SOIL

-Is a non-living finely divided material covering the earth crust
OR *outermost layers of the earth's crust*.
Consists of (i) organic matter(humus), (ii) living organisms (iii) air (iv) water (v) inorganic rock particles of different types and sizes.

Importance of soil

- Provides water and mineral nutrients for plants.
- Habitat (home) for many organisms such as earth worms, termites, bacteria fungi and arthropods.
- Holds plant roots allowing plants to be firm, grow to maturity.
- Provides a medium through which man and all other animals dispose off their wastes.
- An important natural resource which provides construction materials, supports agriculture, craft and art materials.
- Provides oxygen for aerobic respiration by plant roots and other underground parts.

SOIL FORMATION

- Is the gradual breakdown of parent rock involving a series of interrelated physical, chemical and biological processes (weathering) which occurs gradually and over a long period of time.

- **Weathering** : Is thus the ***gradual breakdown of parent rock into small particles of soil by agents*** such as air, water, wind during dust and sand storms , changes in temperature, plant roots, and ice.

During weathering, form, colour, texture and composition of rocks is altered.

Three types of weathering exist i.e.

1. Physical (mechanical) weathering:

-involves breakdown of parent rock into smaller particles by action of **heat**, **wind**, **frost** and **water**.

i) Alternate heating and cooling of the rocks on exposed mountain sides in dry areas causes rapid expansion during day and sudden contraction on sun set, which cause the rock to crack and break up.

ii) Running water from rivers and streams to seas, carries with them rock particles which hit against one another, hence breaking into smaller particles.

iii) Wind blows small particles (sand, grit and sand) against rocks, wearing them away, blasting chips and pieces way from the surface and breaking them over time.

iv) Frost (weather condition where temperatures fall below 0 degrees); water in cracks freezes and expand, causing the rock to break up.

(v). In very cold conditions, on a high mountain, ice is formed; move down slopes, carrying rock particles with it, which hit against one another and breaking into small particles.

2. Chemical weathering:

-Brought about mainly by the action of **rain water** and **Oxygen** on the rocks.

- As it rains, rain dissolves carbon dioxide in the atmosphere to form weak solution of carbonic acid which when falls on rocks ,it dissolves them, resulting in the release of mineral elements like calcium, magnesium, Aluminium, iron etc. which are components of soil.

-Oxygen react with some rock minerals like iron, weakening the rock, causing it to break down into small particles.

3. Biological weathering:

This is brought about by the action and presence of living organisms on rocks. Certain organisms such as mosses and lichens are able to grow on bare rock, secreting chemicals which breakdown rocks; while roots of flowering plants breakdown rocks as they penetrate and enlarge rock crevices as they grow bigger.

When lichens, mosses and flowering plants die they form humus, a component of soil.

Man contributes to biological weathering through direct splitting of rocks during road and house construction and indirectly through cultivation.

COMPOSITION OF SOIL

(i). Soil particles (ii) organic matter(humus) (iii) air (iv) water (v) living organisms (vi) mineral salts.

(i) **Soil particles;**

-Are produced during the process of weathering and vary in size.

- Basing on sizes, are classified as **clay**, **silt**, **fine sand**, **coarse sand** and **gravel** (small stones)

Gravel	Diameter more than 2mm
Coarse sand	Diameter of 0.2- 2.0mm
Fine sand	Diameter of 0.02-0.2mm
silt	Diameter of 0.002-0.02mm
clay	Diameter less than 0.002mm

NB.

-Size of the particles in soil (texture) affects the (i) amount of air in the soil (ii) degree of drainage in the soil (iii) amount of water retained by the so (iv) rise of water by capillarity in the soil.(*New biology for tropical schools page 297*)

- Different soil particles are separated from each other by **sedimentation (**vigorous shaking with water, and allowing the mixture to settle down). T process uses difference in the weight of particles, i.e heaviest at the bottom and lightest at the top.

Uses of soil particles

(i)On sticking together in clumps form **soil crumbs**, that allows water and air, used by plants for growth.

(ii)Tiny roots of plants grow between the crumbs, allowing firm anchorage of the plant in the ground.

(iii)Provide mineral elements to the soil which are the absorbed by plants using roots.

Experiment to observe different soil particles in a soil sample.

Aim. To observe different soil particles in a soil sample.

Requirements:

(i).200cm^3 measuring cylinder (ii) water (iii) soil sample. (iv) sodium bicarbonate (v) beaker (vi) weighing scale.

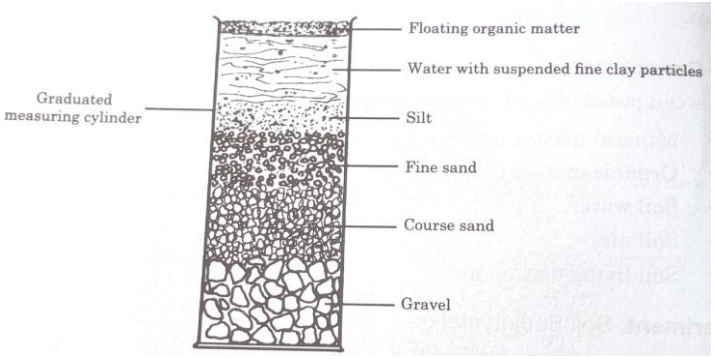
Procedure:

-50cm^3 of soil is poured in a measuring cylinder.

- 100cm^3 of water is then added into the measuring cylinder.
- About 20g of sodium bicarbonate is added to the lumps of soil.
- Open end of the cylinder is covered with a hand, and the mixture shaken vigorously for three minutes to mix well.
- Cylinder and its contents is left to stand for 3minutes.

Observation.

-. Particles separate out according to their weights (densities) and sizes, with the largest heaviest at the bottom, and smallest and lightest at the top.



Conclusion

- Soil is made up of different particles which vary in sizes and weights.

Guiding questions.

1.Explain why different types of soil particles form layers as they settle after shaking with water.

2. The sizes of different soil particles are given below.

(A) > 2.0mm (B) <0.002 (C) 0.2-2.0mm (D) 0.02-0.002mm

Which one of the above is the size of silt?

3. Explain how the small size of soil particles in a soil type affect the soil's suitability for plant growth.

(ii) **Soil air**

-Exists between the soil particles, and consists of mainly oxygen, nitrogen and carbon dioxide.

-Its amount is determined by,

(i) size of soil particles i.e soils with large particles have more spaces between them thus more air and vice versa.

(ii) amount of water in the soil, i.e more water in the soil occupies more space between soil particles, thus reducing the amount of air.

Importance of soil air.

- Provides oxygen (i) used for aerobic respiration by soil organisms and plant roots (ii) decay of plant and animal remains to form humus.
- Provides carbon dioxide , dissolves in soil water, increasing acidity of soil, for proper growth of some plants.
- Nitrogen absorbed in form of nitrates is used by plants for synthesis of proteins.

Experiment to determine the percentage of air in the soil

Aim; To determine the percentage of air in the soil.

Requirements. (i) Measuring cylinders (2), (ii) dry soil samples, (iii) water, (iv) glass rod/ stirring rod

Procedure.

-50 cm^3 of dry soil is poured in a measuring cylinder and the cylinder continuously tapped to allow the soil to be bedded down firmly.

-50 cm^3 of water is measured in another measuring cylinder, and slowly added to the measuring cylinder containing soil.

-Mixture of soil and water is stirred gently to drive off all trapped air bubbles between soil particles.

-Allow the mixture to stand until no more bubbles appear. Read and record the final level of water plus soil in the measuring cylinder(80cm^3)

Calculate the air content in terms of percentage.

