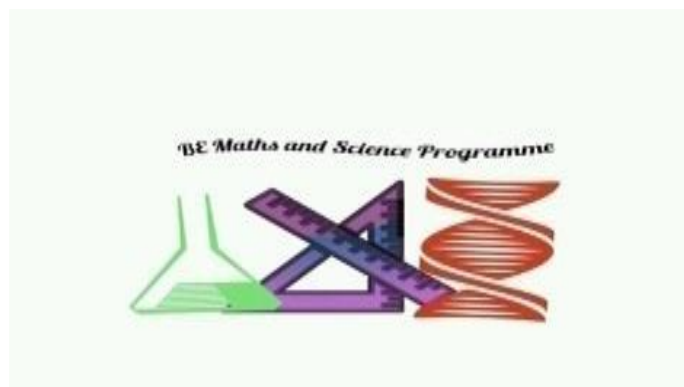


AGRICULTURAL SCIENCES

GRADE 11

NOTES AND ACTIVITY BOOKLET



Topic 1: Basic chemistry

What is chemistry?

Chemistry is the study of the properties, composition and structure of matter, the changes that occur in matter, and the energy that is released during these changes.

1. Important chemistry terminology

- **Matter**- Is anything that can occupy space and has mass (it weighs something) and volume (it take up space)
- **Atom**- is the smallest unit of matter that cannot be broken down by chemical means
They are made up of the following sub-atomic particle; **neutron**, **proton** and **electron**
- **Proton**- is a subatomic particle with a positive charge
- **Neutron**- is a subatomic particle with no charge
- **Electron**-is a subatomic particle with a negative charge
- **Valence electron**- is the electron in the outer shell of an atom
It is determined by the main group number of an element found in its column in a periodic table e.g Carbon is in group 4 and has 4 valence electron
- **Atomic number**- number of protons in the nucleus of an atom
- **Atomic mass number**- number of protons and neutrons in the nucleus of an atom
- **Element**- is a substance that cannot be broken down into simpler substance by chemical means (element adhere to form a molecule)
- **Molecule**- is a group of two or more atoms which are bond together to form a compound (molecule can be broken down chemically into elements they made up of)
e.g water molecule (H_2O) is made up of two hydrogen atom and one oxygen atom
carbon dioxide (CO_2) is made up of 1 carbon atom and two oxygen atom
- **Compound**- substance that result from a combination of two or more different elements
- **Periodic table**- is the table of all the known elements arranged in order of their atomic number
- **Isotopes**- element that has equal number of proton but different number of neutrons

- **Mixture**- two or more substance which has been combined such that each substance retains its own chemical identity.
e.g salt in water (salt dissolve in hot water)

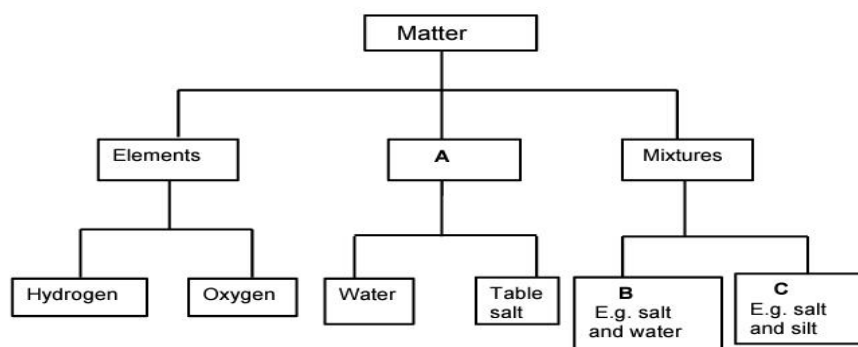
Activity 1 (chemistry concepts)

1.1 Define the following concepts;

- (a) matter
- (b) Atom
- (c) Proton
- (d) Neutron
- (e) Periodic table
- (f) Atomic number
- (g) Atomic mass number
- (h) Isotope
- (i) Element
- (j) Molecule

Activity 2 (chemistry concepts)

1.1 analyse the flow chart below and answer the questions based on it



- 1.1.1 Identify the substance labelled **A**, **B** and **C** (3)
- 1.1.2 Explain the differences between an element and substance in (2)
- 1.1.3 Distinguish between the mixtures B and C (2)

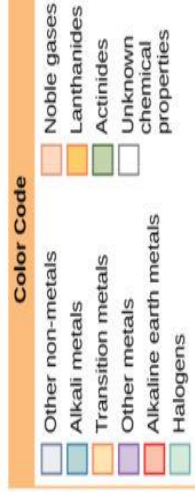
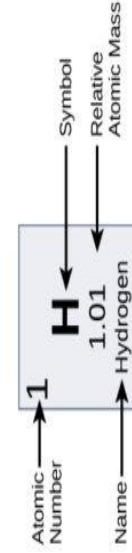
2. The periodic table

Is the table of all known chemical elements in order of atomic number.

Elements in a periodic table are arranged in a series of rows and columns based on shared chemical and physical properties at room temperature (they may be gas, liquid or solid)

Periodic Table of the Elements

Periodic Table of the Elements																																													
1 H 1.01 Hydrogen																	18 He 4.00 Helium																												
2 Li 6.94 Lithium	3 Be 9.01 Beryllium															10 Ne 20.18 Neon																													
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium															17 Cl 35.45 Chlorine	18 Ar 39.95 Argon																												
19 K 39.09 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 51.99 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.41 Zinc	31 Ga 69.72 Gallium	32 Ge 72.64 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.79 Krypton																												
37 Rb 85.47 Rubidium	38 Sr 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc [98] Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon																												
55 Cs 132.9 Cesium	56 Ba 137.3 Barium	57-71 La-Lu [57-71] Lanthanides			72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.8 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 196.9 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 208.9 Bismuth	84 Po [209] Polonium	85 At [210] Astatine	86 Rn [222] Radon																										
87 Fr [223] Francium	88 Ra [226] Radium	89-103 Ac-Lr [89-103] Actinides			104 Rf [261] Rutherfordium	105 Db [262] Dubnium	106 Sg [266] Seaborgium	107 Bh [264] Bohrium	108 Hs [277] Hassium	109 Mt [268] Meitnerium	110 Ds [271] Darmstadtium	111 Rg [272] Roentgenium	112 Cn [285] Copernicium	113 Nh [284] Nihonium	114 Fl [289] Flerovium	115 Uup [288] Ununpentium	116 Lv [293] Livermorium	117 Uus [294] Ununseptium	118 Uuo [294] Ununoctium																										
																		71 Lu 174.9 Lutetium	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.8 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 196.9 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 208.9 Bismuth	84 Po [209] Polonium	85 At [210] Astatine	86 Rn [222] Radon												
																		101 Md [258] Mendelevium	102 No [259] Nobelium	103 Lr [262] Lawrencium																									



Interpreting a periodic table

Periodic table groups

Groups in a periodic table are numbered 1-18 from left to right

- **Group 1:** made up of alkali metals (note: hydrogen is not considered a metal)

Alkali metals are very reactive (most reactive group in the periodic table)

They react violently with water

Has **one** valence electron

- **Group 2:** made up of alkali earth metals

alkali earth metals are **very reactive**, but less reactive than alkali metal

Has **two** valence electron

Differences between alkali metals and alkali earth metals

Alkali metal: have one electron in their outermost shell

Alkaline earth metal: has two outer shell electrons

Similarities between alkali metals and alkaline earth metals

They are both good electrical and heat conductors

They are the most reactive metals in the periodic table

They have low melting point compared to other metals

- **Group 3-12:** made up of transition metals (they contain metals)
Some transitional metals are below the main table (they contain **Lanthanide** and **Actinide series**)

Lanthanide: They follow transitional metal atomic number 57 in period 6 of the periodic table

Has 3 valence electron

They are very reactive

Actinide: They follow transitional metal atomic number 89 in period 7 of the periodic table

Has 3-6 valence electron

They are radioactive

Most can be produced in laboratories

- **Group 13:** Boron group (made up of other metals)
Has 3 valence electron
They are highly reactive
- **Group 14:** Carbon group (made up of other non-metals)
Has 4 valence electron
Reactivity varies
- **Group 15:** Nitrogen group (made up of other non-metals)
Has 5 valence electron
Reactivity varies
- **Group 16:** made up of chalcogens (oxygen group)
It is also known as oxygen family (since oxygen is first member of the family)
Has 6 valence electron
They are reactive
- **Group 17:** made up of halogens
They are called halogens because they give salt when they react with metals
Has 7 valence electrons
This are the most electronegative elements
Elements in group 17 are **highly reactive** (because of the closeness to the noble gases. They can easily achieve the noble gas electron structure)
- **Group 18:** made up of noble gases
Have 8 valence electrons (2 for He)

They are colourless, odourless, tasteless and non-inflammable gases under standard conditions

They are most stable or non-reactive (because they have full number of valence electrons in their outer shell)

Elements and reactivity

Reactivity: is a chemical property that determines how an element will react with others to form a compound.

What makes an elements reactive?

The number of electrons in each atom i.e;

- When the outer shells are full, the atom is stable (halogens)
- When the outer shells are not full, the atom is **reacting** (they either gain, lose or share electron)

Note: the most reactive metals are the elements in group 1 and 2 i.e;

- Element in group 1: they lose an electron so that their outer shell is empty
- Element in group 2: they lose two electrons so their outer shell is empty

This group easily give up valence electrons to make a compound

Note: the most reactive non-metals are elements in group 16 and 17 i.e;

- Elements in group 16 lose two or more electrons to fill their outer shell
- Element in group 17 need one or more electron to fill their outer shell

This groups gain valence electron to make a compound

Activity 3 (periodic table)

1.1 use the periodic table below to answer the following questions

Periodic Table of the Elements

Group 1: H (1.01), Li (6.94), Na (22.99), K (39.09), Rb (85.47), Cs (132.9), Fr (223)

Group 2: Be (9.01), Mg (24.31), Ca (40.08), Sr (87.62), Ba (137.3), Ra (226)

Group 3: Sc (44.96), Y (88.91), La (138.9), Ac (227)

Group 4: Ti (47.87), Zr (91.22), Hf (178.5), Rf (261)

Group 5: V (50.94), Nb (92.91), Ta (180.9), Db (262)

Group 6: Cr (51.99), Mo (95.94), W (183.8), Sg (266)

Group 7: Mn (54.94), Tc (98), Re (186.2), Bh (264)

Group 8: Fe (55.85), Co (58.93), Ni (58.69), Ru (101.1), Rh (102.9), Pd (106.4), Ag (107.9), Au (196.9), Hg (200.6), Tl (204.4), Pb (207.2), Bi (208.98), Po (209), At (210), Rn (222)

Group 9: Co (58.93), Ni (58.69), Cu (63.55), Zn (65.41), Ga (69.72), Ge (72.64), As (74.92), Se (78.96), Br (79.90), Kr (83.79)

Group 10: Ni (58.69), Cu (63.55), Zn (65.41), Ga (69.72), Ge (72.64), As (74.92), Se (78.96), Br (79.90), Kr (83.79)

Group 11: Cu (63.55), Zn (65.41), Ga (69.72), Ge (72.64), As (74.92), Se (78.96), Br (79.90), Kr (83.79)

Group 12: Zn (65.41), Ga (69.72), Ge (72.64), As (74.92), Se (78.96), Br (79.90), Kr (83.79)

Group 13: B (10.81), Al (26.98), Ga (69.72), In (114.8), Sn (118.7), Sb (121.8), Te (127.6), I (126.9), Xe (131.3)

Group 14: C (12.01), Si (28.09), Ge (72.64), Sn (118.7), Pb (207.2), Bi (208.98), Po (209), At (210), Rn (222)

Group 15: N (14.01), P (30.97), As (74.92), Se (78.96), Br (79.90), Kr (83.79)

Group 16: O (15.99), S (32.07), Te (127.6), I (126.9), Xe (131.3)

Group 17: F (18.99), Cl (35.45), Br (79.90), Kr (83.79)

Group 18: He (4.00), Ne (20.18), Ar (39.95), Kr (83.79), Xe (131.3), Rn (222), Uuo (294)

1.1.1 Identify the lightest element from the periodic table (1)

1.1.2 Group 18 on the periodic table is composed of gases that are chemically inactive and cannot react with others as indicated in the periodic table grouping. Suggest the name given to this group and give TWO examples (3)

1.1.3 Copy and complete the table in your book

Element	Valency electrons	Atomic number	Mass number
Magnesium			
Sulphur			

Activity 4 (periodic table)

1.1 Answer the following on a periodic table

1.1.1 Element in a periodic table are arranged in period and group.

Indicate the common characteristic of element in the same:

(a) Period (1)

(b) Group (1)

1.1.2 Elements in group 17 and group 18 differ. Explain how the elements differ with regard to chemical reactivity (2)

1.1.3 Give a reason for the answer in QUESTION 1.2.1 (2)

3. Acids and Bases

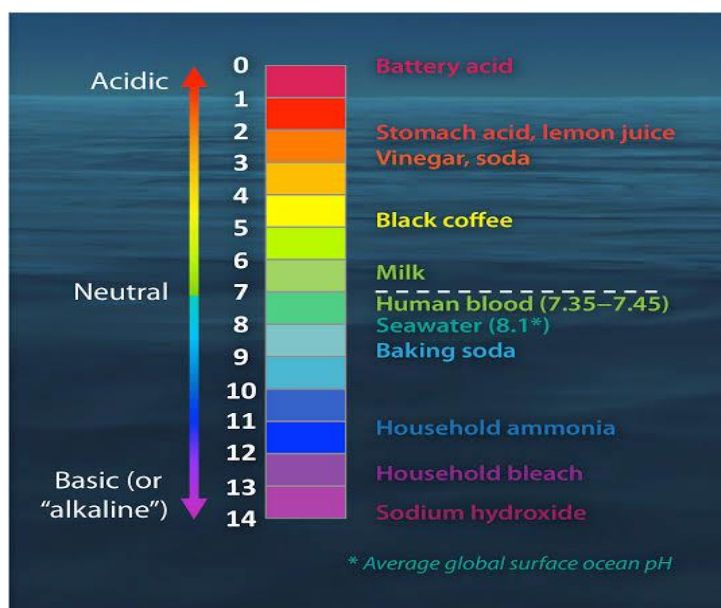
Atoms can sometimes be positively charged or negatively charged.

e.g H^+ atom is a hydrogen atom with a positive charge.

- Presence or absence of hydrogen ion in a liquid determine if the liquid is acidic or basic. For an example;
 - Tap water that we drink has ions in it, and this ion makes water either acidic or basic
 - In our body there are small compounds called amino acids
 - Some acids such as citric acids are found in fruits
 - Vinegar is an acid
 - Bicarbonate of soda is basic

The pH scale

Is a scale that describes how acidic or basic a liquid is.



Acid- is a solution that has an excess of H^+ ions. (it comes from Latin word *acidus* meaning sharp or sour)

- **Strong acid-** acid with very low Ph. (0-4)
- **Weak acid-** acid that is partially ionised in water solution (has Ph close to 7)

Base- is a solution that has an excess of OH^- ions (hydroxides). (also known as alkaline)

- **Strong base** – a base that has a very high Ph. (10-14)

- **Weak base**- a base that is partially ionised in water solution (has pH close to 7 i.e pH 8-10)

Neutral- is a solution that has a pH of 7. It is neither acidic nor basic

- It focuses on the concentration of hydrogen ion (H^+) and hydroxide ions (OH^-)
- **Only distilled water has pH 7 (neutral pH)**
- The scale goes from 0 to 14
- Acids- are very close to 0 and 7
- Bases- are from 7 to 14
- Neutral- right in the middle

Differences between acid and base

Acid	Base
Donates H^+ ion when reacting with water	Accepts H^+ ion when dissolve in water
Taste sour	Taste bitter
High concentration of hydrogen ions	High concentration of hydroxide ion (OH^-)
Turns litmus paper red	Turns litmus paper blue

Activity 5 (acids and base)

1.1 Below are substances with different pH values.

- ☐ Baking powder
- ☐ Orange juice
- ☐ Milk
- ☐ Battery acid

1.1.1 Indicate whether each of the substances above is neutral, acidic, strongly acidic, alkaline or strongly alkaline. Write the substance and the pH indicator. (4)

1.1.2 Indicate the substance in QUESTION 1.1 that has a high concentration of the following:

- (a) Hydroxide ion (1)
- (b) Hydrogen ion (1)

Activity 6 (acids and base)

1.1 acids and base play a vital role in agriculture

1.1.1 tabulate TWO differences between acid solution and base solution

1.1.2 if an acid solution is mixed with an alkaline solution, a chemical reaction take place. Give the name of the reaction

1.1.3 state TWO products of the chemical reaction in QUESTION 1.1.2

1.2 HCL and NaOH are chemical formulae of substances used in agriculture

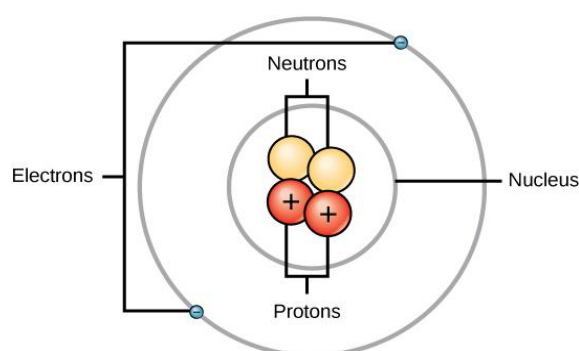
1.2.1 identify the chemical formulae representing the following:

(a)alkine (1)

(b)acid (1)

1.2.2 show the chemical reaction when HCL dissolves in water (3)

4. GENERAL STRUCTURE OF AN ATOM



Not all atoms have same number of protons and electrons

The main sub-atomic particles and their relative charge

- Proton: has a positive charge
: They are determined by the atomic number
- Neutron: has a negative charge
- Electron: has no charge

Relationship between atomic number and the number of sub-atomic particles in the nucleus

The simplest element in the periodic table is hydrogen.

