various parts of East Africa for example mabira, Bwindi forest reserve, Elgon forest, Rwenzori, Kibaale e.t.c
▪Human intervention through afforestation, re-afforestation and agro forestry programs has led to regeneration of formally degraded tropical rain forests.

Maximum…….15 marks

Explain the factors influencing the distribution of tropical rain forests in East Africa.
Account for the distribution of tropical rain forests in East Africa.
Account for the growth of equatorial forests in East Africa.

Approach

- Identify areas covered by tropical rain forests in East Africa
- Give and describe the characteristics of tropical rain forests
- Identify and explain the factors favoring the growth of tropical rain forests

Refer to the question above for the answers

SAVANNA VEGETATION

(a) Describe the characteristics of savanna vegetation.

(b) Explain the conditions which have favored the growth of savannah vegetation in East Africa.

Approach

- define savanna vegetation
- identify the types of savanna
- give and describe the characteristics of each type and where it occurs
- Identify and explain the explain the conditions favoring the growth of savanna

.

Answer guide

Savanna refers to a belt of tropical grassland with scattered trees. It occurs in the interior landmasses experiencing tropical climate.

Savanna vegetation is subdivided into three types depending on the annual rainfall received and the duration of the dry season. That is; dry savanna, grassland and woodland.

Dry savanna (dry bush and thicket) covers areas in northern, north western and north eastern Kenya, north eastern Uganda (Karamoja), Ankole – Masaka corridor, northern Tanzania and some parts of Rift valley.

Dry savanna is characterized by stunted poor vegetation of;

▪bushy thorny trees of 5- 10 meters tall,
▪trees are short with small waxy needlelike leaves,
▪plants are drought and fire resistant,
▪ presence of Shrubs and thicket,
▪very poor and short grasses and grow in bunches or tufts and widely spaced,
▪the bushes and the shrubs have thorns instead of leaves to reduce transpiration
▪some plant species have twisting leaf system to prevent direct sunshine and high transpiration

Savanna Grassland -covers Nyika plateau and Athi plains, parts of Northern Uganda, Rift valley areas of western Uganda, areas of Bukoba e.t.c.

Savanna Grassland is **characterized by**;

▪dominance of tall grasses of about 3-5 m such as spear and elephant
▪few scattered short trees and bushes grow within the grasses for example acacia
▪trees have tiny leaves and are deciduous
▪trees are fire and drought resistant
▪grasses dry during the dry season and turns brown or yellow and green during the wet season

Savanna Woodlands cover mainly parts of western and south western Tanzania, parts of Northern Uganda, parts of western rift valley region for example lake George and Albert flats, parts of southern and Eastern Kenya.

Savanna Woodland vegetation is characterized by;

▪dominance of trees which are umbrella shaped with less grass
▪trees are of tropical hard wood and appear in mixed stands
▪trees are of medium height of about 8- 16 meters
▪trees are deciduous in nature to reduce water loss through transpiration
▪they are also drought and fire resistant with tap roots to reach the water table deep in the ground.
▪Trees have thick barks to resist water loss and destruction from animals and wild fire,
▪trees also have small leaves to reduce loss of water through transpiration
▪dominant tree species include acacia and baobab
▪thick under growth of tall grasses, shrubs and bushes growing under scattered trees because adequate sun light reaches the ground easily than in the tropical rain forests
▪some trees such as baobab have swollen trunks to resist drought and fire

Factors or conditions favoring the growth of savanna vegetation

These include climate, type of soil, drainage, altitude, relief and biotic factors.

Climate- Influences the growth and distribution of savanna vegetation through its elements of rainfall, temperature and humidity. That is;

▪Moderate to heavy rainfall of about 760 mm -1200 mm annually and distributed in one season and hot temperatures of about 24^0c - 30^0 c encourage growth of savanna woodland while

▪moderate annual rain fall of about 500mm-760mm and hot temperatures over 30^0 c encourage grass lands.

▪Low and seasonal rain fall of about 250mm- 500 mm per annum and very hot temperatures over 30^0 C encourages the growth of dry savanna vegetation.

▪high to moderate humidity has favored savanna wood lands and grassland while low humidity for dry savanna vegetation.

Altitude -Low altitude of less than 1500 meters above sea level encourages savanna vegetation. That is;

▪ Low plains encourage dry savanna and grassland while high plains encourage savanna woodland.

Nature of the soil present. The Type of soil in terms of; fertility, depth and texture influence savanna vegetation in the following ways;

▪fairly fertile soils with low water retention capacity have favored the growth of woodlands

▪soils of moderate fertility for example latosols and laterites have favored grass lands

▪Poor sandy soils for example in Karamoja and rift valley regions have encouraged growth of dry savanna vegetation

Drainage of the area influences the moisture in the soil. That is;

▪Well drained areas without or very limited surface water have encouraged the growth of dry savanna vegetation

▪Fairly good drainage especially in the wet season increases moisture in the soil hence growth of tall grasses

▪Fairly good drainage with limited surface water and streams favors growth of savanna woodland characterized by deciduous and drought resistant plants

Influence of relief- determines depth and moisture in the soil for example;

▪Low lying plateau areas have favored savanna woodlands while

▪flat lowlands have favored both savanna grasslands and dry savanna for example rift valley areas and the plains

Biotic factors for example;

▪Occurrence of pests such as tsetse flies, termites, bees, caterpillars and locusts, and diseases such as Nagana and sleeping sickness deter human interference through deforestation hence continuous existence of savannas.