Treatment of results

Total volume of the mixture before stirring = (50 +50) = **100cm^3**.

Total volume of the mixture after stirring= 80cm^3

Volume of air in the soil= (100-80) = **20cm^3**

% of air in soil= $\frac{\text{Volume of air in soil}}{\text{Volume of dry soil}}$ X 100

= 20/50 X100 = 40%

Observation

-Air bubbles escape and total volume of the mixture after stirring is less than sum of the volume of both water and soil before stirring.

Conclusion

Soil contains air in spaces between its particles.

Guiding questions

1.While analyzing a soil sample, the following results were obtained.

Volume of sand=20cm^3. Volume of water =30cm^3 Volume of water and sand after stirring=45cm^3. What is the percentage of air in the sand?

A. 25 B. 2 C. 1 D. 3

2.A sample of soil was poured into a measuring cylinder containing water and the mixture stirred. The readings were as follows.

Volume of water in the measuring cylinder. =21.5cm^3. volume of water +soil =26cm^3. Volume of water + soil after stirring =25cm^3.

What was the percentage of air in the soil?

A.1 B. 3.5 C. 22.2 D. 4.5

3. To 100cm^3 of soil samples **A**, **B** and **C**, in large measuring cylinders, 100cm^3 of water was added. After stirring, the mixture was left to settle for 10minutes. The volume of the contents of the measuring cylinders was taken and recorded as shown below.

Soil sample	Volume in cm^3.
A	175.0
B	185.0
C	150.0

(a)What was the purpose of ;-

(i). stirring (ii) leaving the mixture to settle for 10 minutes after stirring.

(b) Calculate the percentage of air in each soil sample.

(c.) Which soil sample is likely to be (i) clay (ii) sand?

4.Describe an experiment to determine the percentage of air in a soil sample. **UNEB 2010(35)**

(iii). <u>Soil water</u>

-Most of soil water comes from rain while little rise up from the groundwater by **capillary action** to replace water lost by evaporation from the surface.

-It is found as a thin film surrounding the soil particles.

-Excess water that does not sink through the soil i.e. stays on the surface, evaporates or runs off , and not available to plants is called **gravitational water**, while that remaining in the spaces ,easily absorbed by plant roots is called **capillary water**. Water held tightly on the soil particles that it cannot be absorbed by plant roots is called **hygroscopic water**.(*Principles and practices of agriculture page 30 and New biology page 107)*

-In soils with large sized particles, water sinks through very quickly, carry minerals and nutrients with it to deeper layers, a process called **leaching.**

-Amount of water retained when gravitational water has drained away is called **field capacity** of the soil.

<u>Importance of soil water</u>

-It moistens soil and keeps it humid/moist, making it favorable for survival of micro-organisms.

-It dissolves mineral salts making them available for plants to take.

-It dissolves carbon dioxide produced by living organisms to form carbonic acid which causes chemical weathering of rocks.

- Once absorbed by plants,

(i) used as a raw material for photosynthesis.(ii) cools the plants as it evaporates from the plant leaves (iii) formation of cell protoplasm

(iv) plant cells become turgid, thus providing support especially in non-woody plants and plant parts.

-Germination of seeds.

<u>Experiment to determine the percentage of water in a soil sample</u>

Aim. To determine the percentage of water in a soil sample.

Requirements.

(i)Evaporating dish,(ii) fresh soil (iii) weighing scale (iv) oven (v) Dessicator.

Procedure:

-Weigh a clean evaporating dish using a weighing scale and record its weight as , ***X g***.

- Half fill the evaporating dish with soil and record the weight of the soil plus the evaporating dish, ***Y g***.

-Evaporating dish and its contents is placed in an oven at 100 degrees celcius for 30minutes.

-Evaporating dish is removed from the oven, placed in a dessicator to cool,

- Reweigh evaporating dish and record its weight as **Zg**

- Heating and weighing is repeated until a constant mass is achieved.
- Percentage of water is calculated as shown below.

Treatment of results

Weight of water = (total weight of evaporating dish +soil before heating) – (total weight of evaporating dish + soil after heating)

= (Y-Z)g

Weight of fresh soil= (Y-X)g

$$\% \text{ of water in soil} = \frac{\text{Weight of water}}{\text{weight of soil}} \times 100 \qquad \frac{\mathbf{(Y-Z)g}}{\mathbf{(Y-X)g}} \mathbf{\ X\ 100}$$

NB.

-soil should not be heat strongly with Bunsen burner as the humus would be burnt off

- after heating its cooled down in a dessicator so that water from the air doesn't get back into the soil.

Guiding questions.

1.Why is important to keep your dry sample in a dessicator?

2.Describe an experiment to estimate the amount of water in the soil.

(iv) **Humus(organic matter)**

-Part of the soil consisting of decaying remains of plant and animal remains i.e.- the dead bodies of animals, fallen leaves, dead plants and animal droppings. It is a dark brown, rather sticky material that gives soil its dark colour.

- Plenty of oxygen is required for the decay process that forms humus.

- Has well developed colloidal properties (**thick** and **sticky** like glue), swelling on wetting and shrinks on drying.

Importance of Humus

-Forms sticky coat around soil particles, and binds several together forming soil crumbs, greatly improving drainage and aeration of soil.

-Retains moisture and minerals in the top soil and so, greatly reduces the effects of drying and leaching.

-When completely decomposed, releases nutrients e.g. sulphates ,nitrates, phosphates, magnesium ions etc. taken by plants.

-Gives soil dark-colour; thus absorbing more heat, providing warmth used during germination of seeds and speeding up the decomposition process, subsequently forming humus in the soil.

- source of food for soil organisms, thus increases the activity of soil organisms.

- Insulates soil against extreme heat and cold temperatures changes.

Experiment to determine the percentage of humus (organic matter) in the soil

Aim. To determine the percentage of humus in the soil.

Requirements.

(i)Crucible, (ii) soil sample (iii) weighing scale (iv) oven (v) wire (vi) dessicator.

Procedure:

- Weigh a clean crucible using a weighing scale and record its weight as , ***X g***.

- Half fill the crucible with soil and record the weight of the soil plus the evaporating dish, ***Y g***.

-Crucible and its contents is heated in an oven at 100 degrees celcius for 30minutes to a constant weight to dry the soil.

-Crucible is removed from the oven, placed in a dessicator to cool,

- Reweigh the crucible and record its weight as **Zg (*loss in weight of soil is due to the water driven out by evaporation.)***

-Heat the dried soil on a crucible to ***redness*** in an oven while stirring with a wire until no more smoke is seen.

- crucible and its contents is placed in a dessicator to cool and weighed, record its weight as **Wg. (*loss in weight is due loss in humus which has been burnt away.)***

Treatment of results.

Mass of humus = (mass of crucible + mass of dry soil before heating) – (mass of crucible + mass of dry soil after heating)

Mass of humus= (Z-W)g

Mass of dry soil alone = (mass of crucible + fresh soil)-(mass of crucible + mass of dry soil)

=(Z-Y)g

$$\textbf{Percentage of humus} = \frac{\textbf{Mass of humus}}{\textbf{Mass of dry soil}} \mathbf{\ X\ 100} = \frac{\mathbf{(Z-W)}}{\mathbf{(Z-Y)}} \mathbf{\ X\ 100}$$

Sources of errors

-*Soil may contain much calcium carbonate, thus some of the weight loss, may be due to its decomposition to calcium oxide and carbon dioxide which escapes into the air.*

Guiding questions

1.A crucible weighed 20g when empty and 45g when filled with dry soil. It was heated in an oven at 100 degrees celcius until the soil was red hot for some time, then allowed to cool and weighed again. The weight had changed to 40g.What was responsible for the loss in weight?