- It has atomic number 1, which means;
 - There is just 1 proton in the nucleus of hydrogen atom

To balance the positive charge of the proton, hydrogen atom has 1 negatively charged electron around the nucleus

Oxygen has atomic number 8, which means;

- There are 8 protons in the nucleus of an oxygen atom

To balance the positive charge of the proton, oxygen atom has 8 negatively charged electron around the nucleus

- The number of protons + number of neutrons= atomic mass number

Arrangement of electrons around the nucleus and valence

Each layer in an atom can hold a certain number of electrons as follows;

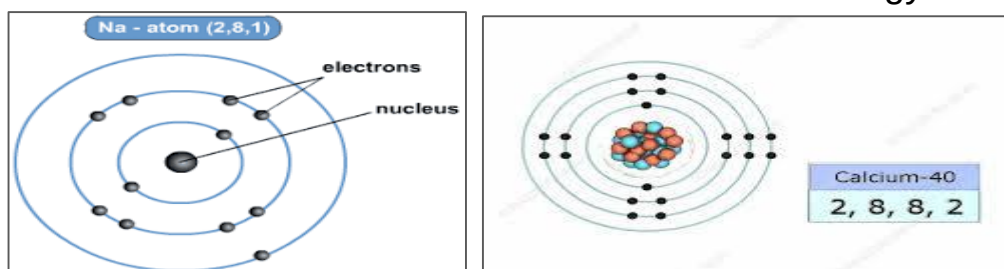
Closest to the nucleus: can hold only **TWO** electrons can exist

Second shell: can hold only **EIGHT** electrons

Third shell: can hold up to **eighteen** electrons

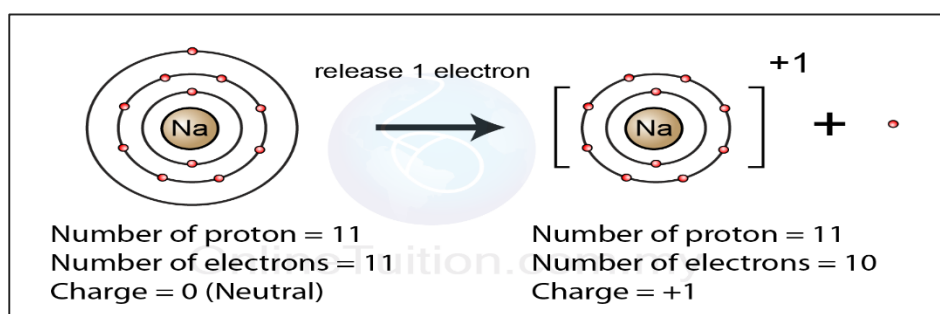
Fourth shell: can hold **twenty-two** electron

Note: the shell closest to the nucleus has lowest energy than other shells



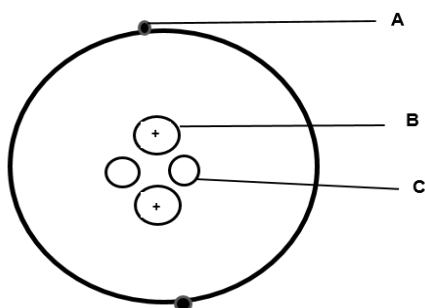
Formation of an ion

- An atom with one or more electron or one or more missing electron is called an **ion**
- Ions which have gained electrons are called **anion** (they are negatively charged)
- Ions that has lost one or more electron are called **cations** (they are positively charged)
- Ions of opposite charge attract one another, while ions of same charge repel one another



Activity 7 (formation of ions)

1.1 The diagram below shows the structure of a substance that is important in agriculture.



1.1.1 Identify the structure above. (1)

1.1.2 Give THREE reasons visible in the diagram to support the answer in QUESTION 1.1.1. (3)

1.1.3 Indicate the charge of the parts labelled **A** and **C**. (2)

1.1.4 Name the type of ion that will be formed when the following occurs:

(a) Part labelled **A** is removed and only one remains (1)

(b) One more part labelled **A** is added to make three (1)

1.2 Draw a diagram showing a Boron atom and arrange all the valence electron in a sequential order

5. CHEMICAL BONDING

- Chemical bonding usually occurs in the formation a molecule
- A molecule is made up of two or more elements joint together by a chemical bond to form a new substance behave or look differently from the original elements

For an example;

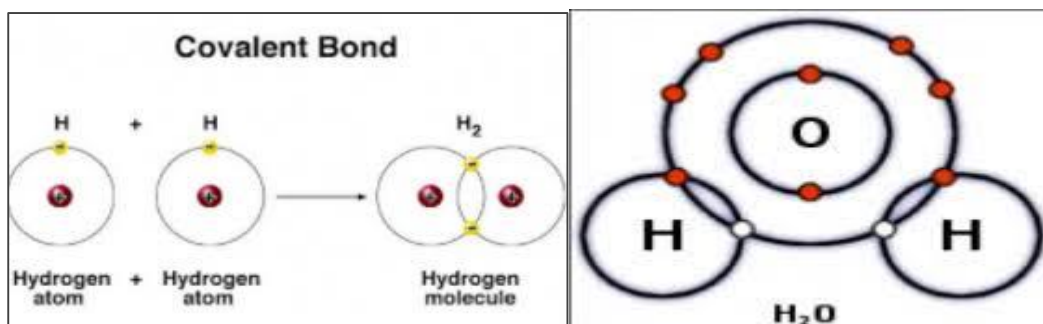
1. Think of hydrogen and oxygen, which both occur naturally as gases. Hydrogen (**H**) is highly flammable and oxygen (**O**) supports the burning process. But the occur together to form **H₂O** which is colourless, odourless, tasteless liquid called water which can be used for many purposes.
2. Think of introducing just one atom of sulphur(**S**) and three more oxygen atom to water, this will form another clear liquid, but one that behaves very different from water. This liquid is known as sulphuric acid (**H₂SO₄**) which is very dangerous to smell, touch and drink

3. Think of Sodium (**Na**) a light coloured metal and Chlorine a green poisonous gas, when chemically bonded they form a sodium chloride. This compound is safe and is used every day when we cook

Types of chemical bonding

1. Covalent bonding

Is the bond in which electrons are shared between atoms

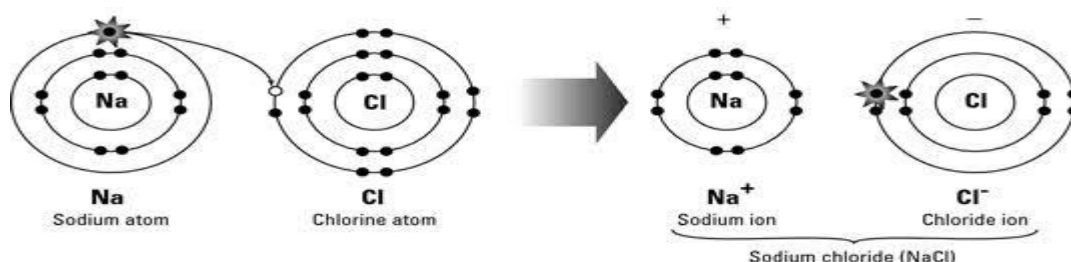


2. Ionic bonding

Is a bond that occur when a negatively charged ion (anion) and positively charged ion (cation) attract each other to forms an ionic compound. Or when an atom gains or lose an electron

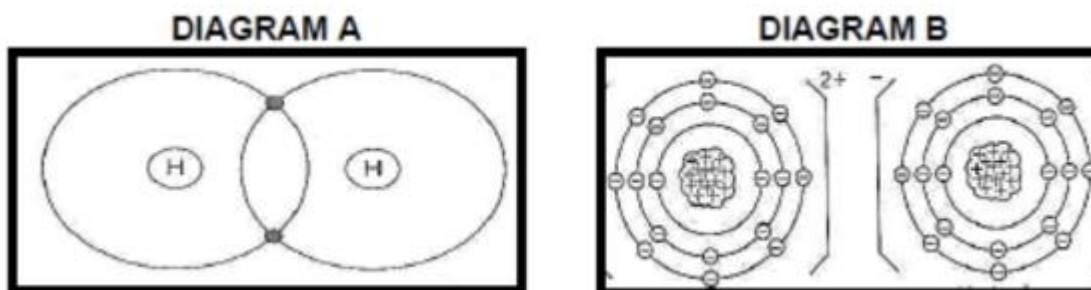
Note: many ions have 8 electrons in their valence shell that form a complete **octet** (eight).

- When sodium and chlorine atom come together the following occur;
 - The sodium atom gives up (lose) its valence electron to form an ion with a complete octet (this is called electron transfer)
 - The chlorine atom receives the electron from sodium to complete its octet and become an ion.
 - The strong attraction between positively charged sodium cation (Na^+) and negatively charged chlorine anion (Cl^-) give rise to sodium chloride NaCl (table salt)



Activity 8 (chemical bonding)

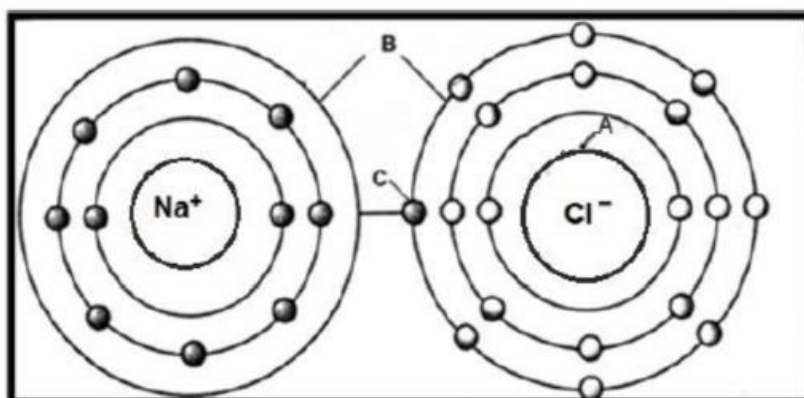
1.1 The illustration below shows the type of chemical bonding. Answer the questions based on these illustrations



- 1.1.1 Identify the type of bond shown by diagrams A and B (2)
- 1.1.2 Differentiate between the two types of bonds, A and B you have mentioned in QUESTION 1.1.2 (2)
- 1.2 analyse the following reaction and answer the questions that follows
- $$\text{HCL} + \text{KOH} \longrightarrow \text{KCL} + \text{H}_2\text{O}$$
- 1.2.1 Identify the chemical reaction illustrated above (1)
- 1.2.2 Give a reason for your answer in QUESTION 1.2.1 (1)
- 1.2.3 Give two chemical bonds that are involved in the above reaction and give one example of each (4)

Activity 9 (chemical bonding)

1.1 The diagram below illustrates atoms responsible for the formation of a compound



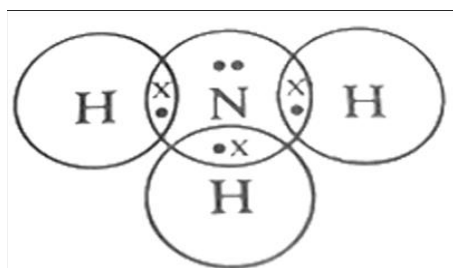
- 1.1.1 identify the compound formed by the atoms in the diagram above
- 1.1.2 indicate the health benefit of the above compound
- 1.1.3 name the parts labelled A, B and C

1.1.4 Elements in a periodic table are grouped according to similar chemical characteristics. Indicate the group to which each of the following elements illustrated in QUESTION 1.1 belong

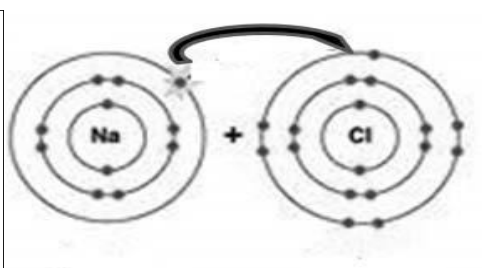
Activity 10 (chemical bonding)

1.1 The diagrams below illustrate the chemical bonding between atoms.

Bonding A



Bonding B



1.1.1 Identify the chemical bondings illustrated in **A** and **B** above. (2)

1.1.2 Give a reason for each of the bondings identified in QUESTION 2.2.1. (2)

1.1.3 Indicate the importance of compound in bonding **A** for the following:

- (a) Agricultural industry (1)
- (b) Household use (1)

6. Organic and inorganic compounds

Differences between organic and inorganic compounds

Organic compound: has both **carbon** and **hydrogen** atom together

- : made up of living organism
- : has faster chemical reaction
- : some organic compounds are highly flammable

Inorganic compound: has less **carbon** and **hydrogen** atom

- : made up of non-living organism
- : has slower chemical reaction
- : most inorganic compound does not burn

Chemical formulae

Chemical formulae show the number and type of atom found in a compound as well as the number of atoms in a molecular element

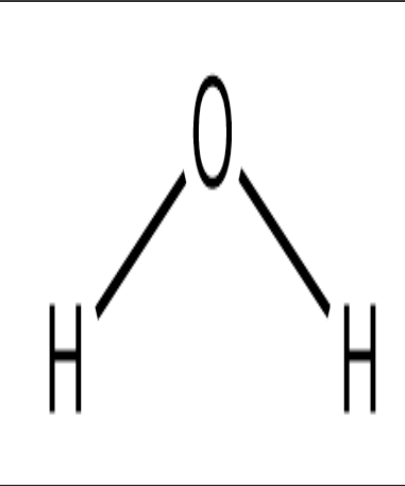
- Water: **H₂O** (has 2 hydrogen atom and 1 oxygen atom)
- Carbon dioxide: **CO₂**

- Glucose: **C₆H₁₂O₆**
- Sodium chloride: **NaCl**
- Magnesium sulphate: **MgSO₄**
- Hydrogen: **H₂**
- Oxygen: **O₂**
- Ozone: **O₃**
- Chlorine: **Cl₂**
- Sulphur: **S₈**

Structural formulae

Is the graphical representation of the molecular structure showing how atoms are arranged and how they are chemically bonded within the molecule.

Water

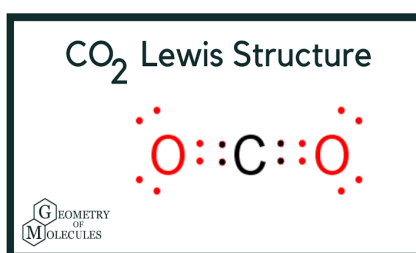
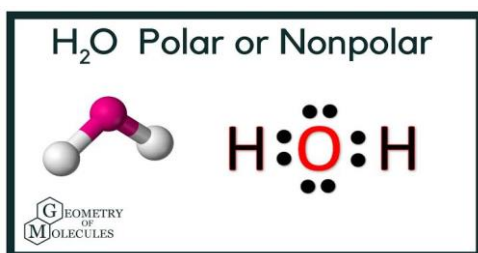
	Substance	Chemical Formula	Structural Formula
	Methane	CH ₄	<pre> H H - C - H H </pre>
	Carbon Dioxide	CO ₂	O=C=O

Lewis structure

Is a diagram that show the bonding between atoms of a molecule.

(You can also exclude the first 2 electrons in the inner shell when drawing a Lewis structure)

Is the quickest way of showing the valence electron of an atom



HYDROGEN 1 H ·	PERIODIC TABLE ELEMENTS 1–20						HELIUM 2 He ·
LITHIUM 3 Li ·	BERYLLIUM 4 Be ·	BORON 5 ·B·	CARBON 6 ·C·	NITROGEN 7 ·N·	OXYGEN 8 ·O·	FLUORINE 9 ·F·	NEON 10 ·Ne·
SODIUM 11 Na ·	MAGNESIUM 12 Mg ·	ALUMINUM 13 ·Al·	SILICON 14 ·Si·	PHOSPHORUS 15 ·P·	SULFUR 16 ·S·	CHLORINE 17 ·Cl·	ARGON 18 ·Ar·
POTASSIUM 19 K ·	CALCIUM 20 Ca ·						

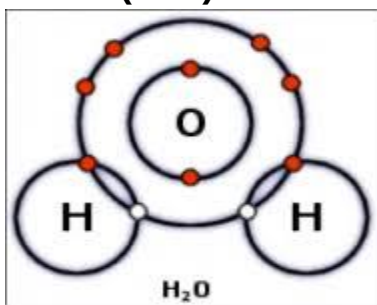
Note: The main group number for an element can be found in its column on the periodic table, for an example;

carbon is in group 4 and has 4 valence electron.