▪Wild fire and animals especially in national parks have destroyed and altered the characteristics of the tropical forests; degradation and changing them into savannas for example Elephants, giraffes, buffaloes and cattle.

Man's activities such as logging, charcoal burning, mining and agricultural expansion in the tropical forests has led to degradation and changing of these forests into savannas

▪**Favorable government policy** of conserving/ gazetting savannas as reserves and national parks for ecological functions has ensured their growth and continuous existence in various parts of East Africa for example Murchison falls national park, Queen Elizabeth national park, Tsavo, Masai Mara and Serengeti national parks.

▪Human intervention through afforestation, re-afforestation and agro forestry programs has led to regeneration of formally degraded savannas.

N.B conditions must be attached to the vegetation type as shown above.

SAVANNA WOOD LAND/ MIOMBO WOODLAND

Account for the occurrence of the Miombo wood land type of vegetation in East Africa.

Approach

- Define Miombo wood land type of vegetation
- Identify areas where the Miombo woodland occur descriptively or by use of a sketch map
- Describe the characteristics of Miombo woodland.
- Identify and explain the various factors that have led to the occurrence of Miombo wood land type of vegetation.

Answer guide

Miombo wood land is a form of savanna vegetation with more or less continuous cover of trees and shrubs intertwined. It is also referred to as tropical wood land/ savanna wood land.

Miombo wood lands occur in Western and South Western Tanzania, parts of the western Rift valley region such as lake George and Albert flats, parts of southern and Eastern Kenya , Northern Uganda e.t.c

A candidate may draw a sketch map of East Africa showing the distribution of savanna woodland vegetation.

Characteristics of Miombo wood land vegetation;

▪dominance of trees forming a continuous cover towards the margin of rain forests trees because of moderate water supply.
▪trees have medium height between 8 -16 meters,
▪trees are umbrella shaped at the top to reduce water loss,
▪trees are tropical hardwoods and of mixed stands,
▪trees are deciduous in nature. That is, they shed off their leaves in the dry season,
▪a dense cover of grass, bushes and shrubs grows among the trees because sun light reaches the surface,
▪trees have tiny leaves, twisted trunks with thick, rough barks to reduce water loss,
▪trees are drought and fire resistant, with long tap root system which enables the plants draw water deep underground,
▪some tree species such as baobab have swollen trunks to store water for use during the hot dry season.
▪dominant tree species are acacia and baobab.
▪Most trees develop branches close to the ground.

Factors or conditions favoring the growth of savanna woodland vegetation

Climate, altitude, soils, drainage, relief, biotic factors, influence of human activities.

Climate- Influences the growth and distribution savanna woodland vegetation through its elements of rainfall, temperature and humidity;
▪Seasonal and moderate rain fall of 760-1000mm per annum has encouraged the growth and dominance of trees to form a continuous cover towards the margin of rain forests.
▪Rain fall is concentrated in one peak.
▪The dry season encourages shedding of leaves and growth of grasses
▪High temperatures over 27^0 C - 30^0 C encourage growth of drought resistant tree species such as acacia
▪Moderate humidity allows fairly high transpiration.

Occurrence of fairly fertile and porous soils enables water to drain easily and trees to develop long tap roots.

Relief. The occurrence of low lying plateau areas has favored the growth of Miombo woodland vegetation.

Low altitude of less than 1500 meters above sea level has encouraged the growth of savanna woodland.

Drainage. Limited or lack of surface water leads to quite good drainage which encourages the growth of Miombo woodland.

Biotic factors for example;

▪Occurrence of pests such as tsetse flies, termites, bees, caterpillars and locusts, and diseases such as Nagana and sleeping sickness deter human interference through deforestation hence continuous existence of savanna woodland.

Man's activities such as logging, charcoal burning, mining and agricultural expansion in the tropical forests has led to degradation and changing of these forests into savanna woodland.

Government policy creating of national parks and forest reserves for ecological functions has led to protection and regeneration of formally degraded savanna wood lands for example Murchison falls national park, Queen Elizabeth national park, Tsavo, Masai Mara and Serengeti national parks.

MEDITERRANEAN VEGETATION

(a)Describe the characteristics of the Mediterranean type of vegetation

(b) Account for the growth of Mediterranean type of vegetation in Africa.

Approach

- State where Mediterranean vegetation is found
- Give and describe the characteristics of Mediterranean vegetation
- Explain the factors which have favored the growth of this type of vegetation

Answer guide

Mediterranean type of vegetation occurs on the west coast of continents in the mid-latitudes for example central California and central Chile; and low lands for example around the Mediterranean Sea basin and the Western Cape Province of South Africa.

Characteristics of Mediterranean vegetation;

▪Mediterranean forests have broad leaves and evergreen trees such as oak, eucalyptus, cork oak, red wood due to wetter winters and withstand the hot and dry summer conditions.

▪Much of the woody vegetation in Mediterranean has small shiny waxy leaves to reduce water loss by transpiration during the hot dry summer months.

▪Trees and other Plants such as grape vine have long tap root system which enables the plants draw water deep underground during the hot dry summer season.

▪Some plants have large fleshy bulbous roots to store water for use in hot and dry summer.

▪Some trees such as cork oak have thick rough barks to store water during summer

▪There are sweet-smelling herbs and shrubs such as lavender, rose Mary, thymes, thyme and oleander.