A. loss of water B. loss of humus C. escape of carbon dioxide D. escape of air.

2.Addition of humus to sandy soil would,

A.Decrease the capillarity of the soil

B.Increase the aeration of the soil

C.Decrease mineral content of the soil

D.Improve the water retention capacity of the soil

3.Give the importance of organic matter in the soil

4. Moi a senior two student performed an experiment to determine the percentage of humus in a dry soil sample. The following results were obtained.

Mass of empty dish =50g

Mass of dish + soil =200g

Mass of dish + soil after heating to constant mass =170g. What is the percentage of humus in the soil sample?

A. 15% B. 30% C. 20% D. 90%

5. Which one of the following is the least important function of humus in the soil

A. Improving soil aeration B. preventing soil erosion C. water retention. D increase soil fertility.

6. The following experiment was carried to determine the percentage of humus in a given soil sample. The soil sample weighing 120g was heated in an oven kept at 100^{o} C. The dry soil weighed 112g. The soil was then heated slowly to burn away humus. The weight of soil after all humus had burnt was 106g

(a)Why was the soil not heated strongly at first? (b)What was the weight of humus in the soil?

(c)Calculate the percentage of humus in the soil. (d) How many times was water more than humus

(v) **Mineral salts**

-Chemical elements in form of ions, dissolved in the film of water, surrounding the soil particle.

- Are obtained from (i) parent rocks during weathering (ii) decay of dead material by microorganisms.

- Examples include. Potassium, calcium, phosphorus, nitrogen, Sulphur and iron etc.

Some minerals and their functions to plants .(***Biological sciences, page 219, New biology, page 110)***

Mineral	**Importance to plants**
Nitrogen	Synthesis of proteins, nucleic acids, coenzymes, and chlorophyll.
Phosphorus	Synthesis of ATP, nucleic acids, some proteins , form structure of cell membranes.
Potassium	Water balance of cells, particularly opening and closing of stomata, component of cell sap of vacuole in plants etc
Magnesium	Manufacture of chlorophyll that traps sunlight for photosynthesis, activation of enzymes.
Calcium	Form structure of cell wall, for enzymes to work properly
Iron	For enzymes to work , chlorophyll synthesis.
Sulphur	Synthesis of proteins.
Manganese	Activation of enzymes, formation of chloroplast membrane.

(vi) **Soil living organisms**

-Form the living component of soil. Are categorized as (i) Macro organisms (ii) Microorganisms

Micro organisms -Bacteria (nitrifying, denitrifying and putrefying) , fungi and some protozoa.

Macro organisms. Roots of higher plants, earth worms, nematodes e.g. Ascaris, hookworms, filarial worm, and soil arthropods , molluscs (snails and slugs)

Importance of living organisms

-Fix atmospheric nitrogen into nitrates, availing nitrogen to plants, e.g. Nitrogen fixing bacteria such as ***Rhizobium, azotobacter, clostridium***.

-Decompose plant and animal remains into humus e.g. by termites , fungi , and bacteria.

-Some living organisms like earth worms, ants,beetles burrow in the soil and this improve soil aeration and drainage.

-Some living organisms in soil destroy plant roots and cause soil borne diseases to plants .e.g.nematodes attack plant roots.

-Wastes from soil living organisms add fertility to the soil.

-Some organisms feed on plant and animal material, thus forming complex food webs.

-Some bacteria compete with plants for food materials

Further reading ***(New biology for tropical schools pages 299,300,310, Integrated approach for East African schools page 292-293)***

Experiment to show that soil contains living organisms

Aim. To show that soil contains living organisms.

Requirements.

(i)Two test tubes (ii) Muslin bag (iii) Top soil (iv) Two corks (v) Oven (vi) lime water/ bicarbonate indicator solution (vii) crucible.

Procedure.

-Collect a hand full of fresh top soil and divide it into 2 **equal** portions.

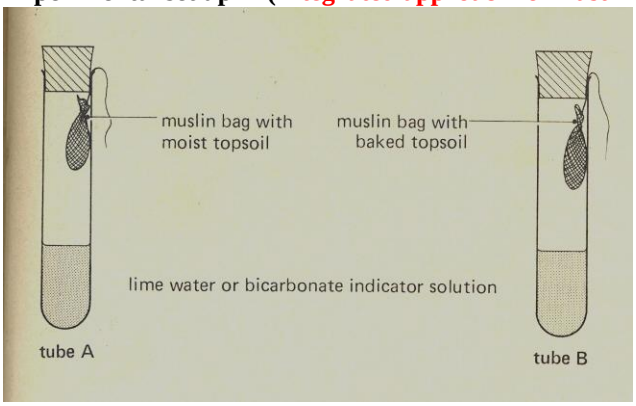
-Sterilize one portion of the soil sample by heating it strongly on a crucible in a steam oven for 30 minutes. Leave it to cool and place it in a muslin bag.

- Place the remaining portion of the fresh soil sample in another muslin bag.

-Add equal amounts of lime water or bicarbonate indicator in the test tubes and then suspend the muslin bags with soil into the test tubes.

-Leave the test tubes to three days and observe the appearance of lime water or bicarbonate solution.(Test tubes may be shaken gently)

Experimental set up **(Integrated approach for East African schools page 293 fig13.3)**



Observation

Lime water turns **milky** or the bicarbonate indicator solution turns **yellow** in test tube **A** but remains clear in test tube **B**.

Explanation

Carbon dioxide was produced in test tube **A** by respiring living organisms, thus turning lime water milky or bicarbonate indicator solution yellow.

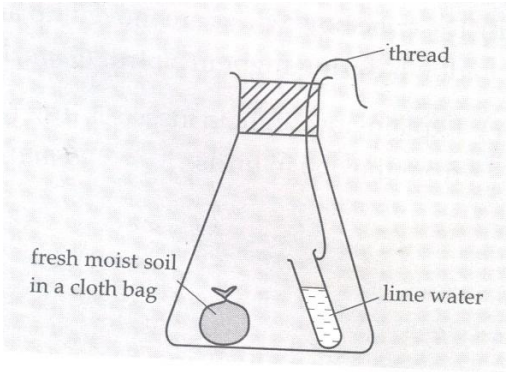
Lime water remained clear in test tube **B** because the living organisms in soil in test tube B were killed by heating.

Conclusion. Soil contains living organisms.

Guiding questions

1.Outline four living organisms in the soil, briefly stating their importance in the soil.

2.The figure below shows an apparatus that was kept in a warm dark cupboard for 48 hours.



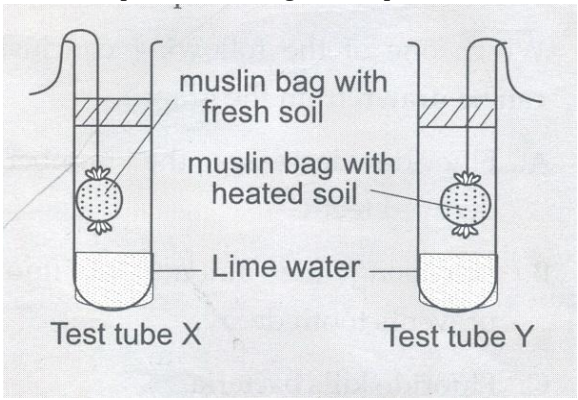
(a)What is likely to be observed after 48hours?

A. Lime water remains clear
B. Cloth bag bursts releasing dry soil
C. Cloth bag produces white fumes
D. Lime water turns milky

(b) What component of the soil is being investigated in this experiment?

(c) outline four importance of the component stated in (b)above.