Oxygen is in group 6 and has 8 valence electron

Importance of inorganic compounds

1. Water (H₂O)

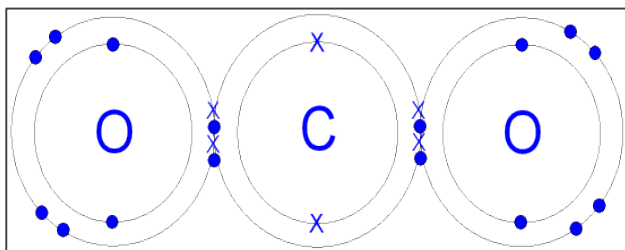


Makes up 80% of plant and animal cells

Act as a cooling agent

Medium for chemical reaction

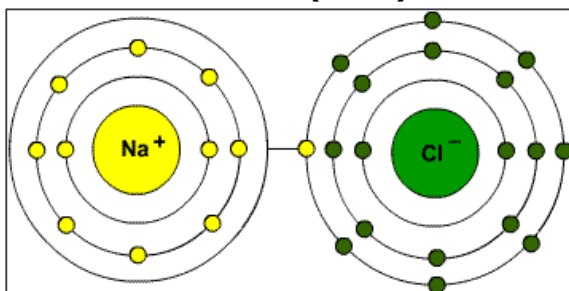
2. Carbon dioxide



Used by plants during photosynthesis

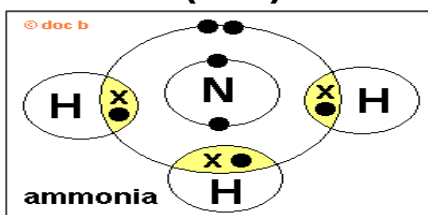
It combines with water to form carbonic acid

3. Sodium chloride (NaCl)



Used as a food preservative

4. Ammonia (NH₃)



It is an important source of nitrogen (used to produce fertilisers)

Used in household cleaning products

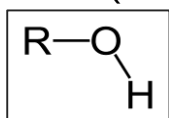
Used in medicine industry

Organic compounds

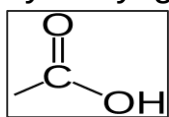
Organic compounds are classified according to their functional group they contain. For an example;

- Methanol and ethanol are both classified as alcohols since they contain **hydroxyl group** (-OH)

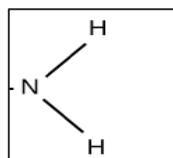
- **Hydroxyl group**: is a functional group made up of a single hydrogen and single oxygen atom (-OH) joined by single bond. (the R represent hydrocarbon radical)



- **Carboxyl group**: is a functional group made up of carbon atom joined to oxygen atom by a double bond and to a hydroxyl group by a single bond



- **Amino group:** is functional group made up of a nitrogen atom joined by a single bond to two hydrogen atoms



Alkanes and alcohols

Differences between alkanes and alcohol

Alkanes: They are made up of carbon and hydrogen atoms.

The Carbon atoms are linked to each other by a single bond

Alcohol: has hydroxyl group attached to the carbon atom

Alkanes

Basic type of alkanes, chemical formulae, structural formulae and name of alkyl group

# Carbons	Name	Structure
1	methane	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$
2	ethane	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$
3	propane	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$
4	butane	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array}$
5	pentane	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array}$
6	hexane	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \quad \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \quad \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array}$
7	heptane	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \quad \quad \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \quad \quad \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array}$
8	octane	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \quad \quad \quad \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \quad \quad \quad \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array}$

No. of C atoms	Name of alkane	Molecular formula	Name of alkyl group
1	Methane	CH ₄	Methyl
2	Ethane	C ₂ H ₆	Ethyl
3	Propane	C ₃ H ₈	Propyl
4	Butane	C ₄ H ₁₀	Butyl
5	Pentane	C ₅ H ₁₂	Pentyl
6	Hexane	C ₆ H ₁₄	Hexyl
7	Heptane	C ₇ H ₁₆	Heptyl
8	Octane	C ₈ H ₁₈	Octyl
9	Nonane	C ₉ H ₂₀	Nonyl
10	Decane	C ₁₀ H ₂₂	Decyl

1. Methane

- is the simplest alkane and main component of natural gas
- it has a single carbon atom
- if you burn methane in the presence of oxygen carbon dioxide and water is produced
- it can be used as a fuel

2. Ethane

- Is a colourless, odourless gas
- It has two carbon atoms
- Can be used as a by-product in oil refining

3. Propane

- It has three carbon atoms
- It is commonly used as a fuel for engines

4. Butane

- Is an alkane with four carbon atoms
- It is highly flammable
- It is used as a lighter fuel for bottle gas or aerosol sprays

Alcohols

The general formulae of alcohol are $R-OH$ (The "R" represents hydrocarbon radical attached to hydroxyl group).

They are named according to the radical in which the hydroxyl group ($-OH$) is attached. For an example;

- If the $-OH$ is attached to the methyl radical CH_3 the compound will be CH_3OH , then we will have methyl alcohol known as **methanol**
- If the $-OH$ is attached to the ethyl radical C_2H_5 the compound will be C_2H_5OH ethyl alcohol known as ethanol

Basic types of alcohol

1. Methanol

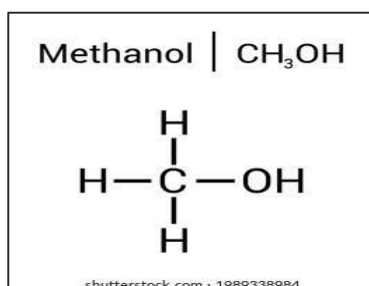
Is the simplest alcohol

It is volatile (it change into vapour easily)

Is a clean energy resource used to fuel cars and cook stoves and found in Methylated Spirit

Can be used as an antifreeze

Chemical formulae: **CH_3OH**



2. Ethanol

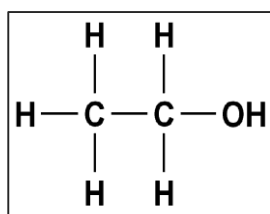
Is pure drinking alcohol

It is volatile (it can change into vapour easily)

Molecular formulae: **C_2H_5OH**

It is flammable

Found in most **alcoholic drinks, perfumes, thermometer and medicine**



Activity 11 alkanes and alcohols

1.1 the table below show a basic groups of organic compounds, structural formula as well as molecular formula

Name of a compound	Functional group	Structural formula	Molecular formula
A (1)	Hydrocarbon	<pre> H- H- H H-C-C-C-H H-H-H </pre>	B (1)
Ethanol	C (1)	D (2)	C ₂ H ₅ OH

1.1.1 complete the table by providing labels A to D

1.2 The products below are displayed in a retail shop. Carefully analyse the products and answer questions that follow

1.2.1 indicate the functional group of product A and B (1)

1.2.2 give the scientific name of both product A and B (2)

1.2.3 Identify the product (A or B) which is ideal to be used for heating

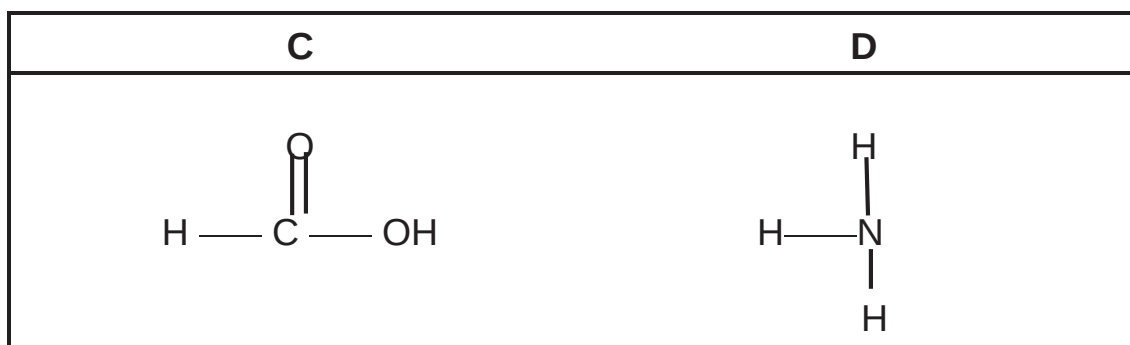
1.2.4 Write the structural formula of product B

1.2.5 Product A can be oxidised to form another product. Give the scientific name of the product

Activity 12 (alkanes and alcohol)

1.1 Analyse the structural formula of compounds below and then answer questions that follow:

A	B
<pre> H H H-C---C-OH H H </pre>	<pre> H H H-C---C-H H H </pre>



1.1.1 Indicate the functional group of each of the compounds labelled:

(a) **A** (1)

(b) **C** (1)

1.1.2 Write down the chemical formula of the compound labelled **C**. (2)

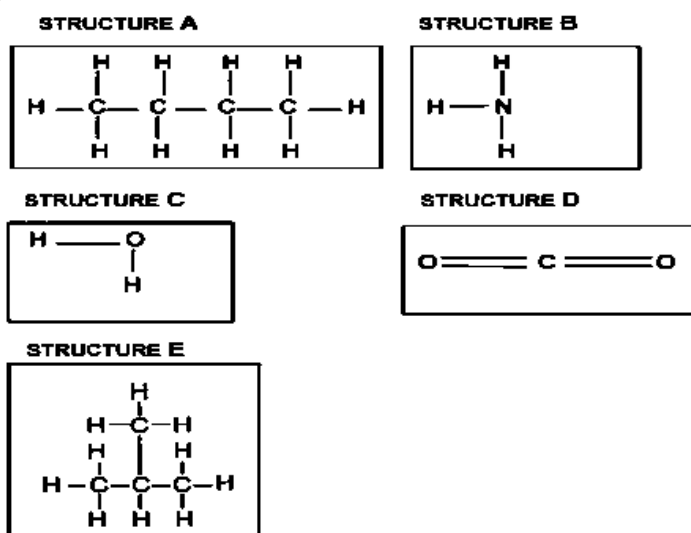
1.1.3 The compound labelled **B** plays a protective role in plants. Justify this statement by explaining THREE roles. (3)

1.1.4 Draw the Lewis structure of the compound labelled **D** showing a covalent link between the atoms. (4)

1.1.5 Compare compound **A** and **B** on the basis of their structural formulae. (2)

Activity 13 (alcohols and alkanes)

1.1 The diagrams below show the structural formula of different compounds.



1.1.1 Classify the compounds represented by structures **A** and **B** into two categories

1.1.2 Give a reason for your answer in QUESTION 2.1.1 based on their structures.

1.1.3 The structures labelled **A** and **E** have the same molecular formula but different structures. Give the name of such compounds. (1)

1.1.4 Write the chemical formula of the compound represented by structure **A** (2)

1.1.5 Identify the letter of the compound responsible for the following:

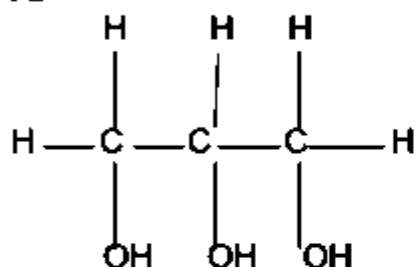
- (a) Catalyst in many chemical reactions
- (b) Used as a cleaning product (2)

Activity 14 (alcohol and alkanes)

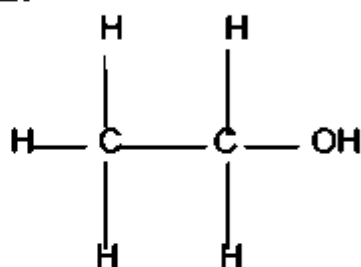
1.1

Organic compounds are very important in our daily lives. They are in the food we eat and clothes we wear. The chemical properties of organic compounds is determined by their functional group. The structural formulas below are the compounds playing a role in our lives.

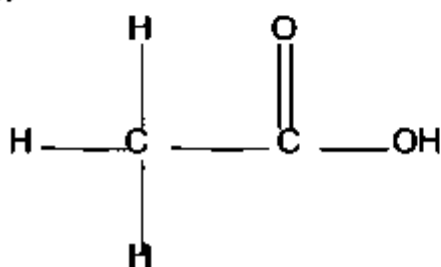
A.



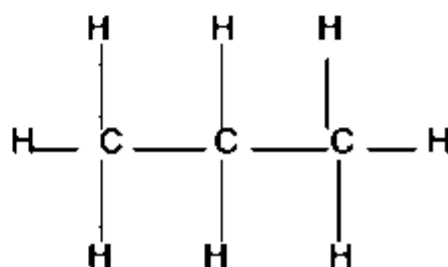
B.



C.



D.



1.1.1 indicate the letter of a compound that matches each of the following descriptions:

- (a) Formed by fermentation process
- (b) It is also known as acetic
- (c) It is formed when the structure represented by letter B reacts with structure C
- (d) Can be used for heating in rural homes with no electricity

1.1.2 Explain the impact of a compound labelled D on the environment

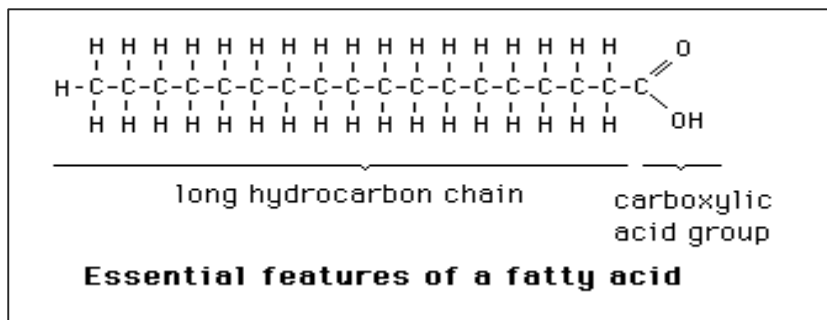
1.1.3 Describe the benefits of using a compound labelled C as a source of energy for cars instead of petrol

1.1.4 Indicate the functional group of compounds labelled B and C

7. FATTY ACIDS AND BIOMOLECULES

Is an organic acid characterised by presence of **carboxyl group** with a long hydrocarbon chain making up a tail

Fatty acids have a chain of an even number of carbon atoms, from 4 to 28



Saturated and unsaturated fatty acids

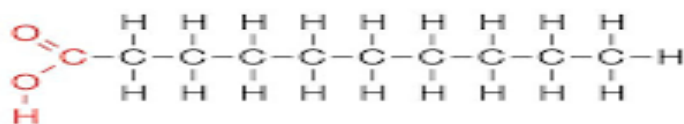
1. Saturated fats

- found mainly in animal products (such as milk, cream, butter, cheese and meat)
- Has a single bond between carbon atoms
- They are solid at room temperature

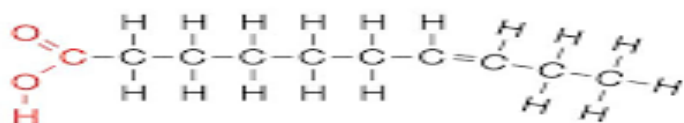
2. Unsaturated fats

- Found mainly in plant products (such as sunflower oil, olive oil, peanut)
- Has one or more double bond between carbon atom
- They are liquid at room temperature

Saturated



Unsaturated



BIOMOLECULES

1. Fats and Oil (lipids)

The monomer of lipids are 3 fatty acids and glycerol joint together by an **Esther bond**

Differences between fats and oil

Fats: they are solid at room temperature

Oil: they are liquid at room temperature

Functions of lipids

- Reserve source of energy
- Act as an insulation material
- Act as a shock absorber
- Important part of membrane of living cells

2. **Proteins**

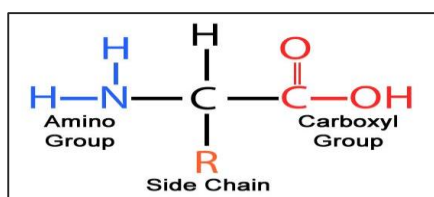
This are large molecule built from small units called **amino acids**
(monomer of proteins are amino acids)

The amino acids are joined together by a peptide bond

20 natural amino acids make up a protein.

They have nitrogen in their structure

Functional group of amino acid: **amino group** (NH₂) and **carboxyl group**



Essential and non-essential amino acids

Essential amino acid: found from eating protein rich food

Non-essential protein: proteins that are produced by the body

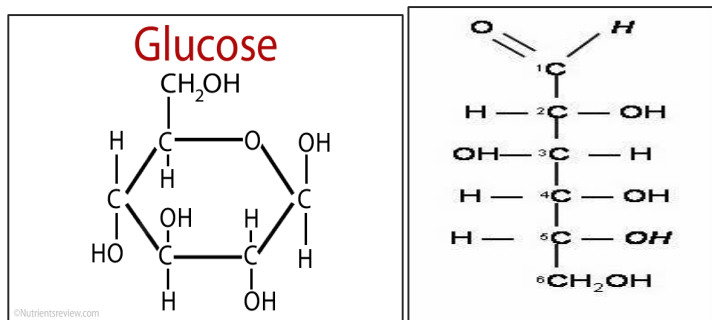
Functions of proteins

- Responsible for growth
- Repair worn out tissues

- Formation of hormones and enzyme

3. Carbohydrates

- Built by small units of monomers called **glucose**
- Glucose is joint together by a **glycosidic bond**
- They are commonly found in plants and plant products
- It includes starch and sugars
- They are organic compounds formed of **carbon** and **hydroxyl groups**
- They form cellulose in plants and cartilage in animals



Classification of carbohydrates

Two Monosaccharides are joints together by a glycosidic bond form a disaccharide.