▪Some trees are cone shaped especially pine.

▪Some trees are short and flat topped for example cork oak.

▪In some places there is mixed type of vegetation with deciduous trees, coniferous, tough grass and dwarf trees.

▪Some trees have compact weedy stems, bushy scrubs with dense thickets

▪Short grass is common especially in the Mediterranean basin, grass land of California, central valley e.t.c

Factors or conditions favoring the growth of Mediterranean vegetation

Climate-that is;

▪They have hot and dry summers of about 25^0 C.

▪Cool and moist rainy winters of about 12^0 C

▪Moderate annual rain fall of about 500mm -750mm and the onshore westerly winds blow in the winter bring cyclonic rain.

Soil-that is;

▪The ashy Mediterranean residual soils support Mediterranean vegetation

▪Limestone soils are porous and drain water easily hence deep root system of plants.

▪In the drier parts, soils are poor hence support Mediterranean scrub-like vegetation composed of sweet smelling herbs and shrubs such as lavender and rose Mary.

Altitude

▪The Mediterranean vegetation is mainly found along the coastal areas with low altitude; except for the Atlas Mountains. Scrubs exist near the sea coasts are often adapted to winds and salt air off the ocean like strandveld in South Africa

Latitude.

▪Mediterranean vegetation is found between 30^0 N and 45^0 N and 30^0 S and 40^0 S of the equator.

▪Areas with Mediterranean vegetation are located mainly on the western sides of continents because of maritime conditions

Influence of human activities. For example logging, livestock farming, expansion of agricultural plantations, urbanization and introduction of exotic species has led to extensive loss of forests, degradation and extinction of many native plants.

▪Many of the pyrolytic plants or plants adapted to fire or even depending on fire for reproduction, recycling nutrients and the removal of dead vegetation for example herbaceous vegetation and some grasses.

MAP EXTRACT OF KASESE

Either

1 a) (i) the grid reference of the quarry is 782258 / 783259 / 781257……1mk

(ii) Butachinga crater / crater……1mk

b) The cross section of the area between Kaisega trigonometrical station (GR 714178) and the Bridge River Rukoki (781216) showing two physiographic regions, drainage features, transport routes and an air strip.

Vertical scale 1cm rep. 500ft

Diagram

Remember to indicate

A complete title……..1mk

Consistent and accurate vertical scale…….1mk

Shading of the cross section……...1mk

Accurate horizontal distance……..1mk

(i)Physiographic regions

▪Highland/ hills/steep slope/ upland

▪Gentle slope

▪Lowland/plain/ flat land.

Any 2 features in correct places …….2mks

(ii)Drainage features

Any one river…….....1mk

(iii)Transport routes

Any one road, railway. Motorable truck……..…2mks

(iv) Air strip……1mk

C. **(i) amplitude** of relief is got by subtracting the lowest point from the highest point of the cross section drawn

highest point 4900 ft

lowest point 3200 ft

1700 ft

Acceptable range of 1600-------1800 ft

Method……..1mk

Answer……...1mk

(ii) Vertical exaggeration= $\frac{\text{Vertical Scale}}{\text{Horizontal Scale}}$

1cm represents 500ft. hence 500x30cm =15000

Therefore vertical scale is 1:15000

$$\frac{1}{15000} \div \frac{1}{50000}$$

$$VE = \frac{1}{15000} \times \frac{50000}{1} = \frac{50000}{15000} = 3.3$$

VE= 3.3
Method……1mk
Answer……1mk

Relief description of Kasese

The North and Western part of the area is mountainous/ upland/ hilly.
There is a flatland/ lowland/ plain land in the South East and Eastern part
Numerous steep sided narrow valleys in the highlands
There is a lake basin in the South and South East
Broad river valley on plain land/ flood plain
There are craters in gentle slopes
There are numerous spurs, conical hills, steep slopes
Existence of cols and saddles in highlands
Highest point is 8200 ft above sea level
Lowest point is 3000 ft above sea level
Amplitude of the areas is 8200-3000 is 5200 ft
Gentle slopes between highlands and lowlands
Generally, the land slopes from west to East

Any 5x1……..05 mks

Relationship between relief and communication for kasese map extract

Foot paths in the lowland
Communication is on lowland to the south
No communication on the highland to the East
Communication is on gentle slopes
Communication is in broad river valley such as Kasese-Kilembe road
Steep slopes are generally avoided
Few foot tracks exist in highlands
Road bridges constructed across river valleys
Air strip constructed in the plain or low land
Foot paths in the lowland

Any 2x1……..02mks

Relationship between relief and settlement

Settlements on broad valleys
Settlements are few/ scattered in the highland areas
Steep slopes are avoided for settlement
Lowlands are avoided for settlement
Gentle slopes are settled
Hill tops are avoided for settlement
Settlements are few/ scattered in the highland areas/ hilly areas.