3.The set up below investigates the presence of one of the soil components.



(a)What soil component is being investigated?

(b) State the use of lime water in this experiment.

(c.) (i) State what will be observed in each of the set ups?

(ii) What was the importance of heating the soil for 2 hours in set up Y?

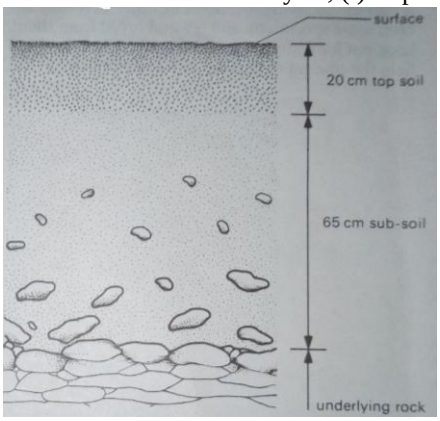
(d).State any three roles played by the soil component being investigated in this experiment.

Extracted from Revision UCE biology, page244. by Higenyi and Appolo

SOIL PROFILE

-Is a vertical section through the soil showing the different soil layers (horizons) from top to bottom.

-Consists of **three** main layers, (i) Top soil (ii) sub soil (iii) underlying or parent rock.



Descriptive features of different soil layers/horizon

Top soil.

-upper most layer, usually about 20cm deep, Dark in colour,

-contains fine particles, much humus, many organisms, much air, more plant roots.

Sub soil

-thicker, light-brown, lying immediately below the top soil.

-consists of coarse particles, little humus ,iron compounds(from leaching), few organisms and deeper roots of plants.

Parent rock

-usually non-porous, (water can't pass through it), thus water collects above the rock, forming a ***water table***.

-lacks humus , low air content, and mineral salts.

Significance of soil profile.

- Shows the difference in soil in a particular area.
- Gives information how soil was formed, whether its suitable for cultivation or prone to erosion.

Question.

Which of the following is the correct order of horizons in a soil profile?

A. Top soil – sub soil- parent rock- weathered rock
B. Superficial layer- parent rock- top soil- subsoil.
C. Superficial layer- top soil- sub soil- weathered rock- parent rock
D. Parent rock- sub soil-top soil.

TYPES OF SOIL

-Are classified by the **proportion of the different sized particles** they contain, which in turn determine the number and sizes of pores (air spaces) in a particular soil type.

-The latter affects the amount of water and air the soil can hold, its drainage and other properties.

Three types exist i.e. (i) loam soil (ii) clay soil (iii) sandy soil.

(i)Loam soil

-consists of balanced quantities of sand, clay and silt particles (sand-40-70%, clay-10-20%, silt-20-30%)

-Most fertile soils because, (i) are well drained (ii) good water holding capacity (iii) well aerated (iv)adequate minerals for plant growth.

-Are dark in colour due to much humus.

(ii) **Sandy soil**

-contains more gravel and sand,

- large space between the particles and these spaces allow water to drain off very quickly.

-Has a coarse structure.

-Has low water holding capacity

-Low mineral nutrients

-Has low capillarity

-Are light , thus relatively easy to plough.

(iii**) Clay soil**

-contains more clay and silt than gravel and sand.

-Has small fine particles i.e.fine texture

-Particles are closely packed, thus small air spaces between them.

-Poorly aerated

-Poorly drained (water logged)

-Has high capillarity.

-Sticky when wet

-Heavy, thus difficult to plough

Differences between sandy and clay soils

Sandy soil	Clay soil
Larger particles	Smaller particles
Larger air spaces	Smaller air spaces
Good water drainage	Poor water drainage
Poor water retention	Better water retention
Poor capillarity	Good capillarity
Low mineral content	High mineral content
Good aeration	Poor aeration
Does not form clumps	Forms clumps
Warms easily due to large air spaces	Does not warm easily
Dries out easily	Does not dry out easily

Guiding question

1.Clay soil has a high degree of water retention because it

A. Has small air space
B. Contains little amount of humus
C. Is sticky when wet
D. Has good capillary attraction

2.Which of these soil types is the best for agriculture?

A. silt B. clay soil C. sandy soil D. loam soil

3.Clay soil is usually water logged because of,

A. too much water B. poor drainage C. small pores D. high capillarity.

4. Which of these is a characteristic of sandy soil?

A. High water retention
B. High capillarity
C. Low porosity
D. High porosity

5.Which type of soil has a poor water retention?

A. Clay
B. Loam
C. Sand
D. Silt

6.The following are soil properties;

(i)high water retention (ii) high capillarity (iii) large air spaces (iv) easy to cultivate

Which one of the is true for clay soils?

A. (i) and (ii) B. (ii) and (iii) C.(iii) and (iv) D (i) and (iv)

7.What are the main differences between **sandy soil** and **clay soil,** clearly explaining how they affect what can grow in the different soils.

8. Which one of the following soils types would you expect to be the most fertile?

A. sandy soil B. clay soil C. laterite soil D. loam

FACTORS AFFECTING THE QUALITY OF SOIL

Quality of soil is the ability of soil to (i) have adequate nutrients required by plants, (ii) retain water and air for use by plants and other living organisms.

Affected by five(5) major factors i.e. (i) Parent rock (ii) climate (iii) topography (iv) living organisms (v) time

(a)**Parent rock**

Influence the physical properties and chemical constituents of soil the soil e.g.

-Granite rocks not easily weathered give rise to soils(sandy) with large particles sizes, low water holding capacity, less nutrients for plants.

-Volcanic rocks easily weathered form soils (clay) with fine particles, good water holding capacity and nutrients but less air.

-Rocks with high amounts of iron and magnesium form red soils rich very rich in iron and magnesium.

- Easily weathered rocks produce deep soils, while rocks not easily weathered form shallow soils.

(b)**Climate**

- involves factors like (i) rainfall (ii) wind (iii) temperature

(i). Rainfall

-Dissolves carbon dioxide in the atmosphere to form weak solution of carbonic acid which when falls on rocks ,it dissolves them, resulting in the release of mineral elements like calcium, magnesium, Aluminium, iron etc. which are components of soil.(***chemical weathering)***

-Influences the type of vegetation, which grows on soil, which on dying, decay forming humus, which holds soil particles together, improving on aeration and drainage of the soil.

-Dissolves soluble minerals in the parent rock, carrying them through the soil to deeper layers of the soil not easily reached by plant roots. Thus such soils formed under heavy rainfall, have **low content of minerals** essential for plant growth, and are usually **acidic**, due to removal of bases like calcium and magnesium.

-Arid areas receiving low rainfall have **alkaline or neutral soils**, and are **richer in minerals** because are less susceptible to leaching but with **low organic matter** due to scanty vegetation

-Rain water flowing down stream and rivers carries with them rock particles which against each other, breaking into smaller particles, forming soil.

(ii) Wind.

-In dry bare areas(deserts) it carries sand, continuously hitting them on rocks, causing their breakdown, forming fine sand.

(iii). Temperature

-Higher temperatures in hot areas speed up rate of chemical weathering by oxidation forming deeper soils. In cold areas, temperatures are lower, thus less weathering occurs forming shallow soils.

-Increase in temperature within limits, increases the activity of soil organisms, thus breakdown of organic matter is accelerated, forming soils rich in humus.

- Alternate heating and cooling of the rocks on exposed mountain sides in dry areas causes rapid expansion during day and sudden contraction on sun set, which cause the rock to crack and break up

(c**.) Topography (Terrain).**

-General physical appearance of a given area or land scape, i.e. land scape may be hilly, flat, steep or with gentle slopes.