Three common disaccharide are:

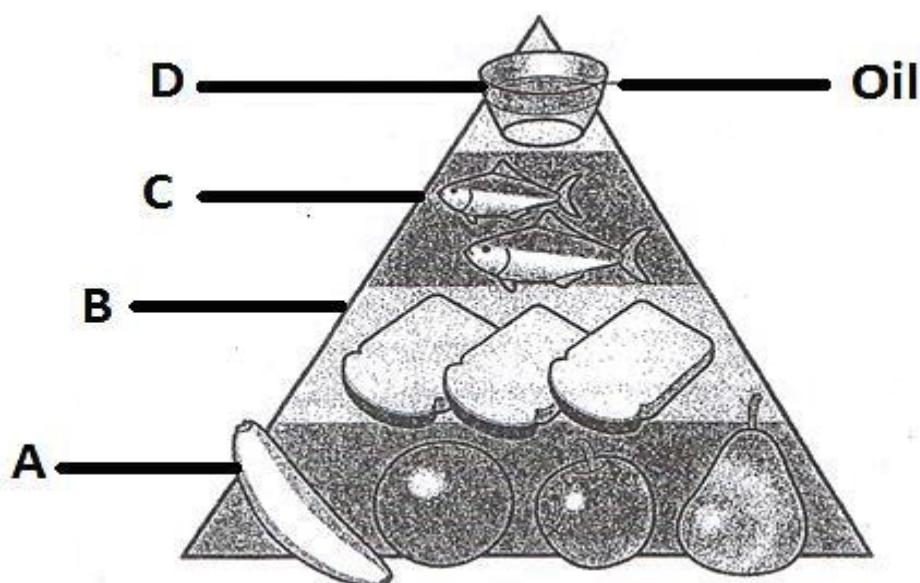
- Sucrose (table sugar) = formed by, glucose + fructose
- Lactose (sugar in milk) = formed by glucose + galactose
- Maltose (product of starch digestion) = glucose + glucose

Functions of carbohydrates

- Store energy
- Main source of energy
- Needed for fattening
- Work as flavour sweetener in human diet

Activity 15 (fatty acids and biomolecule)

1.1 The pyramid below shows the feed components and their quantities that are included in a ration prepared for animals:



1.1.1 Name the organic compound in A and C. (2)

1.1.2 Indicate the building block of the compound in C and D. (2)

1.1.3 The compound in C can be simple or complex. Provide a distinction between the two. (2)

1.1.4 State TWO reasons why the compound labelled B is important. (2)

1.1.5 Indicate whether the compound in D is saturated or unsaturated. (1)

1.1.6 Support with a reason the answer in QUESTION 1.1.5. (1)

1.2 Fats and oils are collectively referred to as lipids.

1.2.1 Tabulate TWO differences between fats and oils. (4)

Activity 16 (Fatty acids and biomolecules)

1.1 The structures below show the bonding of carbon atoms in fatty acids:

FATTY ACID A



FATTY ACID B



1.1.1 Identify the type of fatty acid labelled **A** and **B**. (2)

1.1.2 Indicate the letter representing the fatty acid that matches each of the descriptions below:

- | | |
|-------------------------------|-----|
| (a) Originates from plants | (1) |
| (b) Solid at room temperature | (1) |
| (c) Has a high melting point | (1) |

- (d) Liquid at room temperature (1)
 1.1.3 Name TWO reasons why fats are important in living organisms. (2)

Activity 17 (fatty acids biomolecules)

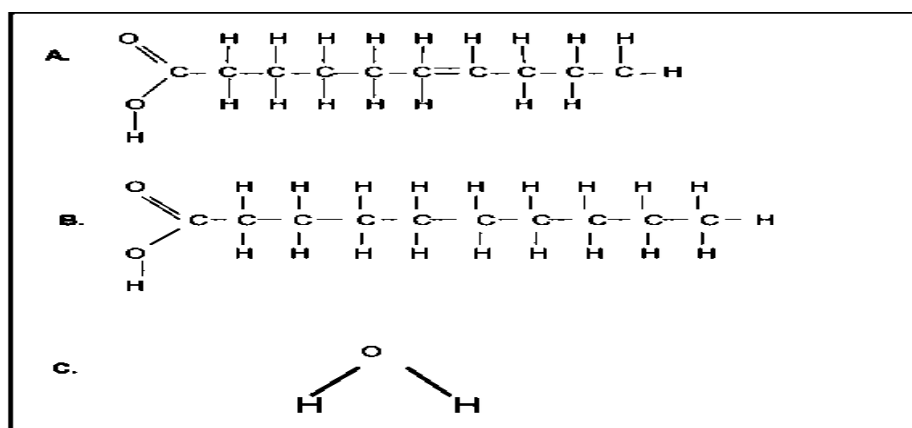
- 1.1 The table below shows the fat content of different nutritional values of fats. Analyse analyse it and answer the question that follow.

Nutritional value per 100g	Olive oil (g)	Sunflower (g)	Hard margarine (g)	Butter (g)
Total fat	98	91.6	80	81
Saturated fat	14	12.0	42	51
Unsaturated fats	73	17.0	28	20
polyunsaturated	11	59.0	10	03

- 1.1.1 Draw a bar graph to compare the amount of saturated, unsaturated and the polyunsaturated fat in lipids that are analysed in the above table (6)
 1.1.2 Distinguish between saturated and unsaturated fats (2)
 1.1.3 Mention any TWO functions of lipids in living organism (2)

Activity 18 (fatty acids and biomolecule)

- 1.1



- 1.1.1 classify the compounds labelled A and C
 1.1.2 Indicate the name of the fatty acids labelled A and B
 1.1.3 Write only the letter representing a fatty acid to which each of the following statement applies:
 (a) is of animal origin

(b) It is of plant origin

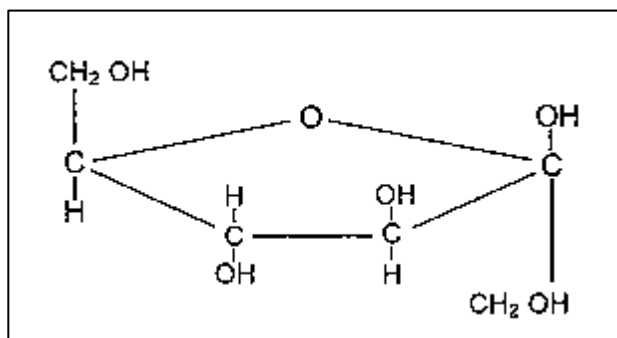
1.1.4 The compound labelled C plays an important role in agriculture.

Justify this statement with TWO important roles of this compound

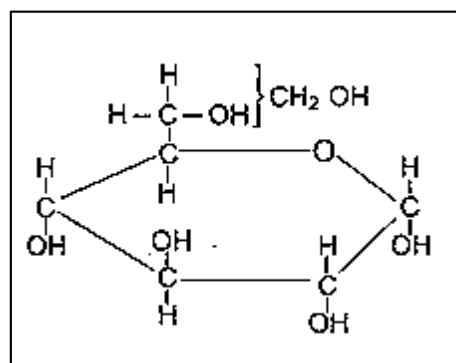
Activity 19 (biomolecule)

1.1 The structural formula below represents monosaccharides.

STRUCTURE A



STRUCTURE B



1.1.1 Name structure **A** and structure **B**. (2)

1.1.2 Indicate the compound formed when structure **A** and **B** are joined together. (1)

1.1.3 Give TWO elements that are the basic composition of all carbohydrates. (2)

1.2

Carbohydrates are organic molecule which acts as energy suppliers in the food of animal. Some carbohydrates are very large and complex while others are simple

Indicate the example of monosaccharaide or disaccharide or polysaccharide supplied by each of the following food and plant source:

1.2.1 Fruits

1.2.2 milk

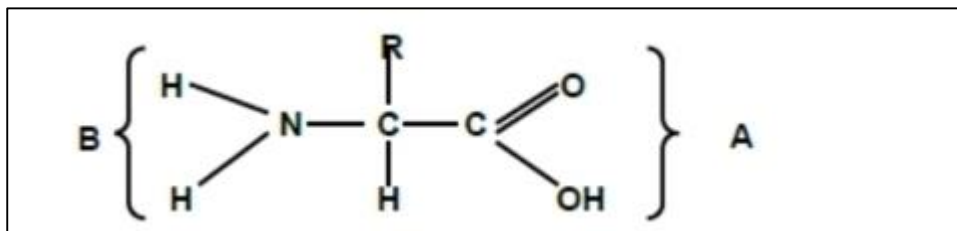
1.2.3 cane sugar

1.2.4 wood

1.2.5 plant cell

Activity 20 (biomolecule)

1.1. Analyse the structure below and answer the questions based on it



1.1.1 identify the structure above

1.1.2 indicate the letter (A or B) that gives the structure in QUESTION 1.1.1 the following:

- (a) basic property
- (b) Acidic property

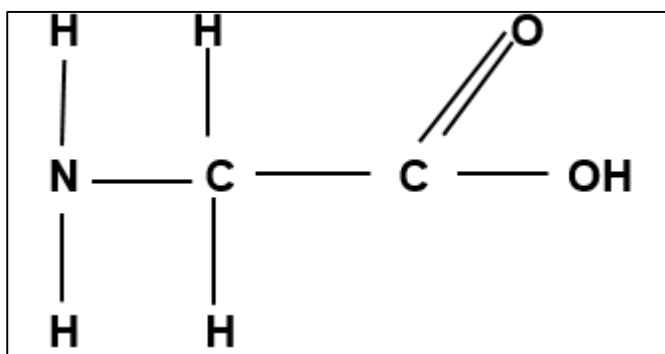
1.1.3 two or more of the structures mentioned in QUESTION 1.1.1 above, can be joined together to form a polymer. Provide the name of this reaction

1.1.4 The polymer formed from joining two or more of the structure above plays a vital role in the body of animal. Justify this statement with THREE reason.

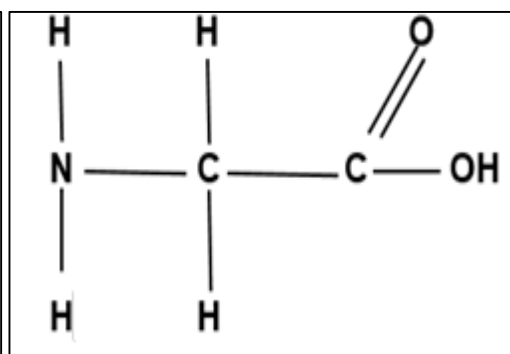
Activity 21 Biomolecules

1.1 The structures below are small units which when joined together form a very complex organic compound.

Structure A



Structure B



2.3.1 Give the name of the structures illustrated above. (1)

2.3.2 Name the bond that links structures **A** and **B**. (1)

2.3.3 When structure **A** joins structure **B** a water molecule is removed. Give the name of this reaction. (1)

2.3.4 Identify TWO groups that make up both structures **A** and **B**. (2)

2.3.5 A large number of the structures illustrated in QUESTION 2.3 can be joined together to form a complex organic compound.

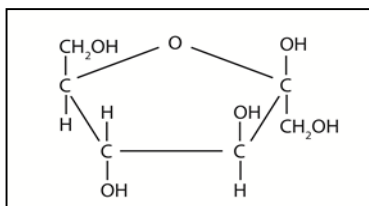
Name the compound. (2)

2.3.6 Name THREE reasons why the compound in QUESTION 2.3.5 is important for living organisms. (3)

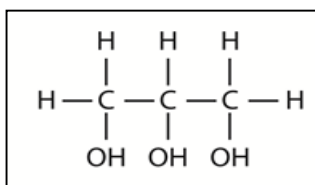
Activity 22 (Biomolecule)

1.1 The following structural formulae represent organic compounds. Study them and answer the questions that follow:

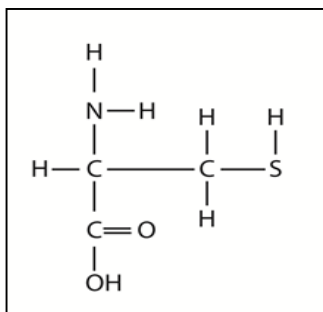
A



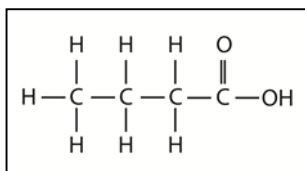
B



C



D



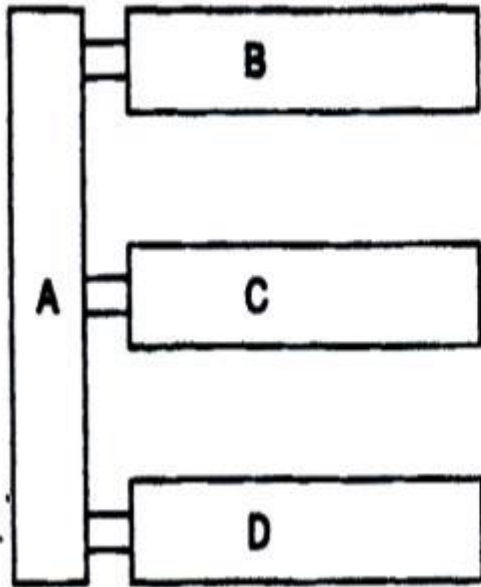
1.1.1 Identify compounds A–D. (4)

1.1.2 Identify which of the structural formulae is a monomer of carbohydrates. (1)

1.1.3 Name the functional groups of the structural formulae B, C and D. (3)

Activity 23 (biomolecule)

1.1 The diagram below represents a bio-molecule



- 1.1.1 Identify the molecule (1)
- 1.1.2 Name the element found in the molecule (2)
- 1.1.3 Name type of the molecule represented by A and B respectively (2)
- 1.1.4 Compare the structures of the types of molecules represented by A and B (2)
- 1.1.5 Name the type of bond that join structure A with B,C and D
- 1.1.5 Name TWO functions of fats. (2)

TOPIC 2: SOIL SCIENCE

1. Soil texture

Relative size of particles in a given soil (i.e Clay particles are small, while sand particles are large)

Different soil particles size according to diameter

Clay: less than 0,002mm

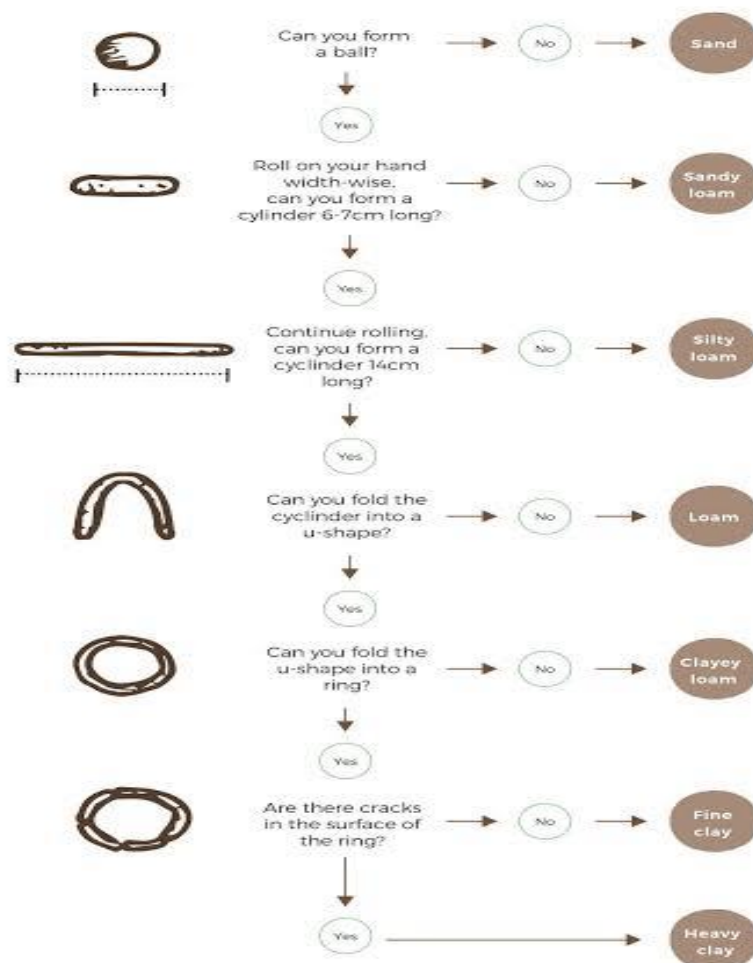
Silt :0,002-0,05mm

Sand 0,05- 2mm

Field Methods of determining soil texture

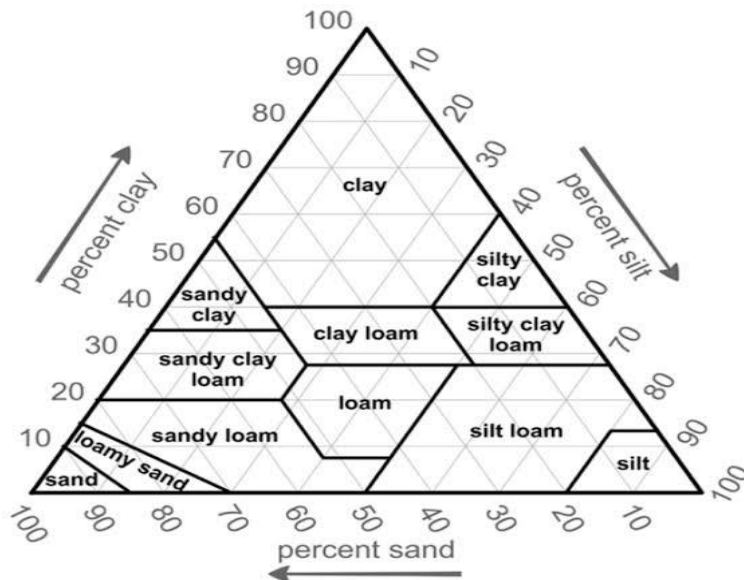
Feeling method

Sausage method



Soil texture triangle and determining soil textural classes

To identify a soil that is 40% sand, 25% clay and 35% silt, you need to find 25 on the side for the clay and draw a line the direction of the arrow. Do the same with sand and silt. In this case the descriptive classification of soil is loam