Any 2x1……02mks

Total 25 mks

Or

Photographic interpretation

a) A landscape sketch of the area shown on the photograph showing any two physiographic regions, two vegetation types, boulders and settlements
Diagram

Marginal information…….1mk
Complete title……1mk
Complete frame……1mk
Key/ labeling……...1mk
Two regions……2mks
Two vegetation type……..2mks
Boulders……1mk
Settlement……1mk
b) (i) a river
(ii) -Shallow river
-cataracts/ rapids/ cascades
-Small water volume.
-Evidence of flooding
-Boulder deposits
-Broad river valley
-Meanders or bends
-Mature/ middle stage river
-Signs of fluctuating volume of water/ regime variation.
Any 4x1……..04mks
C. (i) accounting for boulders
-Eroded channel upstream through
-various processes such as weathering and mass wasting.
-Transporting ability decrease
-Depositing big boulders first and then small boulders last.
Any 2x3…….06 mks
(ii) -differences in the sizes of boulders
-Resistance of rocks in terms of rock hardness
-Attrition due to collision of rocks against rocks.
-Time and distance the boulder has traveled or has been transported.
Any 3x1……03 mks
d) any area which has a river with large variations in the regime/ volume for example river Nyamwamba in kasese, river Sironko, river Manafwa, river mpanga and seasonal rivers in karamoja.
Reason; presence of a river from a highland with marked variation in volume
Area……1mk
Reason ……1mk

Total 25 mks

NYABIRONGO MAP EXTRACT

EITHER
a. (i) the grid reference of Katanda trigonometrical station is
143033, 142032, 144034.
Any of the above ……..1mk
(ii) Man-made feature at grid reference 228086 is a road/ road junction…….1mk
b. The sketch map of Nyabirongo showing two physiographic regions, drainage features, Rwenzori forest reserve and dry weather road.
Diagram
A complete title……..1mk
Physiographic regions
- Highland/ hills/steep slope/ upland
- Gentle slopes
- Lowland/plain/ flat land.

Any 2 features in correct places ……..2mks

Drainage features

River Nyamugasani and its tributaries….....1mk

A crater……..1mk

One dry weather road……..…1mk

Forest reserve……1mk

Labeling/ key……..1mk

Frame……..……1mk

C. (i) the drainage pattern shown on the map is dendritic pattern by river Nyamugasani in its youthful stage.

(ii) The factors responsible for the development of river Nyamugasani profile are;

Relief. In the highland areas, the river is straight and narrow

In the lowland area, the river valley is broad hence the river meanders.

Volume of the load. In the youthful stage, the river has numerous tributaries which bring in water hence the tributaries load is small and therefore the river flows straight in the upper course.

In the mature stage, the increased river volume of load causes meanders and seasonal floods.

Heavy rain fall provides ample water for continuous flow of the river and its tributaries.

Rock structure. That is, the rocks in the highlands are hard but eroded because the river is also powerful hence the river flows straight in a straight course. In the lowland area, the rocks are soft for lateral erosion resulting in the broadening of the valley and the river meanders.

Any 3x1……03mks

d. (i) **economic activities**

agriculture…… evidence, chapman's farm

tourism……. evidence, Rest House, National park and Forest reserve

forestry…….. evidence, Rwenzori forest reserve

trade…….. evidence, roads, cotton stores e.t.c

transport…… evidence, roads.

Any 2x2……04mks

Factors which have favored the activities above.

Tourism;

- Availability of tourist attractions such as craters, National park and beautiful scenery.
- Availability of transport links such as roads
- Good accommodation such as Rest house

Trade

- Presence of roads
- Availability of trade items such as cotton
- Good storage facilities such as cotton stores

Forestry

- Presence of forest reserves
- Sparse population enables creation of extensive forest reserves and less destruction from human activities.
- Government policy of gazetting forest reserves and banning human settlement and other activities
- Heavy rain fall encourages tree growth.

Transport

Presence of roads constructed in low lying plains

N.b the factor should be accompanied by the activity.

Any 2x2……..04mks

e) Relation ship between relief and settlement

- Central highland areas are sparsely populated

▪Settlement is concentrated on gentle slopes and foot hills
▪No/ absence of sparse population in the broad valleys for example further south highlands to the North East and South west have dense settlement
▪The North and Southern part is not settled
▪The North western highlands have no settlement (forest reserve)
Any 3x1……..03mks
Total 25mks

Or photographic interpretation

a)The landscape sketch of the area showing two physical landform features and vegetation types
Diagram
Marginal information……..1mk
Complete title……1mk
Complete frame……1mk
Key/ labeling……...1mk
Two physical regions (peneplain, plateau& Inselberg/rock outcrop…….**…**2mks
Two vegetation types (trees/ thicket, bush/shrub&grass)……...2mks

Processes responsible for formation of land form features
Inselbergs/ tors/ residual hills/ rock out crop.
▪Magma was intruded in the crust under low pressure, cooled and solidified, forming granite rocks with joints
▪Erosion of the over lying land surface took place hence exposed the granite rock on to the surface.
▪Physical weathering due to alternate heating and cooling enlarged the joints, breaking the rock into blocks called tors.
3x1……03mks.
Peneplain/ plain is formed when the older plateau has been destroyed due to continuous weathering and erosion
▪The low gradient of the peneplain presents vertical erosion, but allows lateral erosion where Inselbergs occur within the peneplain
▪The continued weathering of the Inselberg and deposition of materials on the plain leads to the formation of a Pedi plain or pediment.
▪This occurs in both humid and semi arid environments.
▪It also concurrently takes place with the formation of Inselberg.
4x1……04mks
Alternatively,
Surface plateaux was destroyed by weathering and erosion
Deposition of eroded materials took place on the lowered surface
Illustrations by diagrams.
2x1……….**02mks**
c)Possible economic activities in the area include;
Tourism……..evidence, the spectacular scenery of tors/ boulders/ kopjes/ Inselberg.
Quarrying. The hard granitic rocks are suitable for building and construction of houses, roads e.t.c
Livestock farming. Grass available for animal rearing such as goats, sheep, cattle
forestry, the few trees already existing can be used to establish forest reserve.
d) area in East Africa. Any district in Uganda where Inselbergs are found is considered. For example Teso area, Nakasongola, Mwanza (Bismarck rock) e.t.c
🕮Remember to identify the activity and to give the evidence.
Any 3x2…… 06mks
Reason- presence of tors/ Inselbergs
Reason…… 1mk