-Influences the movement of soluble substances and soil particles formed during weathering from the highland to low land. i.e.

(i) Low lands e.g. valleys, receiving water flowing from uphill carrying with it soil particles, experiences high weathering, thus have very fine particles. Such soils are deep, poorly drained (water logged), poorly aerated, slower rate of decomposition, resulting in high accumulation of organic matter.

(ii) In steep slopes, soils formed are easily eroded by runoff water forming shallow soils. Soil particles here are also loosely held, thus have more spaces between them, giving it a good drainage, aeration, and fast decomposition of organic matter.

(d) **Living organisms**

-Decompose plant and animal remains into humus e.g. by termites , fungi , and bacteria.

-Some living organisms like earth worms, ants, beetles burrow in the soil and this improve soil aeration and drainage

-Certain organisms such as mosses and lichens are able to grow on bare rock, secreting chemicals which breakdown rocks; while roots of flowering plants breakdown rocks as they penetrate and enlarge rock crevices as they grow bigger.

-When lichens, mosses and flowering plants die they form humus, a component of soil.

-Man's activities e.g. construction, mining, quarrying, cultivation result in physical breakdown of the parent rocks into smaller particles necessary in soil formation.

(e)**Time**

-Age of soil is determined by length of time over which soil forming processes have been in action. Provided factors like parent rock, climate, topography and living organisms favour soil formation, rocks exposed to these agents over many years produce deep mature fertile soils with a well differentiated profile.

-Rocks weathered for a shorter period of time, produce shallow immature soils, with large particles.

Guiding question

State and explain five factors that affect the quality of soil

PROPERTIES OF SOIL

(I)Physical properties of soil (II) Chemical properties of soil.

(I) **Physical properties of soil**

(i)**Soil porosity.(presence of spaces between soil particles that allow movement of air and water)**

-Sandy soil possess large spaces between the soil particles and so more porous.

-Clay soils possess very small spaces between the soil particles thus less porous.

-Loam soil is moderately porous.

(ii) Air content:

-Sand contains a lot of air (well aerated), because it has large spaces existing between the particles.

-Clay soil contains little air (poorly aerated) due to presence of small spaces between the particles.

-Loam soil has varying amounts of air.

(iii) Drainage of water:

-Sandy soil has good water drainage so it allows water to pass through it very quickly.

-Clay soil has poor drainage of water, thus holding a lot of water, making it **water logged**. This can be improved by **Flocculation** (addition of lime, so as large crumbs are formed, leaving spaces are left in between soil particles)

-Loam drains water moderately.

(iv)Water holding/retention capacity:

-Sandy soil has poor water holding capacity. It can be improved by adding humus to it. Humus sticks sand particles together.

-Clay soil tends to become water logged i.e. it holds a lot of water so has a high water retention capacity, with all the spaces occupied by water, thus no air (oxygen) for aerobic respiration by plant roots.

-Loam soil holds water moderately but not becoming water logged.

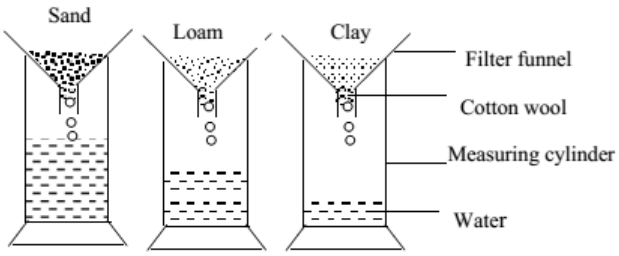
Experiment to compare drainage and water retention in clay, loam and sandy soils

Aim To compare water retention and drainage in clay, loam, and sandy soils.

Requirements.

(i)Three funnels (ii) three filter papers/cotton wool (iii) three measuring cylinders (iv) water (v) dry samples of loam, sandy and clay soils (vi) Stop clock.

Experimental set up. (*Extracted from Kugonza Arthur compilation*)



Procedure

-Equal volumes of dry sandy, clay and loam soils are placed in different funnels with filter papers/cotton wool.

-Filter funnels and their contents are placed in the necks of different measuring cylinders.

-Equal volumes of water is poured into each soil sample at the same time.

-Set up is left to stand for some time, until no more water drips.

-Volume of water drained is read on the measuring cylinder.

Observation

-least water drains through clay soil

-More water drains through sandy soil

-Moderate amount of water drains through loam soil.

Conclusion.

Sandy soil has the least amount of water retained.

Guiding questions

1.Describe an experiment to compare the amount of water retained by dry samples of sandy and clay soils.

(v)**Soil capillarity:**

-Is the ability of water to rise up through the spaces in soil due to attractive forces between water molecules(cohesive) only and between soil particles and water.(adhesive).

- Magnitude of these cohesive and adhesive forces increases with decrease in the size of spaces between soil particles, thus;

-Sandy soil has the lowest capillarity of water while clay soil has the highest water capillarity and loam soil has medium water capillarity.

Experiment to compare the rate of capillarity in sandy, loam and clay soil samples.

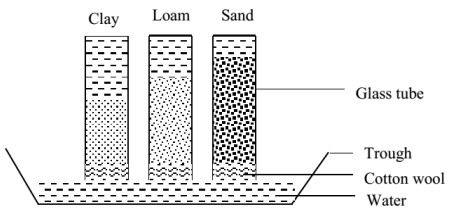
Aim. To compare the rate of capillarity in sandy, loam and clay soils.

Requirement.

(i)3 long glass tubes (ii) trough (iii) cotton wool (iv) 3 clamps stands (v) 3 samples of dry sandy, clay and loam soils (vi) cotton wool

Procedure.

- Plug three open ended calibrated glass tubes of the same diameter with cotton wool at the end.
- Glass tubes are filled with same volume of different dry soil samples
- Glass tube are made to stand by use of clamp stands in a trough of water as shown below.
- Height of water in all the three glass tubes at regular interval for one day.



Observation:

-Water rises faster for a short distance in sandy soil while in clay soil water rises slowly but to higher distances. In loam soil, water rises moderately to a moderate distance.

Conclusion:

Clay soil has the highest capillarity of water. Sandy soil has the lowest capillarity while loam has moderate water capillarity.

Explanation:
-Water rises to the greatest height at the early stages of the experiment in sandy soil, because sand has large spaces that enable water to rise more rapidly in the first hours.
-Clay soil shows the highest rise of water hence the highest water capillarity, because it is composed of tiny soil particles which present the large surface area over which water molecules hold.
-Water rises at a slow rate in clay soil because clay has small air spaces between its particles.

(vi) **Soil colour**
-Determines the amount of heat that can be trapped in a soil sample. Dark soils retain heat more than light soils.

Guiding question
1.A soil with low capillarity has;
- **A.** Poor drainage
- **B.** Poor aeration
- **C.** Poor water retention
- **D.** Small particles

(II)**Chemical properties of soil**
-Includes the ability of soil to react other chemical substances.
-Determined by **soil pH**

Soil pH

-**Degree of acidity or alkalinity of the soil**.

-Dependent on the hydrogen ion concentration. High hydrogen ion concentration results into low pH (High acidity), Low hydrogen ion concentration results into high pH (low acidity).

Importance of soil pH.

-Affects availability of various nutrients to plants i.e.in acidic conditions, phosphorus is unavailable plants, because it combines with less soluble compounds of iron and aluminium.

-At very low pH, concentration of certain nutrients like iron and aluminium become toxic to some plants.

-Extremes of pH, inhibits the activity of soil micro-organisms especially the nitrifying bacteria.

-Affects the prevalence of certain plant pathogens, e.g. At low soil pH fungal plant diseases are more prevalent than bacterial diseases.