Activity 24 (Soil texture

1.1

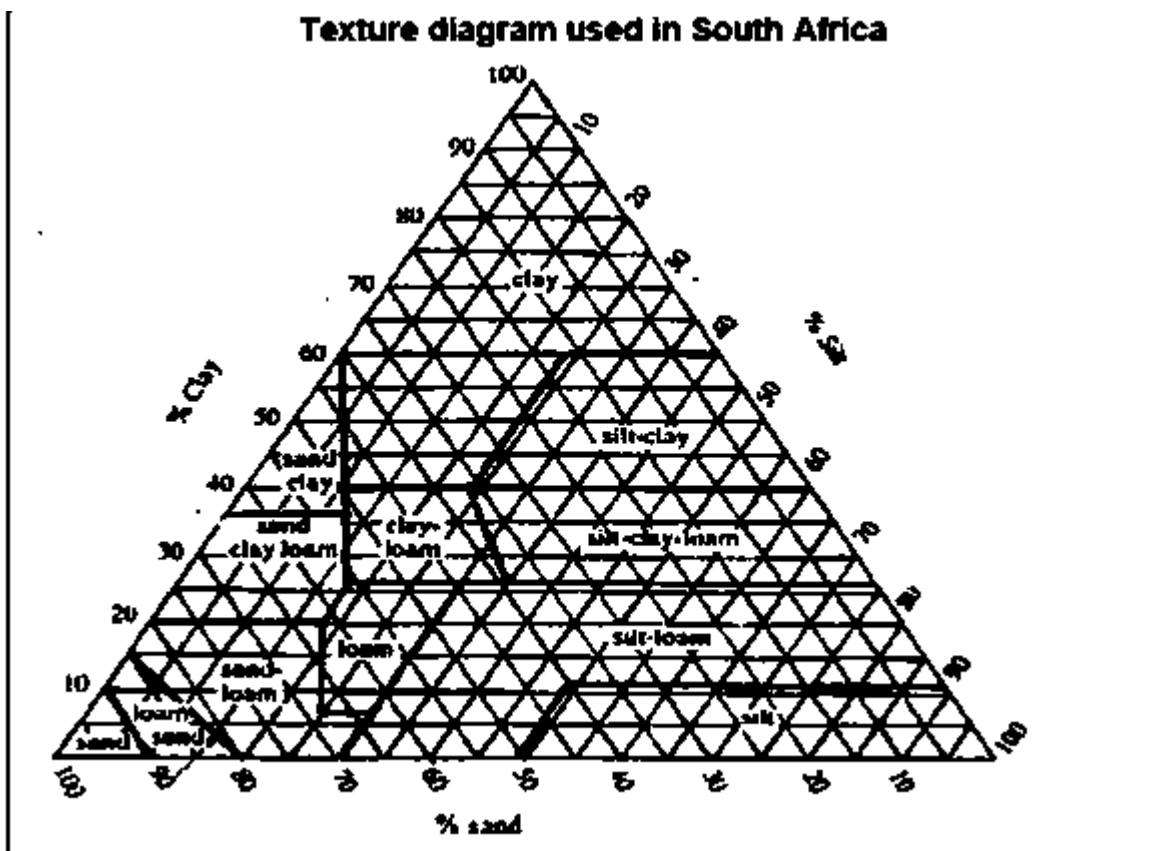
The sieve method is one of the important methods to determine the soil texture. Before sieving, the soil sample is weighed and placed in the top sieve. The entire set of sieves vibrates automatically, or can be shaken by hand. Soil samples should be crushed to break the peds before sieving. The soil sample is usually dried and any organic matter is burned off or removed. Thereafter the individual weights are calculated as a percentage of the total weights. In an experiment 3 800g of soil mass was taken to determine the weights of different sizes which are as follows, 1700g of sand, 1200g of clay and 900g of silt.

- 1.1.1 calculate the percentage of sand in the soil sample (3)
- 1.1.2 apart from sieve method, mention other TWO methods that are used in determining soil texture (1)
- 1.1.3 why should the farmer know the textural class of his/her soil? (2)

Activity 25 (soil texture)

1.1

When soil is to be allocated to a particular texture class, analysis is done in a laboratory where particles sizes are expressed as a percentage in respect of other particles. Knowledge of the texture class influences the decisions farmers make about farming and also assist traditional people to make pots which they use to serve traditional beer during certain ceremony



1.1.1 analyse the texture diagram above and determine the texture class of the following soil sample:

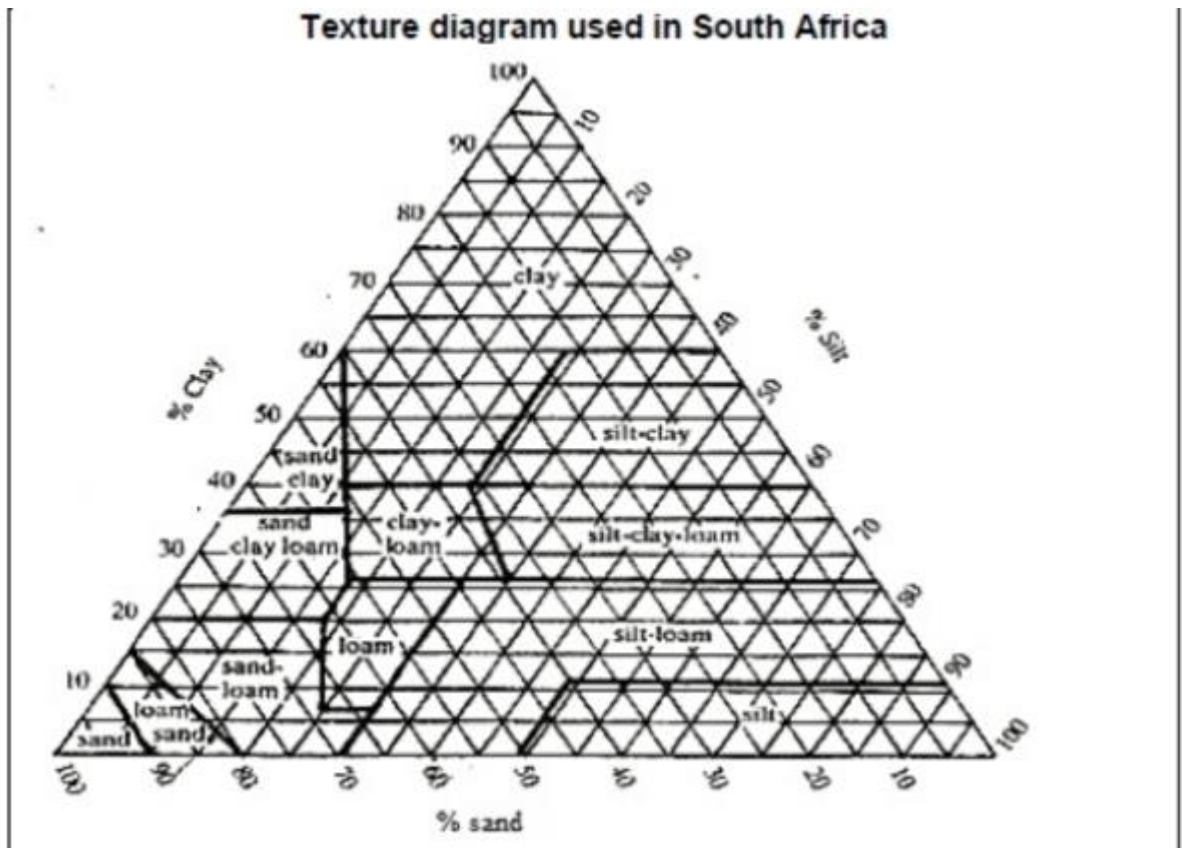
- A. 50% sand, 20% clay, 25% silt
- B. 40% sand, 50% clay, 10% silt
- C. 94% sand, 3% clay, 2% silt

1.1.2 indicate the sample (A, B and C) to which each of the following characteristics applies.

- (a) Suitable for pottery work in rural communities
- (b) Most suitable for cultivation

Activity 26 (soil texture)

- 1.1 soil texture is the proportion of sand, silt and clay in a given soil sample. Below is a texture diagram used to identify soil texture classes, on the basis of particle size analysis



- 1.1.1 use the texture diagram above to determine the percentage of sand and clay in the following texture classes:
- clay loam (2)
 - Silt loam (2)
- 1.1.2 The texture class with 20% sand, 20% silt and 60% clay has an influence on soil characteristic. Substantiate this statement by explaining how this texture influences the following:
- Tillability of the soil (2)
 - Drainage of the soil (2)
- 1.1.3 indicate the texture from the texture triangle that is ideal for crop cultivation

Activity 27 (Soil texture)

1.1 Different texture classes can be known through determining the quantity of clay, silt and sand in a given soil sample. Indicate the method of determining texture through the following:

1.1.1 Diagram showing the percentage of clay, silt and sand of a given sample. (1)

1.1.2 Allowing light to pass through a dispersion of particles. (1)

1.1.3 Soil sample is released into water and the size of particles reaching the bottom is determined. (1)

1.2 Explain the influence of clay and sand on the following soil characteristics:

1.2.1 Chemical reactivity (2)

1.2.2 Fertility (2)

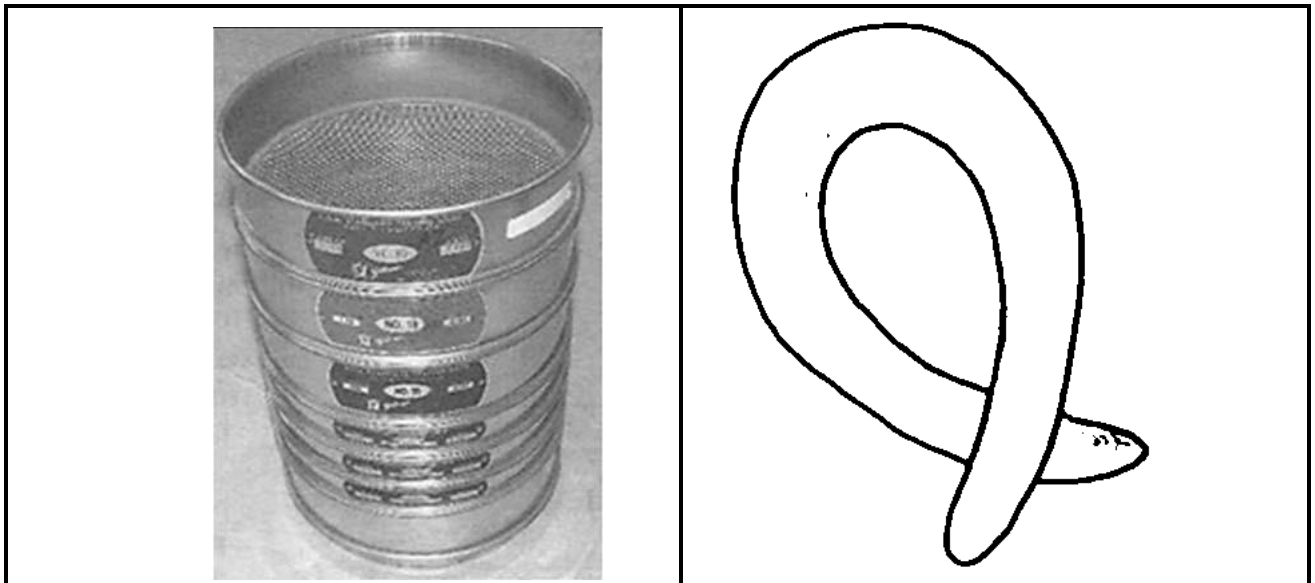
1.2.3 Erodability (2)

Activity 28 Soil texture

1.1 The diagrams below show different methods that can be used by a farmer to determine the texture of the soil.

DIAGRAM A

DIAGRAM B



1.1.1 Identify the methods of determining the texture as illustrated in

Diagrams **A** and **B**.

(2)

1.1.2 Predict the texture that will remain on top of the sieve if the method in Diagram **A** is used.

(1)

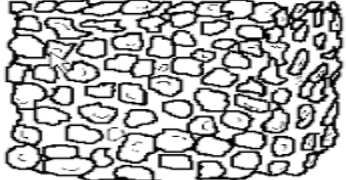
1.1.3 Suggest the texture illustrated in Diagram **B**.

(1)

2. Soil structure

It describes the combination of particle to form aggregates

Classification of different soil structures

		
Granular: Resembles cookie crumbs and is usually less than 0.5 cm in diameter. Commonly found in surface horizons where roots have been growing.	Blocky: Irregular blocks that are usually 1.5 - 5.0 cm in diameter.	Prismatic: Vertical columns of soil that might be a number of cm long. Usually found in lower horizons.
		
Columnar: Vertical columns of soil that have a salt "cap" at the top. Found in soils of arid climates.	Platy: Thin, flat plates of soil that lie horizontally. Usually found in compacted soil.	Single Grained: Soil is broken into individual particles that do not stick together. Always accompanies a loose consistence. Commonly found in sandy soils.

Factors influencing the development of soil structure

- **Soil texture**
 - sandy soil has little or no structure (because particles do not bind easily)
 - clay soil displays good structure
- Organic matter content
- Soil water content
- Micro-organism

Factors causing soil structure to decline

- Over grazing
- Movement of animals or farming equipment on wet soil
- Cultivating when soil is too wet or too dry
- Over irrigation
- Mono-cropping

Methods to improve poor soil structure

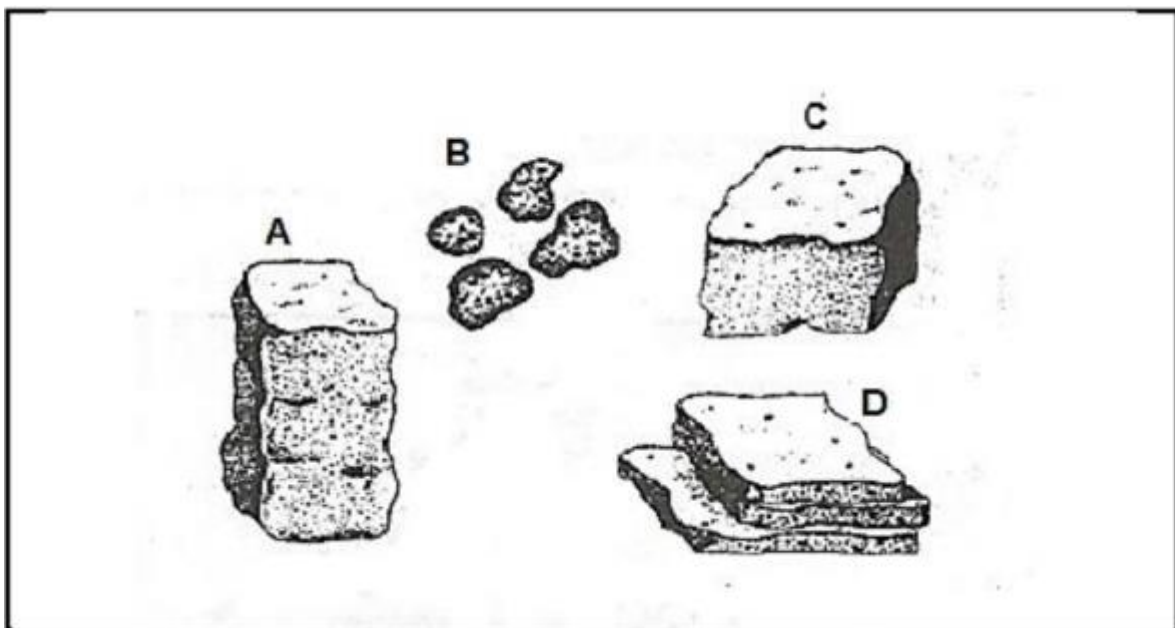
- Practice crop rotation
- Add gypsum
- Avoid cultivation and tillage when soil is too wet or too dry
- Prevent soil erosion

Advantages of good soil structure

- Prevent soil crusting
- Prevent soil erosion
- Prevent soil compaction (compacted soil lose their pore spaces so they cannot hold water and air)
- Has nutrient balance

Activity 29 (soil structure)

1.1 soil particles are grouped together to form aggregates or peds. These peds are classified on the basis of shape. The diagram below show different structures based on shape.