Example…… ……1mk

DEBEZA MAP EXTRACT

1a) (i) the grid reference of Mpologoma peak is……

(ii) The name of the feature is……..

diagram

A complete title……..1mk

Nabakazi swamp……1mk

Physiographic regions

- Highland/ hills/steep slope/ upland
- Gentle slopes
- Lowland/plain/ flat land.

Any 2 features in correct places ……..2mks

All weather loose weather roads…… ..…1mk

Kasanda – Buwekula county boundary…….1mk

Labeling/ key……. .1mk

Frame……..……..…1mk

b. (i) **working:**

Old scale 1:50000

Reduction factor 2 times

$\frac{1}{15000} \div 2$ $\frac{1}{15000} \times \frac{1}{2}$

$\frac{1}{15000} \times \frac{1}{2} = \frac{1}{100000}$

New scale is 1: 100.000

Method……..1 mk

Answer……...1mk

c) Relation ship between relief and drainage

Ridges in the North East form a divide or watershed for rivers flowing in either direction

Lowland areas are gently sloping with numerous broad valley filled with streams

Lowlands and broad valleys have swamps.

Most rivers in lowland areas have trellised drainage pattern such as serunyabi and lwabiwojolo

Gentle slopes or highlands are well drained

Highland areas are dominated by rivers with dendritic pattern

Any 3x1……03mks

d) (i) settlement patterns found in the area include;

Scattered / dispersed for example at sunga and lukonge.

Linear settlement for example at Debeza.

Nucleated/ clustered/ grouped for example at Nyegeza.

Any 3x1…….03mks

(ii) **Factors that have influenced** the settlement pattern identified above.

Relief. Ridges are unsettled or avoided

Drainage; settlements avoid swampy areas. River valleys and banks are also avoided.

Vegetation. Forested areas are avoided

Communication. Linear settlements have been attracted along roads, foot tracks

Any 3x2……06mks.

Explanation should be emphasized.

0r photographic interpretation

a) Landscape sketch showing physiographic regions and land uses

Marginal information……..1mk
Complete title……1mk
Complete frame……1mk
Key/ labeling……...1mk
Two physical regions (hills/highlands, steep slopes, gentle slopes, lowlands/ valleys, saddles and cols……..……**…**2mks
Land use activities (agriculture, settlement, forestry/trees)……2mks

b) (i) relief description

There is a ridge in the back ground
Ridges have steep slopes
Saddles and cols exist in the highlands in the back ground
Steep slopes exist in highlands
There is a broad valley/ plain in the middle and fore ground
There are gentle slopes
Upland/ hilly area in the back ground and on the right and left middle ground
Conical hills exist in the highlands in the back ground.
The area in the west and the East is higher than the area in the central part.

Any 3x1…….03mks

(ii) Relation ships between relief and land uses

Steep slopes have been used for forestry
Gentle slopes have also been utilized for forestry
Agriculture in the broad valley or plain
The gentle slopes have also been used for settlement

Any 3x2……..06mks

c) Problems facing the people living in the area

Limited land for settlement and cultivation/ agriculture due to steep slopes or hilly nature of the area.
Soil erosion affects the upper and lower slopes since agriculture is concentrated in valleys where soils are fertile.
Difficult use of machinery due to rugged nature of the relief.
Flooding evidenced by broad valleys or low lying area in the middle and fore ground.
Difficult transport or inaccessibility due to mountainous nature of the relief.
Poor visibility due to fog formation in valleys and hills
Cold weather on top of hills discourages settlement and agriculture.
Occurrence of land slides due to steep slopes.
Cold conditions limit working hours.
Diseases such as pneumonia because of cold conditions.
Poor visibility due to fog formation results into accidents.
Frost conditions in valleys discourage growth of some crops such as cotton.

Problems with correct evidence 3x2……..06mks

d) Any highland area with hills separated by broad valleys for example:
Kigezi highlands/ kabale/ kisoro
Kenya highlands
Mbale/ Kapchorwa
Kasese/ Bundyibugyo
Mbeya/ southern highlands of Tanzania.