(potato scab caused by bacteria, ***Streptomyces scabies*** is prevalent in soil with high pH, while club root disease caused by fungi, ***Plasmodiophora brassicae*** prevail in soils with low pH.)

An experiment to determine the soil pH

Aim. To determine the soil pH

Requirement

(i)Fresh soil sample (ii) Distilled water (iii) Universal indicator solution (iv) Indicator chart. (v) White tile.

Procedure:

-Place a small sample of soil on a white tile and soak it with universal indicator and eave it for about 2 minutes.

-Tilt the tile slowly to drain off the indicator from soil, and then compare the indicator colour with the indicator chat.

SOIL EROSION

This is the process by which the fertile top layer is detached, removed and carried away from the earth's surface by animals, wind or running water.

Types of soil erosion

(i)Sheet erosion: involves gradual, uniform removal of thin top layer of soil on gentle slopes by slowly moving water.
(ii)Rill erosion: involves removal of soil by water leading to the formation of small, clearly cut channels, **rills**. Most serious where heavy storms occur especially on loose soil. Rills can be removed by ploughing.
(iii)Gully erosion: results when rills widen and deepen, forming deep channels, gullies. Very large quantities of soil are removed from the fields. Occurs in very steep slopes, and when rains are heavy.
(iv)**Splash or raindrop erosion:** occurs when raindrops hit the ground, dispersing soil particles from the surfaces of the soil, and carrying them to other places
(v) Wind erosion: Occurs when strong winds detach, remove and carry small and light soil particles from earth's surface. More common in dry, bare soils without vegetation.

Causes of soil erosion

(i)Topography: (Terrain)
-The steeper the slope, the greater the speed of water flow over the surface, with greater ability to erode the soil.
-The longer the slope, the larger the volume of water flowing over it, increasing the eroding power of water, and thus more soil is carried.
(ii)Over grazing:
Many grazing animals on a small area, trample the vegetation cover, exposing it to agents of erosion.
(iii)Deforestation:
-Leaves reduces intensity at which raindrops reach the ground thus extensive falling of trees in an area removes this cover thus facilitating erosion on slopes.
(**iv**)**Bush burning:** Uncontrolled burning of bushes in dry seasons removes the grass top cover, thus leaving the soil bare for erosion.

(v) Poor farming methods:

-Continuous cultivation of a piece of land, breaks down the soil structure, making the soil more susceptible to erosion.
-Ploughing up and down sloping land, creates channels through which soil is carried away by water.

(vi) Type of vegetation.

-In the grass lands, where vegetation is dense with numerous leaves, stems and litter left on the surface, reduces (i)direct impact of raindrops on the soil surface, (ii) speed of run off, decreasing the power of water to carry away soil particles, as well as allowing more time for water to infiltrate into the soil.
-Plant roots bind soil particles together, improving on its structure, making soil more resistant to the forces of erosion.
-Death of plants and on decomposition, form humus which binds soil particles, increasing on water holding capacity.

(**vii) Type of soil.**

-Soils with large amounts of organic matter, and rich in iron and aluminium containing compounds, their particles are bound together, thus have a good water holding capacity, which reduces on the amount of run-off. e,g clay soil
-Sandy soil has loosely bound particles, thus more prone to erosion.

(viii) **Rainfall intensity**

-A large annual rainfall received as gentle rain over a long period of time may cause little erosion.
-A lower yearly rainfall coming in storms result greater erosion.

Guiding question

1.What are the factors that affect soil erosion?

Effects of soil erosion to farmers

-Nutrients and soil organisms are carried a way in the top soil.
-Washing away of many shallow rooted crops e.g. in gulley erosion.
-Fields are irregularly cut into pieces, by gulley erosion, making it difficult to be crossed by farm machinery.
-Leaves the soil bare and hard, making the soil difficult to plough.
-Silting of dams and lakes, resulting into massive growth of algae, which cuts off oxygen supply to fish, leading to death of fish.
-Reduction in crop yields due to loss of soil fertility.
-Many crops at the foot of slopes are buried by the debris carried by runoff water
-Reduces the depth of soil, that it cannot support plant roots.

Methods of controlling soil erosion

(i)Contour ploughing:

-Ploughing a long contour i.e. across a slope and not up and down. It allows furrows to trap water and thus reduce runoff.

(ii)Strip cropping:

-Involves growing crops that provide good cover alternating with crops that provide little cover in strips along contours.
-Cover crops trap all soil that may be carried from the strip with widely spaced crops.

(iii)Terracing:

-Involves making trenches and ridges along contours on steep slopes.
-Terraces (i) reduce the surface flow of water and allow more water to sink into the soil. (ii) Carry away surplus water which cannot be absorbed by soil.

(iv)Afforestation:

-Planting large areas of land with trees where they did not exist before.
-Trees and grasses reduce wind erosion
-Debris from the plants absorbs water and reduces runoff
-Roots of plants have binding effect on soil particles, increasing on water holding capacity, preventing surface runoff.

(v)Mulching:

- Covering of top soil with plant material e.g. banana leaves, maize stems after harvest, cut grass etc.
-Mulches (i)break the fall of rain drops, thus expending their energy and reducing their action on the soil structure. (ii) Interrupts any surface flow of water, thereby increasing water infiltration.

Guiding question

1.The table below shows time taken to erode $18cm^3$ of top soil per $1000m^2$ area under different soil covers. Study it and answer the questions that follow.

Type of ground cover	**Kg of soil removed per $1000m^2$**	**Number of years needed to erode $18cm^3$ of top soil**
Virgin forest	5	500000
Grass	775	3225
Field under crop rotation	358,000	70
Cotton	79000	32
Bare ground	166000	15

(a)What was being investigated according to the information in the Table?

Effect of ground cover on controlling soil erosion.

(b)Which human activities would reduce the number of years to erode $18cm^3$ of top soil in virgin forest?

-Deforestation
-bush burning
-road construction through the forest

C)Which ground cover was efficient in controlling soil erosion? Give a reason for your answer.

Virgin forest, because it took the longest time to erode $18cm^3$ of the top soil.

(d)Which ground cover was inefficient in controlling soil erosion?

Bare ground, because it took the shortest time to erode $18cm^3$ of the top soil.

(e) Why is the field under crop rotation better in the control of soil erosion than field of cotton?

Field under crop rotation have grasses, growing closer to the ground than cotton, thus providing a better ground cover, reducing on soil erosion. Roots of the grasses also hold soil particles together, rebuilding soil structure.

(f)How would the farmer control soil erosion on a flat bare ground?
-(i)***Afforestation*** (ii) ***Crop rotation*** (iii) ***Mulching***
2. Which of these is not a cause of soil erosion?
A.Wind B. Rain C. Sloping position D. Regular fertilizer
3. Which combination of statements explains best explains why reforestation is important in preventing soil erosion?
(i) Tree roots help to bind the soil together and prevent soil erosion
(ii)You can make money selling the timber
(iii)Trees break up the wind, so reducing soil erosion
(iv)Leaves of trees stop rain from washing away the soil.

A. (i), (ii) and (iii)
B. (i), (iii), and (iv)
C. (ii), (iii), and (iv)
D. (i), (ii) and (iv)

4. Which one of the following is not a reason for adding calcium hydroxide to the soil?

A. Causes flocculation – particles stick together to form crumbs
B. Replaces calcium used by plants as they grow
C. Balances the pH of the soil and helps to keep it neutral
D. Lowers the pH of the soil

SOIL FERTILITY AND CONSERVATION

(A)SOIL FERTILITY

-Refers to the ability of soil to supply nutrients in adequate amounts, right proportions and in available forms for crops to produce high yields.