1.1.1 indicate the structure A and D

1.1.2 Indicate the letter representing a structure to which each of the following statement applies:

(a) It is found in compacted soil

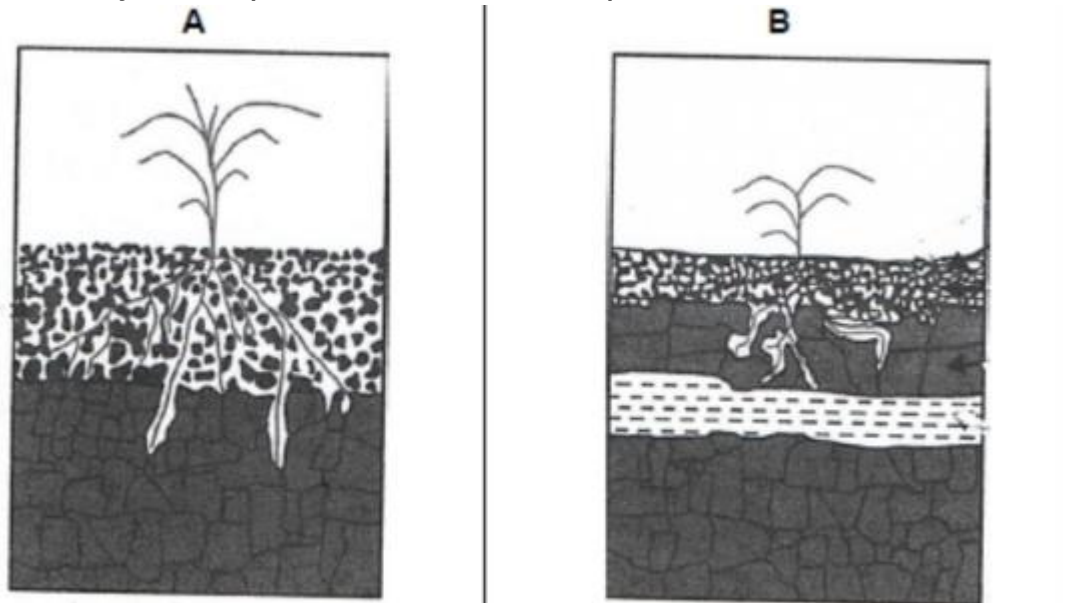
(b) Develops in soils of arid climate

1.1.3 indicate a letter of a structure you would recommend to the farmer for crop production

1.1.4 give THREE reason for recommendation in QUESTION 1.1.3

Activity 30 (Soil structure)

1.1 the pictures below show soil with good structure and compacted soil. Analyse the pictures and answer questions



1.1.1 identify the soil (A or B) that is compacted soil from the pictures

1.1.2 justify your answer in QUESTION 1.1.1 by indicating TWO visible signs

1.1.3 provide TWO traditional methods in which the compaction can be improved

1.1.4 Mention THREE advantages of soil with a good structure like A

Activity 31(Soil structure)

1.1 the table below shows the physical characteristics of soil on two wheat farms

Physical soil characteristics	Farm A	Farm B
Structure	Crumb	Blocky
Soil fraction (mm)	2, 00 - 0, 50	Less than 0,002
Depth (mm)	950	450
Colour	light	Grey

1.1.1 indicate the farm which was likely to be easily saturated with water

1.1.2 give TWO reasons for the answer in QUESTION 1.1.1

1.1.3 Deduce the farm which is likely to have a higher wheat yield

1.1.4 Justify by explaining TWO characteristics on the table that can result in higher yield

3. Soil colour

Colour in soil gives an indication of soil condition. When used with other soil characteristics, soil colour can be useful in determining how that soil formed.

Homogeneous and nonhomogeneous soil colour

Differences between homogeneous and non-homogeneous soil colour

Homogenous: soil sample display a single and uniform colour

For an example in a region when iron oxide occurs on sand, a homogenous red colour may be spotted

Non-homogenous: occur when there's mixture of colours. (the colour might appear homogeneous from a distance, but appear different when closely analyse. For an example; a mottled soil has a mixture of yellow and orange-brown colours with some grey spots.) mottling are easy to be seen when the soil is wet and fade away when dry.

Soil colours and their characteristics

➤ **Dark or black soil**

Indicates presence of organic matter

It is usually very fertile

Well drained soil

➤ **Light soil or whitish soil**

Presence of salt

Result of server leaching

Less organic matter

➤ **Red soil**

Indicated presence of iron oxide

Presence of less water and enough oxygen

Well drained soil

➤ **Grey soil**

Less iron oxide (less oxidation)

Results of waterlogging

Poor drainage

Factors determining soil colour

- Presence of water
- Organic matter content of soil
- Soil aeration
- Drainage
- Water holding capacity

Activity 32 soil colour

1.1 soil colour has a great influence on the fertility and productivity of soil

1.1.1 Compare TWO interpretation of dark coloured soil and light coloured soil on crop productivity (4)

1.2 Soil colour is a useful indicator of some physical and chemical properties that occur beneath the surface. Compare red and grey coloured soils with regard to the following:

1.2.1 Air (2)

1.2.2 Moisture (2)

1.3

The colour of soil can give much information to the farmer or sell to the soil scientist provided it is interpreted correctly

Indicate the colour of soil that is likely to occur under the following climatic conditions

1.3.1 cool temperate regions (1)

1.3.2 humid region (1)

1.3.3 dry condition (1)

Activity 33 Soil colour

1.1. Soil colour is a useful indicator of some properties of soil. Different soil colours exist as a results of certain soil conditions

Indicate the cause of the following soil colours:

1.1.1 Black (1)

1.1.2 Red (1)

1.1.3 Grey (1)

1.2 characteristics and conditions of the soil.

1.2.1 Distinguish between homogeneous and non-homogeneous soil colour. (2)

1.2.2 Name TWO factors that determine the colour of soil. (2)

4. Soil pores

Pore space and porosity

Total pore spaces: is the volume of soil that is occupied by air and water

- Pore spaces allow water to move through the soil.
- Pore spaces determine the amount of water a soil can hold.

Clay soil can hold more water than sandy soil (clay soil has low permeability)

Water drains for fast in sandy soil that in clay soil

Differences between macro pores and micro pores

Macro-pores

- This are large pores that has bigger diameter.
- They drain freely under the influence of gravity
- It allows easy movement of water and air

Importance of macro-pores

- They influence water air exchange
- Stimulate plant roots penetration
- Provide habitat for microorganism

Micro-pores

- This are small pores that has small diameter
- Water will remain in this pores (unless suction forces occur)
- Has high water retention capacity

Bulk density

Is the mass per unit volume of soil

Calculating bulk density

750g of soil occupies a space of 500cm³. Calculate the bulk density of this soil

$$\begin{aligned}\text{Bulk density/BD} &= \frac{\text{Mass of dry soil (g)}}{\text{Volume of dry soil (cm}_3\text{)}} \\ &= \frac{750\text{g}}{500\text{cm}^3} \\ &= 1,5\text{g/cm}_3\end{aligned}$$

➤ **Low bulk density**

Indicates well drained Suitable for cultivation

➤ **High bulk density**

Indicates compacted soil not suitable for cultivation

Factors influencing bulk density of soil

- Size of particle (soil texture)
- Degree of compaction
- Amount of organic matter

Activity 34 (Soil pores and bulk density)

1.1 bulk density is the mass per unit volume of any substance. The sample of oven dried soil has a mass of 560 g and 75cm³ of volume

1.1.1 use the information above to calculate the bulk density of the soil sample (4)

1.1.2 supply ONE factor that influence bulk density of soil (1)

1.2

Pore space of soil is important because soil pores are filled with water and gases which are important for plant growth. The percentage of the total pore space is determined by various factors

1.2.1 Describe the influence of the following factors on the total pore space

- (a) Soil depth (1)
- (b) Soil cultivation (1)

1.2.2 Name TWO other factors that may have an influence on the total pore space (2)

Activity 34 (Pore space and bulk density)

1.1 the table below shows the mass, volume, bulk density and percentage pore space of different soil sample.

Soil Sample	Mass (g)	Volume (cm ³)	Bulk density (g/cm ³)	Pore space (%)
A	450	600	0,75	62,7
B	620	550	1,13	56,2
C	880	500		52,5
D	680	80	8,5	30,8

1.1.1 Use the information in the table to draw a bar graph showing the mass and the volume of soil sample (6)

1.1.2 Identify the soil that has not been disturbed by heavy implements (1)

1.1.3 Deduce TWO reason from the data in the table above for your answer in QUESTION 1.1.2 (2)

1.1.4 Calculate the bulk density of soil sample C (4)

5. Soil air

Soil air makes up the volume of soil (pores) not occupied by liquids

Soil air differ from atmospheric air (soil air has more water vapour and lower oxygen concentration than atmospheric air)

- All living organism need to get access to air to survive
- In the soil, living organism must also get access to oxygen to survive
- Aquatic organism must extract oxygen for them to survive

Factors influencing the movement of soil air

Soil depth

- Oxygen concentration **decrease** with depth, due to slow movement from the atmosphere down through the soil.

Pore size

- Soil with large pores make it easier for CO₂ to escape from the soil to the atmosphere and O₂ to diffuse into the soil from the atmosphere.

Aeration

- Soil with large pore generally has good aeration than soil with poor aeration

Drainage

- Soil with large pore (sandy) has good drainage (water moves freely in the soil) than soil with small pore (clay) with poor drainage (water is retained)

Comparison between atmospheric air and soil air

	%	%	%
	Nitrogen	oxygen	Carbon dioxide
Soil air	79.2	20.6	0.3
Atmospheric air	79	20.9	0.03

From the table above you can note that;

- In the soil air, Oxygen is replaced by carbon dioxide and at the same time used by the roots and soil micro-organism during respiration. That's why the concentration of oxygen is relatively low
- In the soil air, carbon dioxide is released by soil micro-organism and roots. That's why the concentration of carbon dioxide is fairly high in the soil air.

Factors affecting the composition of soil air

Temperature

- High temperature stimulates soil micro-organism activity which result in increased concentration of carbon dioxide

Microbial activity

- Micro-organism require oxygen from the soil air for respiration, this lowers the concentration of oxygen in the soil

Type of crop

- Soil in which crops are grown contain more carbon dioxide than bare soil (CO₂ concentration is greater near the roots of the plant than further away)

Plant roots

- Plant roots require oxygen, so they take it from the soil air. This lower the concentration of oxygen in the soil air

Importance of carbon dioxide, oxygen and nitrogen

- **Oxygen**
Needed for respiration of plant plant roots and micro-organism
Needed for oxidation of minerals which contain iron
Play a role in decaying of plant remains or organic matter
- **Carbon dioxide**
It combines with water to form carbonic acid
Help to dissolve rocks and minerals to form soil (carbonic acid stimulate weathering of rock to form soil)
It releases plant nutrients in a soluble form
React with inaccessible compound to make them accessible to plant root
- **Nitrogen**
Dilutes oxygen in the soil
It slows down oxidation
It is utilised by nitrogen-fixing bacteria in soil to make microbial protein

Activity 35 (Soil air)

1.1 carbon dioxide from the root and decomposition of organic matter reacts with water to form carbonic acid. Carbon dioxide in the air combines with rain water to also form carbonic acid

1.1.1 carbon dioxide + water = carbonic acid

Express this as a chemical equation (2)

1.1.2 indicate THREE functions of carbon dioxide (3)

1.2 Name the gas responsible for each of the function below:

1.2.1 Inaccessible compounds become accessible to plant roots

1.2.2 slows down oxidation

1.2.3 improves the formation of humus in the soil

Activity 36 (soil air)

1.1

Soil air makes up the volume of soil not occupied by liquid. The amount of gases in soil is determined by the condition of soil. The oxygen content in lower horizons is less due to poor diffusion and carbon dioxide can escape easily in soils with a low total porosity.

1.1.1 Deduce TWO factors that influence storage and movement of soil air from the scenario above. (2)

1.1.2 Compare the levels of gases mentioned in the scenario above with those in the atmosphere. (2)

1.1.3 Explain the relationship between porosity and bulk density. (2)

1.2 A soil scientist conducted an experiment to test the influence of soil gas in plants.

Experiment no.	No.1	No.2
Conditions under which seeds are planted	Planted seeds in soil and kept soil waterlogged	Planted seeds with a well rooted organic matter and watered when needed
Results	No growth occurred	Luxurious growth

1.2.1 Indicate the gas that is deficient in experiment No.1. (1)

1.2.2 Explain the role that the gas mentioned in QUESTION 1.1.1 could have played if it was not deficient. (1)

1.2.3 Name the gas that is high in soil as a result of activities in experiment No 2. (1)

1.2.4 Explain the reason for the high amount of gas mentioned in QUESTION 1.2.3 (2)

6. Soil water

- This is the water in the soil
- Such soil is available in the form of: gas – **water vapour**

: liquid- **water**

: solid- **ice**

- Main focus will be on soil water in its liquid form

Basic types of soil water

Gravitational water

- Is a free water that moves through the soil due to the force of **gravity**
- it is found in **macro-pores**
- it is not available or taken up by plants (it may cause plant to wilt as it occupies air space and restricts the supply of oxygen to plant roots)

Hygroscopic water

- Is the water that forms a thin film around soil particles
- It is not available to plants (because this water is held tightly by force of adhesion)
- Usually found in clay soil

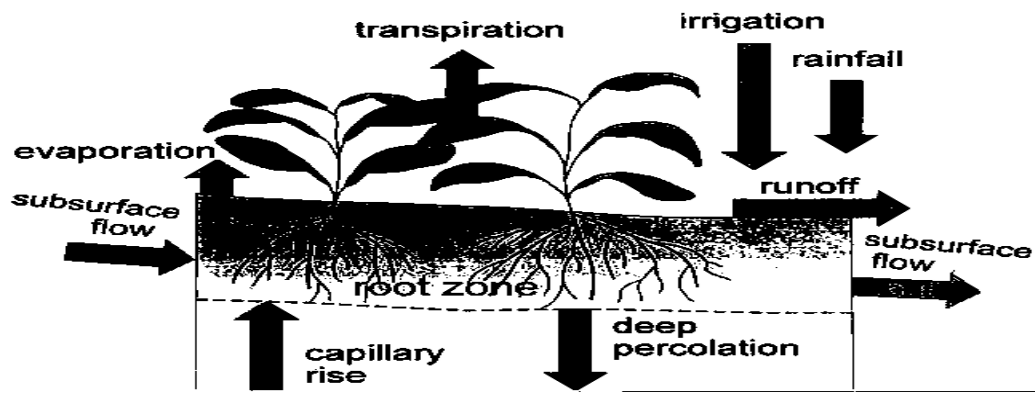
Capillary water

- Is water found in **micro-pores**
- It is available for plant growth (since capillary forces are stronger than the force of gravity)
- It is held by cohesion and adhesion

Cohesion –bond of two or more different molecules

Adhesion- force of attraction between similar molecule

Soil water losses and ways to limit the loss



Through run-off (occurs especially on sloping soils)

- Cover sloping soil with vegetation in rainy season
- Use contour wall to control run-off of water
- Use organic matter to increase infiltration
- Use gypsum the surface of soil to increase water infiltration

Through evaporation (occur when soil moisture is higher than moisture in the atmosphere)

- Avoid irrigation during the hottest part of the day
- Plant wind breaks

Trough transpiration (occur when water is lost through the stomata of leaf)

- Cultivate plants with low transpiration rate (since they require small amount of water)
- Plant cultivars with short growing season (since they use less water than long season crops)
- Eliminate weeds (since it uses too much water)
- Limit use nitrogen fertiliser as it stimulate development of larger leaves which uses much water)

Through percolation/seepage (occur in soil that is saturated)

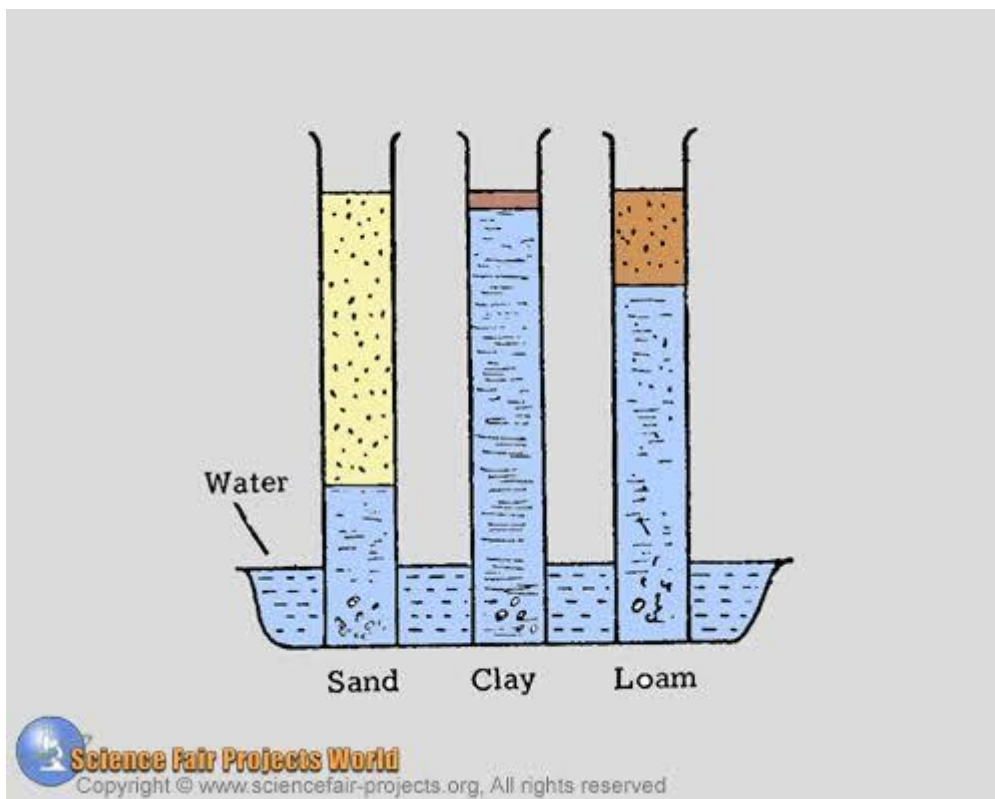
- Use controlled irrigation (since flood irrigation on sandy soil may lead to great percolation loss)
- Add organic matter to the soil (since it will increase the water capacity of soil)