Reasons

Highlands/ mountains
Broad valleys
Forested slopes
Crops grown on gentle slopes

Settlement on gentle slops
Area……01mk
Reason…….01mk
Total……...25mks

RUBANDA MAP EXTRACT

1. a) (i) the grid reference for the Nyarurambi secondary trigonometrical station is 092629/ 091630……1mk
(ii) The man-made feature at GR 124718 is a culvert/ road……..1mk
b) (i) reduced sketch map of Rubanda 2½ times showing physical and human features.
Two relief features (highlands, upland, highland/ hilly region, lowland/ basin region)……2mks
Forest reserve……1mk
All weather loose surface roads……..1mk
Lake Bunyonyi……1mk
Rivers kyeni, kitagata and Nangara…… 03mk
Title……01mk
Campass……01mk
Frame……01mk
Labeling…….01mk
(ii) Calculation of new scale

$\frac{1}{50000} \div 2\frac{1}{2}\left(\frac{5}{2}\right) \quad \frac{1}{50000} \times \frac{2}{5} = \frac{2}{250000} = \frac{1}{125.000}$

New scale is 1: 125.000
Method……01mk
Answer…….01mk
c**) (i)** trellis drainage pattern/ rectangular……..1mk
(ii) Formation of trellis/ rectangular pattern.
▪Tributaries join the main stream at right angles. Soft rock bands are eroded and hard ones remain resistant.
▪Major and minor streams flow in accordance with the slope direction. Obsquent streams flow in opposite direction to the slope joining other streams at right angles.
Factors which bring about this pattern include;
▪Variation in rock resistance or Presence of heterogeneous rocks in alternating hard and soft rocks lying at right angel to the general slope.
▪Develops in areas of gently sloping landscape
▪Heavy rainfall to maintain the flow of rivers
▪Large catchment area
▪It is found in fault zones and some times where
▪River capture takes place.
Any 4 pointsx1……**04mks**
d) Problems faced by people living in the area
-limited area for settlement due to steep slopes, forest reserves and permanent swamps
-limited agricultural land due to highly dissected nature of the landscape with numerous streams
-Remoteness- most areas/ settlements are away from communication lines.
-Difficult transport because of steep slopes and swampy valleys. Roads are too winding to avoid steep slopes.
-Soil erosion because of steep slopes
-Land slides due to steep sloping land
-Flooding in valleys and lowlands
-Destruction of life and property by wild animals in game parks and forest reserves.

-Water borne diseases/ insect borne diseases such as bilharzias and malaria.
Problems with correct evidence 4x1……..04mks.
0R

PHOTOGRAPHIC INTERPRETATION

a) A landscape sketch of the area showing two physiographic regions and land use types.
Marginal information- title, frame and labeling/ key……..03mks
Regions (highlands/ upland/ hills, valley or lowland)…….02mks
Land use (forestry, transport, settlement, agriculture)…….03mks
b) (i**)** mist/ fog……01mk
(ii) Account for the occurrence of the climatic condition identified in (b) above
▪The climatic condition occurs in hilly/ highland region and during a clear and calm weather as a consequence of temperature inversion.
▪During day time, much insolation is received leading to intense heating of slopes/ land surfaces
▪Radiation and rapid cooling occur at night on hill/ mountain tops
▪Heavy/ cool dense air descends the valley and collects in the hollow,
▪Displacing the warmer lighter air to higher levels.
▪At the edges/ boundaries of cool and warm air, mixing occurs resulting into ▪condensation at lower levels forming fog or mist…….06mks.
c) Explain the problems faced by people living in the area shown in the photograph.
Limited land for settlement and cultivation/ agriculture due to steep slopes or hilly nature of the area.
Soil erosion affects the upper and lower slopes since agriculture is concentrated in valleys where soils are fertile.
Difficult use of machinery due to rugged nature of the relief.
Flooding evidenced by broad valleys or low lying area in the middle and fore ground.
Difficult transport or inaccessibility due to mountainous nature of the relief.
Poor visibility due to fog formation in valleys and hills
Cold weather on top of hills discourages settlement and agriculture.
Occurrence of land slides due to steep slopes.
Cold conditions limit working hours.
Diseases such as pneumonia because of cold conditions.
Poor visibility due to fog formation results into accidents.
Frost conditions in valleys discourage growth of some crops such as cotton.
Problems with correct evidence 8x1……..08mks
d) Any highland area with hills separated by broad valleys/ hollows/ basins for example:
Kigezi highlands/ kabale/ kisoro
Kenya highlands
Mountain Elgon areas such as Mbale/ Kapchorwa
Kasese/ Bundyibugyo
Mbeya/ southern highlands of Tanzania.
Mountain Kilimanjaro e.t.c
Reasons
Highlands/ mountains with marked
Broad valleys and
Occasional occurrence of fog and mist.
Forested slopes.
Settlement on gentle slopes.
Area……01mk
Reason…….01mk
Total……...25mks.