Features of the fertile soil.
-Adequate amounts of water/moisture/well drained/good water retention.
-Sufficient air/well aerated
-Sufficient amounts of nutrients, in correct proportions, and in available forms.
-Sufficient amounts of humus/organic matter.
-Deep enough to give(i) plant roots greater volume to obtain nutrients. (ii) support to the plant (iii) Hold much water for the plant
-Living organisms e.g. bacteria
-Optimum pH for the desired crop.

Loss of soil fertility
(i)**Soil erosion**.
(ii)**Leaching**;
-Washing down of soluble minerals from topsoil layers to bottom layers, beyond the reach of plant roots.
-Common during heavy rains.
(iii) **Immobilisation**
-Minerals e.g.ammonium compounds in the soil become fixed on clay particles, thus unavailable to the plants.
(iv)**Volatilisation**
-Involves loss of nitrogenous fertilisers when applied in dry weather.
(v)**Soil exhaustion**;
- Is the depletion in soil nutrients, and loss of humus from the soil, that it can no longer support plant life.
- Caused by poor farming methods like monoculture, over cropping, Bush burning, over grazing etc.
(vi)**Soil compaction**;
-Hardening of soil on the surface due to action of heavy machinery, movement of animals and man on soil, etc. Soil compaction prevents water from penetrating into the soil.

Guiding question.
1.What is soil exhaustion?
A. The state of a farmer after working all day in the fields.
B. Soil that is tired.
C. Soil that has lost all the mineral nutrients needed for plant growth.
D. Soil that has been washed away by heavy rainfall
3.Describe ways a soil can be exhausted.

2.Which of the following is not a characteristic of a fertile soil?
A. Rich in humus
B. mixture of clay, silt, and sand particles
C. low pH
D. contains plenty of minerals.

(B)SOIL CONSERVATION

-Refers to protection and careful management of soil to maintain its fertility.
-It's done by taking care of (i) organic matter (ii) mineral matter (iii) top soil (iv) water and avoiding use of toxic substances.

Methods of soil conservation
(i)Crop rotation.
-Involves a farmer changing the crops grown on a piece of land each year, for balanced mineral salts.
(ii)**Bush fallowing**
-Involves leaving a piece of land uncultivated for some time to give it rest.
-Allows naturally occurring plants to refertilise the soil by the decay of their organic matter.
(iii)**Addition of fertilisers and manure** at recommendable time to avoid loss through leaching and volatilization.
(iv)**Regular weeding**
Removes unwanted plants (weeds) that would compete with plants for the available minerals and water in the soil.

(v) **Irrigation.** Improves the amount of water in the soil
(vi) **Mixed cropping**
-Growing different crops on the same piece of land, the drain of nutrients is spread and stress on the soil is reduced e.g. by planting maize and legumes, legumes supply nitrates absorbed by maize, without taking much from the soil.
(vii) **Addition of slaked lime**, (calcium hydroxide) in acidic soils to balance the pH , keeping the minerals right and produce a good soil crumb structure.
(viii)**Methods of controlling erosion like mulching, terracing, contour ploughing, strip cropping, re-afforestation, paddocking etc.**

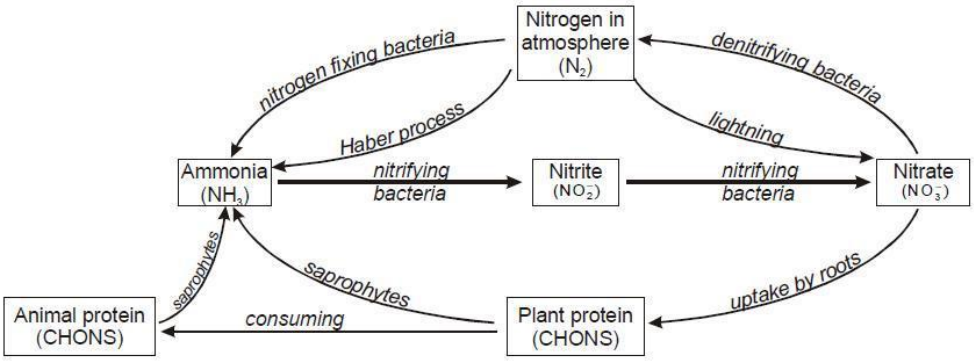
Guiding questions

1.(a)What is mulching and how does it help an exhausted soil?
(b)Why are fertilizers important?
2.A natural fertilizer produced from the bodily waste products of animals. What does this describe?
A. manure B. compost C. artificial fertilisers D. fertile soil.
3What are the constituents of a fertile soil?
(b) In what ways may human activities
(i) improve soil?
(ii) degrade soil?
4. How does clay affect fertility of soil?

MATERIAL CYCLING/(NUTRIENT CYCLING)
-Process by which chemical compounds of a particular element that constitutes living matter are transferred between living organisms and non-living environment.

(A)NITROGEN CYCLE
- **Is the circulation of nitrogen in the environment, and through organisms either in different compounds or free.**

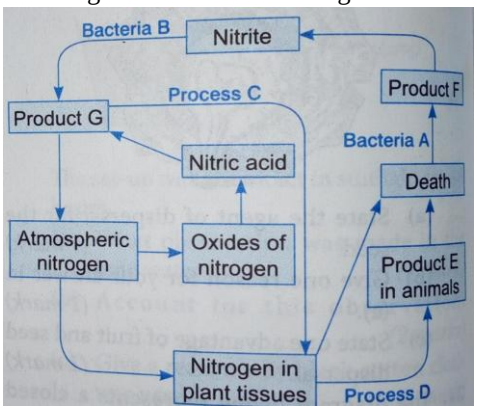
❖ Nitrogen is the atmosphere's most abundant element, with chemically unreactive nitrogen gas making up 78% of the volume of the troposphere. However, N2 cannot be absorbed and metabolized directly by multicellular plants and animals.
❖ Atmospheric electrical discharges in the form of **lightning** causes nitrogen and oxygen in the atmosphere to react and produce oxides of nitrogen, which dissolve in rainwater and fall to the ground as weakly acidic solutions.
❖ **Nitrogen fixation** occurs when the nitrogen in soil is reduced to ammonium ions, catalysed by(i) nitrogen-fixing bacteria which may be free-living e.g. **Azotobacter** and **Clostridium**; **symbiotic bacteria in root nodules** e.g. **Rhizobium or blue- green algae** e.g. Nostoc.
❖ **Nitrification** occurs when ammonium compounds in soil are converted first to nitrite ions (highly toxic to plants) by ***Nitrosomonas* bacteria** and later to nitrate ions by ***Nitrobacter* bacteria**.
❖ **Ammonification** (putrefaction) occurs when decomposers e.g. saprophytic bacteria and fungi convert nitrogen-rich organic compounds, wastes like urea and dead bodies of organisms into ammonia and ammonium ion-containing salts.
❖ **Assimilation** occurs when inorganic ammonia, ammonium and nitrate ions are absorbed by plant roots to make nucleic acids, amino acids and protein.
❖ **Denitrification** occurs when mostly anaerobic bacteria e.g. ***Pseudomonas denitrificans*** and ***Thiobacillus denitrificans*** in water logged soil and deep in ocean, lake and swamp bottoms convert ammonia and ammonium ions back into nitrite and nitrate ions, and then into nitrogen gas and oxygen. Nitrogen gas is released into the atmosphere while oxygen is used for aerobic respiration by these bacteria.