Capillary movement

Is the upward movement of water from the soil through micro-pores

- **In soil with fine texture**
Water will rise much higher because the particles are closer together and capillary forces are stronger
Water movement is slow
- **In soil with coarse texture**
Water will rise very slow (capillarity is less)
Water movement is fast since the pores are too large

Diagram showing capillary movement



Availability of water of soil water to plants

This refers to the capacity of a soil to retain water that is available to plants

Saturation point

- This occur when all soil pores are filled with water that is held by adhesion
- There is no space available for air in the soi (therefore plants will grow normally)

Temporary wilting point

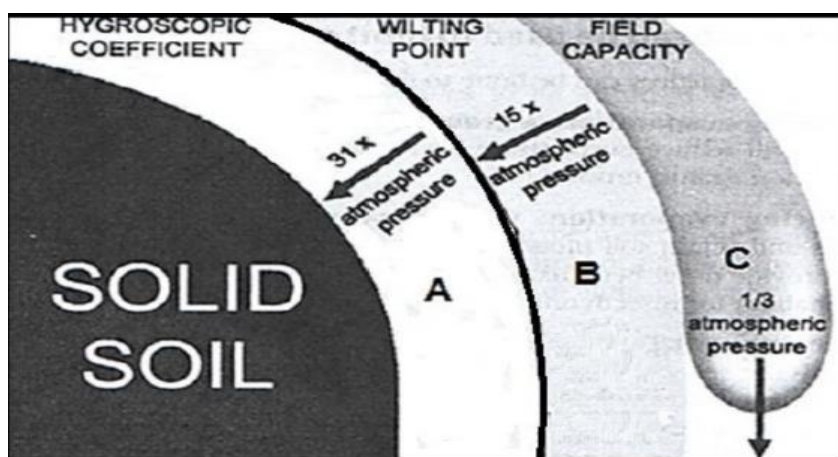
- It occurs when the soil does not provide enough water to the plant for it to retain its turgidity
- Plants will be slightly wilted during the hottest part of the day due to increased transpiration

Permanent wilting

- Occurs when there is not enough water in the soil to support the growth of a plant, or if water loss continues, the plant will appear wilted
- Occurs when there is hygroscopic water in the soil

Activity 37 (soil water)

1.1 the schematic representation below indicates the forces with which water is attracted to soil particles at different distances



1.1.1 deduce the forces that attract water molecules at distances labelled **A**, **B** and **C**

1.1.2 Explain the reason why water drains away at C'

1.2

A farmer has a small piece of land for growing crops because of different moisture conditions, the land was divided into two, one piece for vegetables and another piece for maize. The farmer cleared the land in preparation for planting. Soon after preparation, there was a heavy rain for 2 days and the land was saturated with water.

Moisture content of both pieces was measured for a period of 10 days. The results are shown in the table below

DAY	1	2	3	4	5	6	7	8	9	10
Moisture content of land for maize	20	13	9	7	5	4	3	2	1	1
Moisture content of land for vegetable (%)	20	18	16	14	13	12	10	7	6	5

1.2.1 Plot a line graph of the moisture content for two pieces of land against time in days

1.2.2 suggest THREE ways to limit the loss of water in land used for maize

Activity 38 (Soil water)

1.1 The availability of water for plants is influenced by presence of accessible soil water. The plant can either wilt, die or grow optimally depending on soil moisture conditions

Indicate the plant's response to the following soil conditions

1.1.1 water is held at a point equal to permanent wilting

1.1.2 field water capacity

1.1.3 temporal wilting point

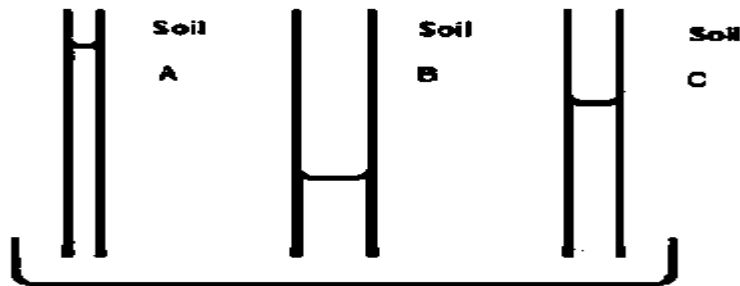
1.1.4 saturation point

activity 39 (soil water)

1.1

Grade 11 learners conducted an experiment to determine the movement of water in different soil textures. Three soil columns containing sand, loam/ silt and clay were set up and placed in a pan with water. Two observations were made:

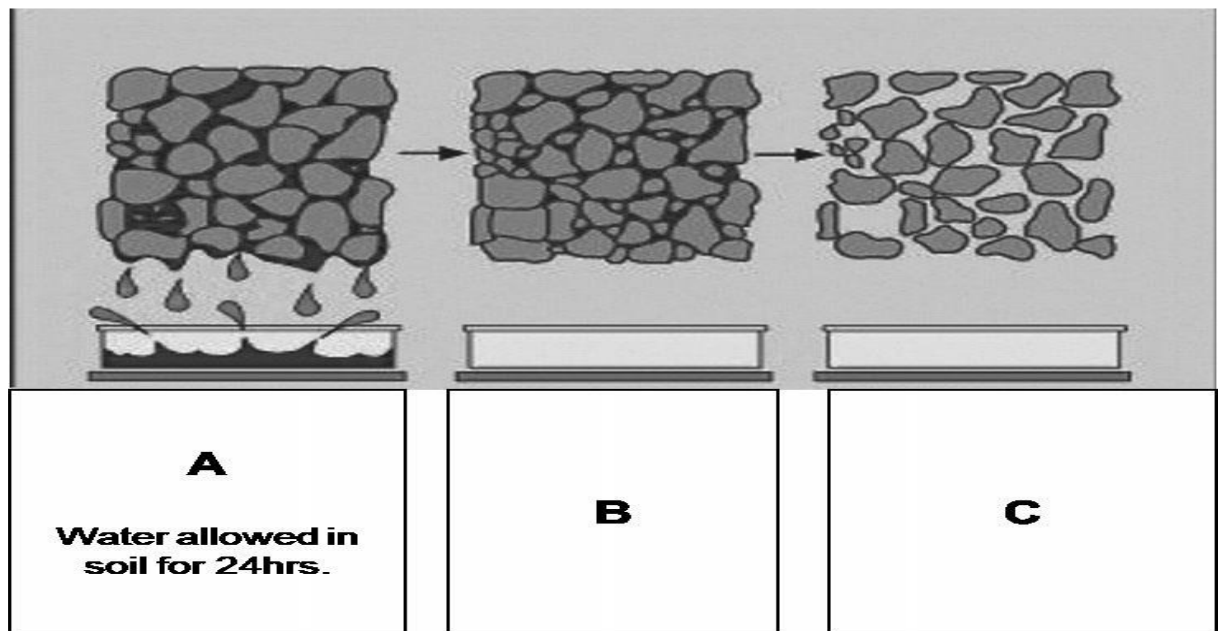
- Height at which the water rises in each soil column
- Time the water took to reach the highest level



- 1.1.1 formulate a hypothesis for this experiment (2)
- 1.1.2 indicate the type of water movement the learners demonstrated in the experiment (1)
- 1.1.3 based on the observations, label the soil types represented by A, B and C (3)
- 1.1.4 Indicate the soil where the following occurs:
 - (a) Water rises most rapidly (1)
 - (b) Water rises the slowest (1)
- 1.1.5 Give a reason for your answer in QUESTION 1.1.4 (a) and (b) (2)

Activity 40 (soil water)

1.1 Analyse the illustration on soil water below and answer questions that follow.



1.1.1 Name the appropriate term referring to the illustrations labelled A and B. (2)

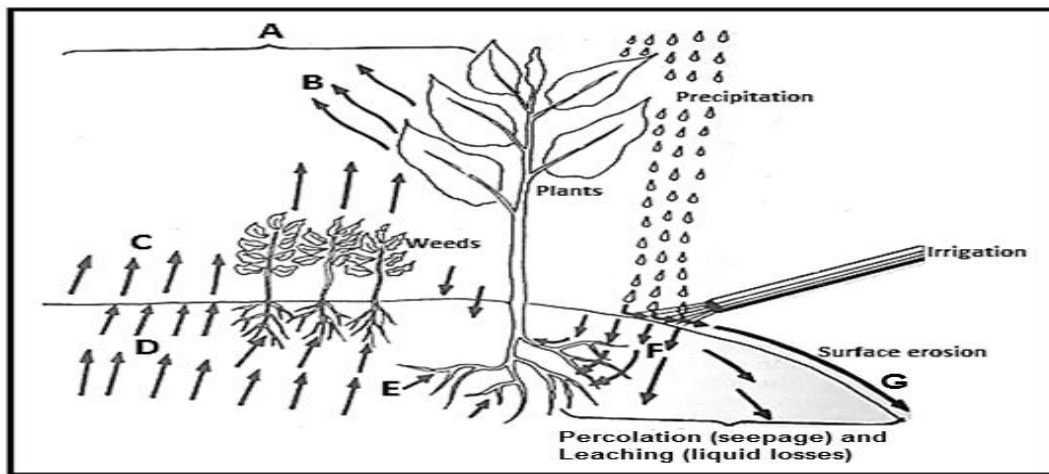
1.1.2 Justify with a reason the answer to QUESTION 1.1.1. (2)

1.1.3 Explain the plant response when grown in soils in the illustrations labelled B and C. (2)

1.1.4 Differentiate between temporal and permanent wilting points. (2)

Activity 41 (soil water)

1.1 The picture below shows different ways in which moisture can be lost from soil.



3.3.1 Identify the water loss labelled B, C and G. (3)

3.3.2 Water loss in B can be prevented by minimising the use of nitrogen fertiliser. Justify this statement. (2)

3.3.3 Indicate the letter representing the water loss that can be prevented by each of the following measures:

(a) Contour walls (1)

(b) Planting wind breaks (1)

3.3.4 Identify the movement of water labelled D. (1)

3.3.5 Give a reason for the answer in QUESTION 1.1.4. (1)

7. Soil temperature

- It play an important role in many processes taking place in the soil
- The process includes: **chemical** and **biological reaction**
- The temperature of the soil is determined by heat exchange between the soil and the atmosphere
- (heat is transmitted down to the soil through conduction)

Factors influencing soil temperature

Soil colour

- Dark coloured soil absorb much heat
- Light coloured soil reflects heat

Amount of water in soil

- Wet soil takes time to heat up than dry soil

Vegetation

- Soil with dense vegetation is cooler than soil with sparse vegetation (vegetation shade the soil from sunlight)

Slope aspect

- North facing slope is much warmer than south facing slope (in the shadow)

Season

- Soil will be warmer in summer and cooler in winter

Distance from the equator

- Soil closer to the equator is warm and soil away from the equator permanently frozen because is cold

Influence of soil temperature on physical, chemical and biological process taking place in soil

Biological

- When the temperature is high there is greater microbial activities in the soil
- High temperature stimulate seed germination
- High temperature stimulate root development

chemical

- When temperature is high speed up chemical reaction in the soil

physical

- Day and night temperature help promote physical weathering of rocks

Ways to manipulate soil temperature for better production

Mulching

- Covering soil with straws to insulate it

Irrigation

- It helps reduce the soil temperature (as water in the surface evaporates, energy is used and temperature drops)

Add organic matter

Activity 42 (Soil temperature)

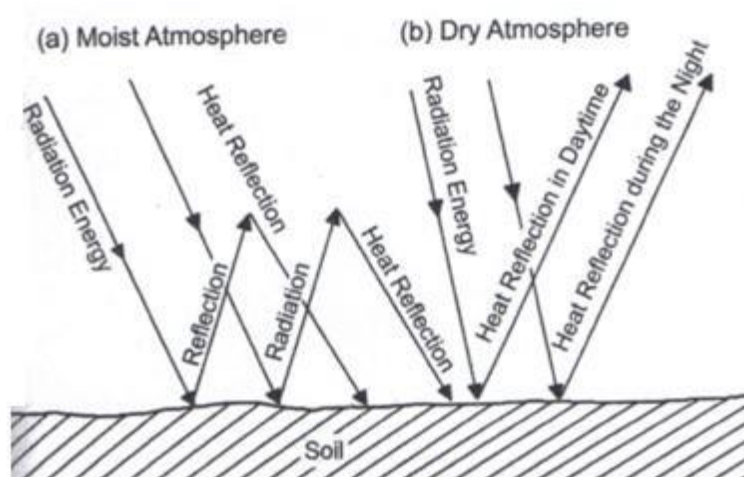
1.1

Soil temperature plays an important role in many processes which take place in soil. These includes chemical reactions, biological and physical action

1.1.1 Explain how soil temperature has an influence on chemical processes in the soil (2)

1.1.2 Name TWO ways in which a farmer can manipulate soil temperature (2)

1.2 The following diagram illustrate the factor that influences soil temperature



1.1.1 indicate the factor that influence the temperature as illustrated above (1)

1.1.2 explain the reason for each of the following soil temperature:

(a) land will be warmer for long time under moist and cloudy condition (2)

(b) Low temperature in light coloured soil compared to dark soil

1.1.3 State THREE influences of soil temperature on biological process

Activity 43 (Soil temperature)

1.1 The data below shows the soil temperature reading at two different depths measured from 06:00 until 18:00

Time	Temperature reading on the surface (°C)	Temperature reading 20 cm deep (°C)
06:00	08	04
08:00	10	04
10:00	14	15
12:00	21	12
14:00	27	16
16:00	24	18
18:00	19	16

1.1.1 draw a bar graph showing soil temperature readings at different depth during different times of the day (6)

1.1.2 state your observations about the trend of temperature on soil surface (1)

1.1.3 name TWO ways to minimise the situation in QUESTION 1.1.2 (2)

1.2 Soil temperature has an effect on physical, biological and chemical processes taking place in soil. Indicate whether each of the following process listed below is a physical, chemical or biological effect of soil temperature:

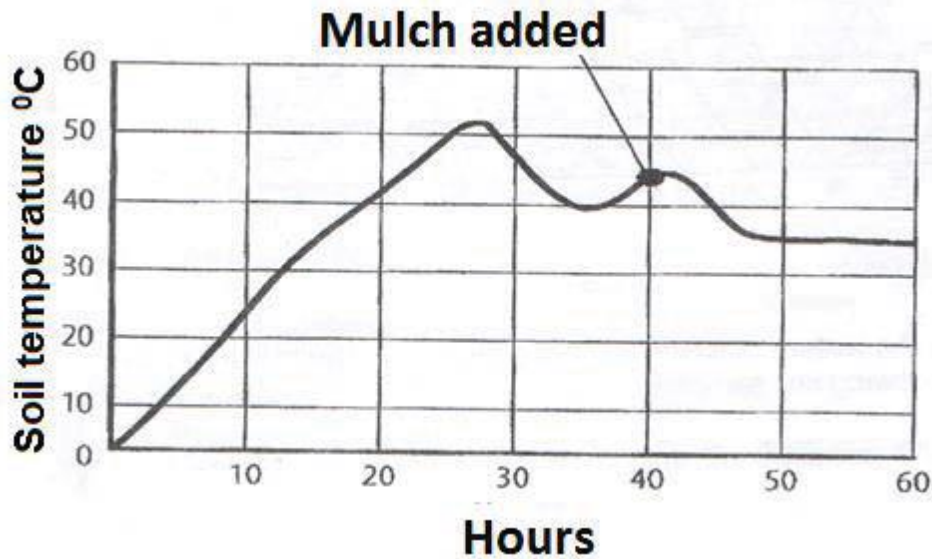
1.2.1 Faster chemical reactions due to warm temperatures (1)

1.2.2 Micro-organisms are more active at temperatures between 15 °C to 35 C (1)

1.2.3 At high temperatures rocks break up to form soil particles (1)

Activity 44 (Soil temperature)