MAP EXTRACT OF KABERAMAIDO

a) (i) the grid reference of Acinga conical hill peak is 193138/ 192139…….01mk
(ii) The man made feature found at grid reference 269048 is a dam…….01mk
b) (i) the bearing of Chwagere ginnery from secondary trigonometrical station at grid reference 168957 is 325^{0}.(accept between 323^{0}-----327^{0})……1mk
(ii) amplitude of relief is the highest altitude minus lowest altitude
Highest…….3700 ft
Lowest……..3450 ft
Therefore 3700 ft-3450 ft = 250 ft
Method …….....01mk
Answer……01mk
c) The cross-section drawn should have the following
Marginal information. That is title, vertical scale, horizontal distance,
shading**…….4mks**
Features marked and labeled in their correct positions@ features is...**1x5**…05mks
A cross section from kaberamaido road junction (GR 175950) to Kalito dam (GR 189016) showing man-made features.
d) (i) the nature of the physical landscape is
Generally flat/ peneplain/ plateau
Highest elevation is 3700 ft
Lowest elevation is 3450 ft
Amplitude of relief 3700-3450= 250 ft
Broad valleys such as river Abalang
Isolated/ scattered hills in the north such as Acinga
Dissected plateau
Gentle slopes
The land gently slopes from North East to South West
Steep hills such as Acinga
Conical hill for example Acinga.
Presence of spurs
Lowland on North West and South East
Any 4x1……04mks
(ii) **processes leading to the landscape**
The landscape is a result of denudation. That is prolonged denudation and sustainable erosion processes.
Erosion by running water on the surface rocks with varying resistance.
Resistant rocks form Inselbergs while soft rocks become peneplain due to deposition
Valleys form on soft rocks by rivers
Any 3x1…….03mks
e) Relation ship between relief and drainage
Broad valleys are occupied by seasonal and permanent swamps
Valleys occupied by rivers such as Awimon
Lowlands are poorly drained for example North West
Gentle slopes are well drained
There are water shed/ divide for example in the East and west of the map
Rivers flow from higher slopes/ areas to lower slopes such as Abalang tributaries
Narrow valleys are occupied by streams/ rivers.
Dams and ponds are in valleys.
Any 4x1……..04mks
Total ……..**25mks**
0R

PHOTOGRAPHIC INTERPRETATION

a) A landscape sketch of the photograph showing relief landforms and land uses.
Diagram
Marginal information- title, frame and labeling/ key……..03mks
Relief landforms (hill; steep slopes, gentle slopes, valley/lowland)….03mks
Land use types (forestry/trees, transport/roads, settlement/ houses, agriculture……03mks
b) Processes of formation of the landform/ relief landform in the foreground of the photograph.
The landform should be identified/ named. That is valley/ lowland……..1mk
Explain the processes responsible for the development of the valley/ lowland.
The valley/ lowland is a result of the processes of denudation.
Weathering of rocks took place on the hill and slopes by both physical and chemical means.
The weathered rocks on the hill and slopes were eroded by running water.
Running water transported the eroded rock debris down slope
Deposition of the eroded materials which were transported by running water took place on the valley/ lowland at the foot of the hill hence formation of the landform in the fore ground.
Max……..04mks
c) Relationship between relief and land use in the area shown on the photograph.
- Forests or trees have been planted on steep slopes of hills to protect the soils from erosion by running water e.t.c
- Settlement exists on gentle slopes and on hill top where gentle gradient allows for building and construction.
- Agriculture/ crop cultivation takes place in the valley/ lowland/ gentle slopes where fertile alluvial soils support crops
- Roads have been constructed on gentle slopes; where the gentle gradient/ slopes ease movement of people, vehicles e.t.c

Any valid relation ship and explanation 2x4…….08mks
d) Areas;
Kondoa district of Tanzania
South western Uganda in Kigezi/ kabale areas
Central region of Uganda in Buganda, Jinja e.t.c
Kabarole e.t.c
Reasons;
Presence of broad valleys
Existence of undulating landscape
Presence of dissected plateau
Hilly topography/ landscape
Settlement exist in valleys
Planted forests on slopes.
Area……1mk
Reason……1mk
Total……25mks

MAP EXTRACT OF KIJURA

1 a) the grid reference of fort waver tree is 116874/ 115875/ 117873….01mk
(ii) Drainage feature found at grid reference 144013 is a pond/ lake/ swamp..1mk
b) Area covered by Itwara forest reserve
Area= number of complete squares+ no. of incomplete squares÷ two
Therefore,
No. of complete squares = 28
No. of incomplete squares= $\frac{55}{}$ = 27.5 there fore 28+27.5 = 55.5≏56km^2

2

0r

Full squares = 28

Incomplete = $\frac{79}{2}$ = 39.5 therefore 28+39.5 = 67.5≙68 km^2

Accept between 54 km^2------69 km^2

Method……..01mk

Answer…….01mk

c) A reduced sketch map of kijura showing physical and human features

Marginal information…….04mks

Any two physiographic regions……02mks

Rivers (should be named)…….02mks

Agricultural plantations, any one……01mk

Itwara forest reserve…….01mk

Road (all weather loose surface)……..01mk

d) (i) settlement pattern on the map are;

Nucleated/ grouped/ clustered settlement found on the agricultural estates such as fort waver tree estate, Nsororo, Buhunga estates e.t.c

Linear settlements found along the all weather and dry weather surface roads and foot paths

Dispersed / scattered settlements to the south of Nyakabale estate and other areas.

Grid/ planned settlements at Nsororo factory waver tree estate.

Any 2 types and evidence/ area x2……04mks

(ii) Factors which have influenced settlement distribution include;

Relief.

- The undulating/ dissected plateau is gently sloping and allows settlement

The steep slopes discourage settlement because of difficult construction and movements such as landslides, erosion e.t.c

- Lowlands in the north are avoided for settlement due to fear of floods
- Deep/ narrow valleys are avoided for settlement

Drainage

- Rivers with steep banks are avoided for settlement
- Well drained areas in the central part are settled
- Poorly drained areas in the north are not settled

Transport

- Existence of loose surface roads, dry weather roads and foot paths attract settlements for easy movement
- Areas in the West, North, East e.t.c without transport routes are not settled. That is remoteness.

Government policy

Gazetting of Itwara and Toro game reserves restrict/ discourage settlement.

Social services, schools and bores holes attract settlement.