Ways of adding nitrogen in the soil
-Application of nitrogen containing fertilisers e.g CAN, NPK.
-Planting leguminous plants, whose root nodules have nitrogen fixing bacteria that fix atmospheric nitrogen into the soil.
-Oxidation of atmospheric nitrogen by electrical charges during lightening, forming oxides that are later washed to soil.
-Fixation by free living bacteria in the soil (azotobacter)
-Decomposition of dead animal and plant remains.

Ways through nitrogen is lost from the soil
-(i)leaching (ii) volatilization (iii) soil erosion (iv)Denitrification (v) uptake by plants.

Guiding question
1.The figure below shows a diagram of the nitrogen cycle.



(a). Identify bacteria **A** and **B**
(b) Name processes **C** and **D**
(c.) Name products **E** and **F**
(d) State **two** ways in which free nitrogen in the air is made available for plant use.
2.(a)State how flowering plants obtain nitrogen from the soil
(b)How is nitrogen utilized by plants?
(c.) Outline the possible sources from which plants obtain nitrates.
(d) Explain why water logged soils are usually deficient in nitrates
3. Which of the following bacteria fixes nitrogen freely in the soil.
A. Rhizobium B. Nitrosomonas C. Azotobacter D. Nitrobacter.
4. Which bacteria converts nitrites to nitrates in a nitrogen cycle.
A. Rhizobium B. Nitrosomonas C. Azotobacter D. Nitrobacter

(B)CARBON CYCLE

- **Is the circulation circulation/flow of carbon in nature between green plants, animals and atmosphere.**

❖ Based on carbon dioxide gas, making up 0.03% of the volume of the atmosphere and is also dissolved in water.

❖ Carbon fixation involves the reduction of carbon dioxide to large organic molecules during photosynthesis and chemosynthesis.

❖ During ***aerobic respiration*** by all organisms, carbon dioxide is returned to the atmosphere or dissolves in water.

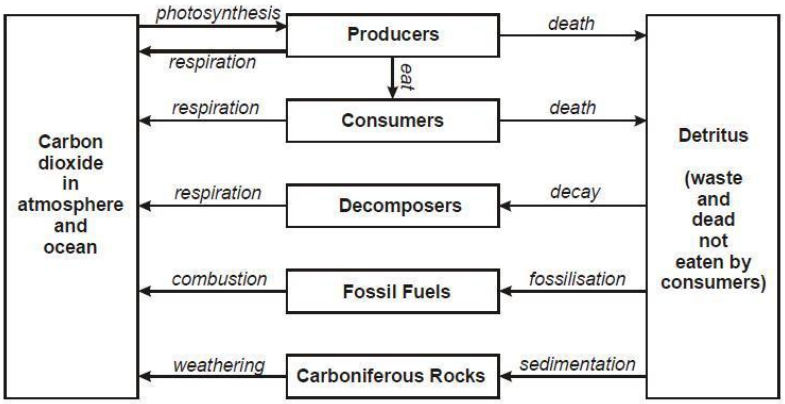
❖ Over millions of years, buried deposits of dead plant debris and bacteria are compressed between layers of sediment to form the carbon-containing fossil fuels e.g. coal, oil and natural gas, which when burnt release carbon dioxide into air.

❖ In aquatic ecosystems, carbon dioxide may (i) remain dissolved (ii) be utilized in photosynthesis (iii) react with water to form carbonate ions and bicarbonate ions . As water warms, more dissolved carbon dioxide returns to the atmosphere.

❖ In marine ecosystems, some organisms take up dissolved carbon dioxide molecules, carbonate ions and bicarbonate ions and these ions react with calcium ions to form calcium carbonate ($CaCO_3$) to build their shells and skeletons.

❖ When the animals with calcium in shells and skeletons die and drift into deep bottom sediments of oceans, immense pressure causes limestone and chalk to form after a very long period of time.

❖ ***Weathering*** processes release a small percentage of carbon dioxide from limestone into the atmosphere.



Removal of Carbon dioxide from the atmosphere:

-Green plants remove into the atmosphere during the process of photosynthesis.

-Some of the carbon dioxide in the atmosphere dissolves in rain water to form carbonic acid. This acid reacts with soil mineral salts to form carbonates.

Addition of Carbon dioxide in the atmosphere:

-Combustion of carbon containing fuels e.g. petroleum, coal, natural gas, fire wood releases carbon dioxide into the atmosphere..

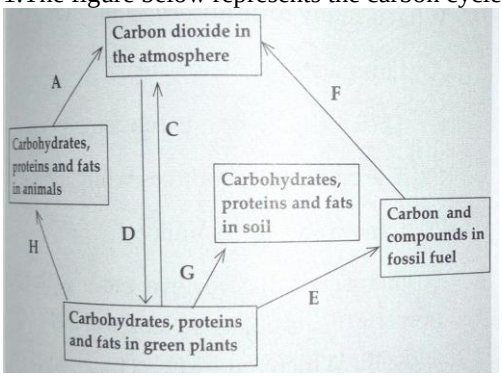
-Respiration in animals and plants.

-Decomposition of organic matter by bacteria and fungi

-Weathering of limestone.

Guiding questions

1.The figure below represents the carbon cycle. Study it and answer the questions that follow.



(a)Name the process labelled **A, C, F**, and **G**.

(b) State one physical factor that promotes process **D**.

(c.) Give two uses of process **D** to animals.

(d) Describe one way in which process E may be harmful.

(e) (i) Suggest **one** human activity that tends to lower the level of carbon dioxide in the atmosphere.

(ii) Explain how the activity suggested in e(i) lowers the level of carbon dioxide in the atmosphere.

2. Which of the stores carbon for the longest period in the carbon cycle.

A. Animals B. Plants C. Fossils D. Atmosphere

(C.) WATER CYCLE/ HYDROLOGICAL CYCLE

-Is powered by energy from the sun and by gravity, and it involves;

(i) Vaporation (conversion of water into water vapour)

(ii) Transpiration (evaporation from leaves of the water extracted from soil by roots and transported throughout the plant)

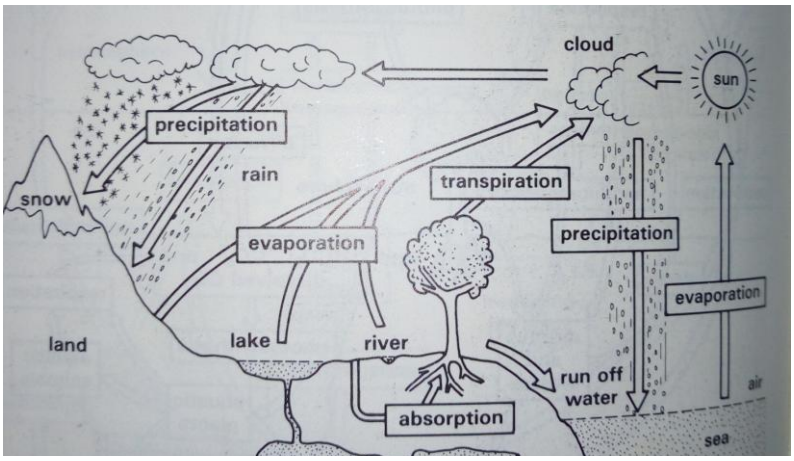
(iii) Condensation (conversion of water vapour into droplets of liquid water)

(iv)Precipitation (rain, hail, snow and sleet/freezing rain)

(v) Infiltration (movement of water into soil)

(vi)Percolation (downward flow of water through soil and permeable rocks to ground storage areas called aquifers)

(vii) Runoff (down slope surface movement back to the sea to resume the cycle)



Guiding question

1.Which one of the following does not release water back to the atmosphere.

A. Absorption
B. Evaporation
C. Transpiration
D. Exhalation