Any 3x2……06mks

- **Total……..25**mks

0R

PHOTOGRAPHIC INTERPRETATION

A landscape sketch of the area shown on the photograph showing two relief regions, two vegetation types and settled area.

Marginal information…….03mks

Relief regions……04mks

Vegetation types……..02mks

Settled area……01mk

b) The type of land use is fish farming/ aquaculture/ apiculture…02mks

c) (i) conditions which have favored the establishment of fish ponds

Availability of water, a habitat for fish
Broad valleys/ low lying relief area with a high water table
Clayey nature of the soil that retain water in ponds
Ample rainfall to provide water due to trees and highland in the back ground
Availability of capital to dig ponds, fence the area and buying fish fries and food e.t.c
Availability of labor to construct the ponds and harvest fish
Availability of market for fish
Government policy of encouraging fish farming as a source of food and house hold income.
Availability of land for construction of ponds
Any 4x2……..06mks

(ii) **Importance of the land use type to the people**

Source of vital protein/ diet
Provides employment to the population
Source of income to fish farmers
Source of revenue to the government through taxing fish farmers' e.t.c
Promotes sustainable management of the environment
Demonstration for agriculture modernization
Study and research purposes
Source of water for various purposes
Tourism e.t.c
Any 3x2…….06mks

d) Area in East Africa where the photograph could have been taken;

Area should be mountainous/ hilly
It should be broad valleys occupied by wet lands and tall trees for example;
Kigezi highlands
Ntungamo both in south western Uganda
Mbale district eastern Uganda
Eldoret region of Kenya
Arusha in Tanzania (chagga area.)
Any1x1……01mk

Total……25mks

KIGOROBYA MAP EXTRACT

1 a) (i) the grid reference of the bore hole at kiryawanga is 144838……01mk

(ii) Drainage feature at grid reference 289684 is river confluence/ river……01mk

b) the distance in km of the dry weather road from kitoba T.C road junction (Grid reference 212686) is 21km. accept between 19----------23km…….02km

c) A cross section of kigorobya along Northing 67 between Easting 17 and 25 showing physical and human features.

Diagram
Marginal information
Title……..01mk
Vertical scale……...01mk
Horizontal distance……01mk
Shading.....…...01mk
Features……..07mks

d) (i) **description of the relief**

- Highest point is 4750 ft above sea level t Rwensoga hill in the south
- Lowest point is 3300 ft in the North West

- Amplitude of the relief of the area is 4750-3300 = 1450 ft
- There are numerous conical hills such as mbiwe, kaburungi, kibegenya e.t.c
- There are ridges such as kitoba in the south and central
- Ridges have steep slopes
- There are numerous narrow valleys in the south- East
- Broad valleys exist such as waki
- Dissected plateau area in the west
- Most areas in the west have gentle slopes
- The area has spurs
- Saddles and cols characterize the upland area
- Uplands/ hilly area in the central
- The area slopes to the North West/ West
- The South Western part is higher than the North West.

Any 4x1……04mks

(ii) Gentle slope for example around kitoba are settled
Gentle slopes have been used for road construction
Steep slopes around kayanja have been used for forestry
Gentle slopes to the north have been used for forestry
Agriculture plantations are on gentle slopes
County and sub country boundaries are in valleys
Bore holes are in gentle slopes.

N.b state how land has been used not the influence.

Any 3x2…….06mks

Total……25mks

0r

PHOTOGRAPHIC INTERPRETATION

a) a landscape sketch of the photograph showing relief features, vegetation types and settlement.
Diagram
Marginal information……03mks
Relief…….02mks
Vegetation (grass, trees, forests, woodland)……..……..……...02mks
Settlement……..01mk

N.b doesn't give savannah because it is broad.

b) the economic activity taking place in the fore ground is livestock rearing/ diary farming/ animal rearing/ ranching/ pastoralism……..01mk

N.b wrong identification in b will lead c to be wrong.

c) (i) the factors which have favored the economic activity identified in (b) above include;
Flat/ low land/ plain land that allows easy movement of animals
Availability of water for animals from the channel in the middle ground and troughs.
Conducive climatic conditions for animals and pasture growth
Labor Availability to undertake the activity from settlements in the middle and back ground.
Pastures for animals due to grass in the fore ground
Availability of capital for buying exotic animal breeds and swamp draining
Availability of Extensive land for animal rearing
Favorable government policy for agriculture modernization
Trees for provision of shade and poles for fencing the land
Availability of market for animal products
Easy transport/ accessibility of the area
Trenches for water draining excess water to avoid floods.
Factors…..4x1……..04mks

Description..4x1……..04mks
(ii) Impact of the activity in (b) above on the environment.
Destruction of the original vegetation cover replacing it with pasture grass
Drainage channels lower the water table
Habitat destruction for aquatic organisms
Animal trampling leads to soil compaction
Destruction of trees leads to a reduction of rain fall, temperature rise hence desertification
Over grazing for example around water troughs may expose soil to erosion
Cow dug however helps in soil fertility improvement
Land conservation by maintaining pasture and trees e.t.c
Any 6x1…….06mks
An area in East Africa where the photo was taken may include;
Kisoro, Kabale, Bushenyi, Kabarole, Kenya highlands, mountain Elgon area e.t.c
Reasons
Presence of highland
Wide valleys
Forested slopes
Terraced hill slopes
Settlements in lower slopes
Area……01mk
Reason…….01mk
Total……25mks