1.1 The graph below shows soil temperature ranges over 60 hours.



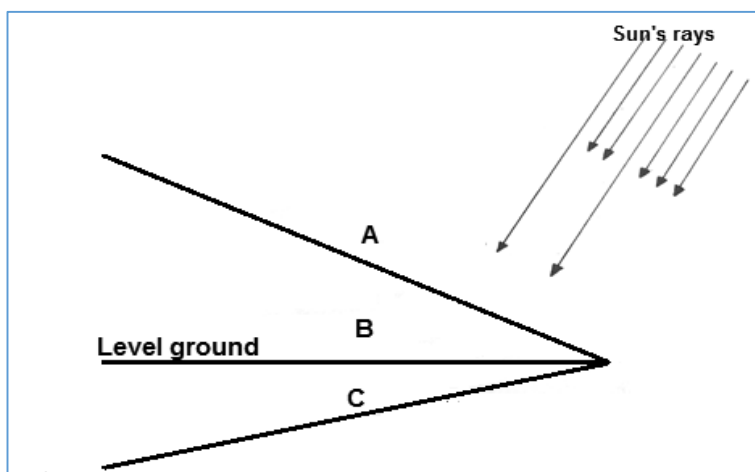
1.1.1 Explain the trend of soil temperature as reflected in the graph above. (2)

1.1.2 Use a table to present the information given in the graph above. (6)

1.1.3 Name TWO ways in which the farmer can manipulate temperature other than the one shown on the graph. (2)

Activity 45 (soil temperature)

1.1 The diagram below shows the orientation of land as a factor influencing soil temperature.



1.1.1 Indicate the letter that represents the land where the following occurs:

- (a) Increased seed germination and germination percentage (1)
- (b) Retard microbe activity (1)
- (c) Faster chemical reaction (1)

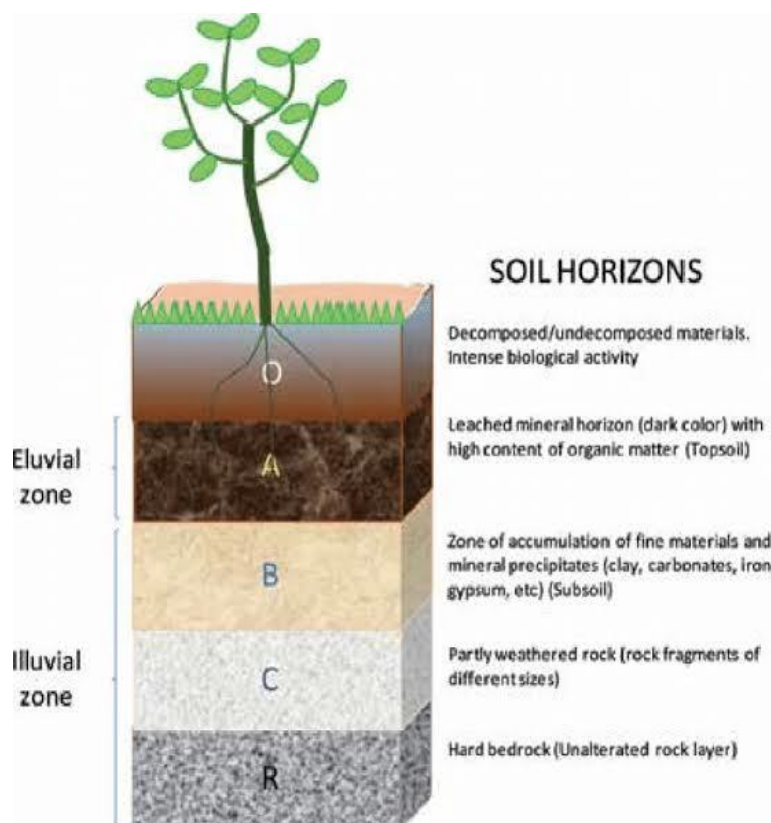
1.1.2 Give TWO methods the farmer can apply to manipulate soil temperature. (2)

8. Soil morphology/ soil profile

soil profile- is the vertical exposure of soil showing various horizons

soil horizon- these are layers in the soil profile

profile hole- is a pit dug in the soil to expose all horizons



Development and description of major soil horizon

O- HORIZON

- Top soil/ surface horizon
- Known as organic horizon
- Contain decayed organic matter

A- HORIZON

- It is a top soil horizon
- It is always present unless it is removed
- Most biological activities take place
- It is the most important horizon for agriculture
- It is the first horizon to be ploughed
- It develops through weather
- Has a mixture of organic and inorganic matter

B- HORIZON

- It is a subsoil
- Illuviated horizon
- Contain material that leached from A-HORIZON
- Contain clay silicate and oxide(iron oxide, manganese oxide, aluminium oxide)

C- HORIZON

- Contain partially weather rock
- Contain unconsolidated rock

R- HORIZON

- Contain unweathered rock material
- Made up of unconsolidated rock material

Additional horizon

E- HORIZON

- Found after A-HORIZON
- It doesn't occur in every soil profile
- Contain little organic matter (due to leaching)
- Found from soil in high rain-fall areas
- It is more lighter than A HORIZON above it and B-HORIZON below it

G-HORIZON

- It is sticky and clay rich horizon

- It reflects permanent waterlogging
- Found near water table

Mature (Adult soil)

- Has all the clear distinguishable soil horizon

It has : **A**

E

B

C

Young soil

- This are usually immatured soil
- It has minimal horizons (A horizon is above the R horizon)
- Parent material is the only influence
- It has: **A** **A**

C or R

Water logged soil

- It is a poorly drained soil
- It hardens and crack into cubes when dry
- It fails to support plant and microbial life
- It has: **A** **O**

B or G

G

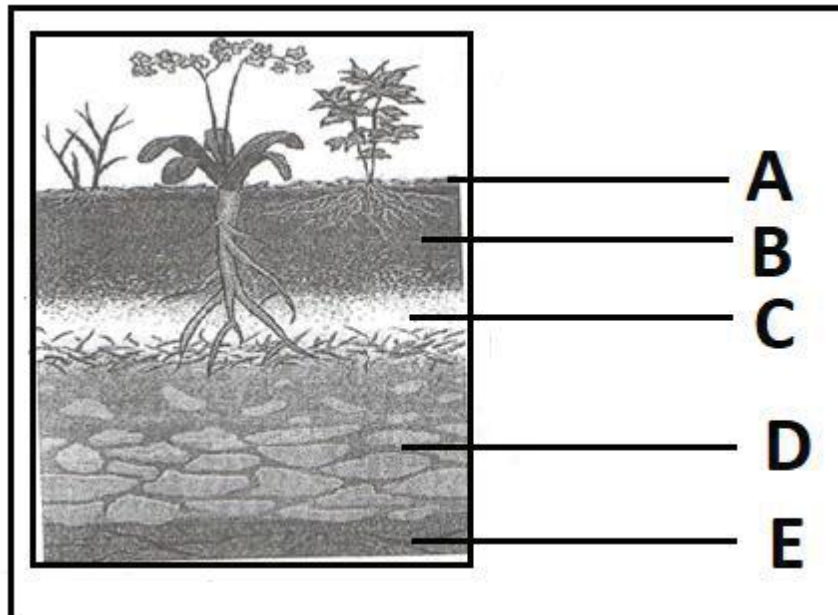
Eroded soil

- Such soil has part of it's A HORIZON and B HORIZON is remove by wind or water erosion
- It cannot sustain crop life
- It has: **B**

C

Activity 46 (soil morphology)

1.1 The diagram below shows horizontal layers.



1.1.1 Identify the letter of the horizon in which the following information applies:

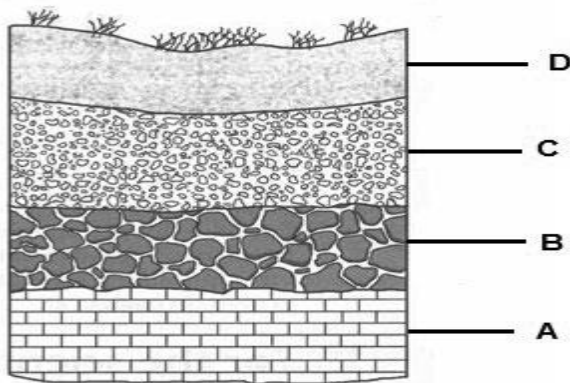
- (a) Soil is directly formed (1)
- (b) Physical weathering occurs (1)
- (c) Signifies the loss of organic matter (1)
- (d) Decomposed organic matter mixed with mineral particles (1)

1.1.2 Sketch the profile of the following soils:

- (a) Wet soil (2)
- (b) Eroded soil (2)

Activity 47 (soil morphology)

1.1 The diagram below shows horizontal layers of a soil.



1.1.1 Sketch the profile of the soil with horizontal layers in the diagram above. (2)

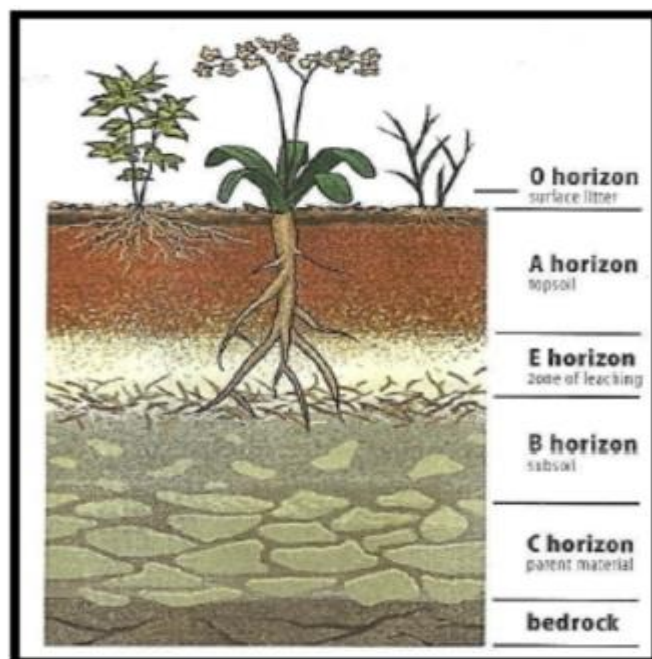
1.1.2 Indicate the horizon that will be visible if the soil above can be subjected to the following:

(a) High degree of leaching (1)

(b) Very wet conditions (1)

Activity 48 (soil morphology)

1.1 the diagram below shows the development of master horizon and the schematic representation of a soil profile. Answer the questions based on it.



Use the diagram above and relate the horizons with the following characteristics:

- 1.1.1 The horizon is formed by marked loss of soil structure
- 1.1.2 Mineral particles are found in this horizon
- 1.1.3 Contain only inorganic material
- 1.1.4 Mixture of inorganic and fully decomposed organic matter
- 1.1.5 Material from which soil is directly formed
- 1.1.6 Physical weathering occurs in it

Activity 49 (soil morphology)

- 1.1 The illustration below shows different horizons visible after digging through the soil
 - 1.1.1 determine the age of the soil above
 - 1.1.2 give a reason for your answer
 - 1.1.3 sketch the profile for the type of soil mentioned in Question 1.1.1
 - 1.1.4 indicate the letter representing a horizon with the following characteristics
 - (a) enriched with eluviated material
 - (b) inorganic material mixed with organic

9. Soil classification

Is the grouping of soil with similar properties (such as texture and structure)

- Classification of soil helps you to understand, identify and communicate knowledge about soils, as well as to properly manage the soil

Ways of classifying soil

Binomial soil classification system (used in S.A)

- The system is based on identifying master horizons
- According to this system, soil is divided into 73 **soil forms** and **soil families**

Soil forms

- ✚ This is an upper or general level
- ✚ They are defined by the unique vertical sequence of horizons

Soil families

- + This is a lower and more specific level
- + It shares same properties of soil form but different to soil form with other properties

Steps involved when classifying soil

1. Demarcate master horizon
2. Identify all the horizon'
3. Name a soil form
4. Identify a mark that differentiate soil family
5. Identify soil family
6. Determine the texture of the A- horizon

Reason for classifying soil

- + To know which crop to cultivate
- + To know which fertilizer to be used
- + To manage irrigation of the crop

Activity 50 (soil classification)

1.1 Soil classification is an important aspect of agriculture.

1.1.1 Outline THREE reasons why soil classification is important in agriculture. (3)

1.1.2 In South Africa soil classification system contains two categories or levels. Name these categories. (2)

1.1.3 Outline the procedure when soil classification is done in sequence.

Soil colloids

What are soil colloids?

This are negatively charged ion that attracts positive cations

They are very tinny soil particles (less than 0,001mm)

They are the most active portion of soil

They have ability to adsorb cations

Types of colloids

IN-ORGANIC COLLOID

- They have layered structure with flat plate (they have structure)

Note: each layer is made up of two or THREE sheets compose of THREE element: Silicon, oxygen and aluminium. These elements combine to form different kinds of clay.

Silicon combine with oxygen to form **SILICA SHEETS**.

SILICATE CLAY have two or three layers (depending on combination of silica and aluminium)

Groups of silicate clay: **Vermiculite** – has high fertility because of high negative charges which adsorb high amount of cations

: **Kaolinite**- 1:1 type. Has less fertility because of less negative charges which adsorb less cations

: **Montmorillonite**- 2:1 type

1:1- is one silica layer and one aluminium layer

2:1- is two silica layers and one aluminium layer



- Form from weathering of minerals such as; **FELDSPAR** or **MICA**
- They are rich in mineral **Silica**
- Made up of clay minerals
- Contain aluminium, magnesium and hydroxide

e.g. Clay mineral

ORGANIC COLLOID

- They are structure less
- Form from decomposed organic matter
- They are more reactive chemically
- They have greater influence on properties of soil

e.g. humus

Differences between organic and in-organic colloids

Organic colloid	In-organic colloid
Have a net negative charge	Have net positive charge
They are sticky	They are not sticky
They shrink and swell	Do not shrink and swell
They hold nutrients on the surface	Do not hold water and nutrient
Made of humus	Made of clay mineral

CATION ADSORPTION AND CATION EXCHANGE

Cation adsorption

- Is the binding of positive charged cation to the negatively charges on the surface
- In humid region, most of the colloids are dominated by three main cations: **Ca²⁺**, **H⁺** & **Al³⁺**

Acidic soil

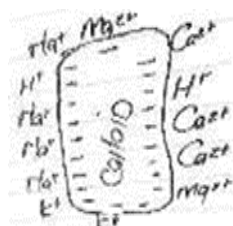
Soil with predominance of the following cation:

- Hydrogen (**H⁺**)
- ALUMINIUM (**Al³⁺**)



NOTE: **Mg²⁺**, **K⁺** & **Na⁺** are found in lesser amounts

ALKALINE SOIL



Soil with predominant of the following cation:

Calcium (**Ca²⁺**)

- Magnesium (**Mg²⁺**)
- Potassium (**K⁺**)
- Sodium (**Na⁺**)

Note: **H⁺** and **Al³⁺** are found in lesser amount

Predominant ions and soil type

Predominant ions	Type of soil	Ph.
Hydrogen (H ⁺) and Aluminium (Al ³⁺)	Acidic	Low
Calcium (Ca ²⁺) and Magnesium (Mg ²⁺)	Sweet	neutral
Sodium(Na ⁺) and potassium (K ⁺)	Brackish	alkaline

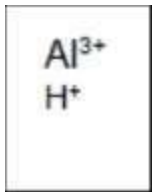
CATION EXCHANGE

Is the measure of the ability of soil to exchange cations with the soil

Note: the (+) superscript indicates how many positive charges the cation carries)

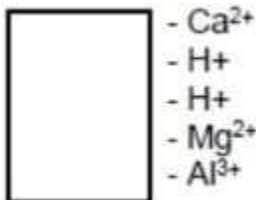
Neutralisation

- Is the reversal of acidity
- H^+ ions are exchanged for Ca^{2+} and Mg^{2+} **Acidification**
- Is the process of exchanging basic cation such as Ca^{2+} , Mg^{2+} , K^+ and Na^+ for acid cation H^+ and Al^{3+} **Active acidity**
- Is the hydrogen concentration in the soil water
- Hydrogen ions are in a solution and can easily exchange



Reverse acidity

- Hydrogen ions are bound onto the soil particles, and not the solution
- Hydrogen ions are not readily exchanged



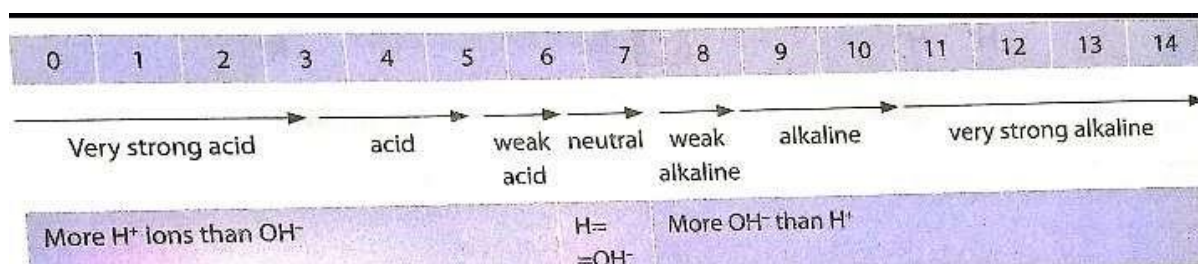
Note: clay soil- hold more cation

: Sandy soil- **hold less cation**

PH SCALE

Measures the acidity and alkalinity of the soil

Degree of acidity is determined by the amount of H^+ ion in the soil It ranges from 0-14



Factors causing soil acidity

- Carbon dioxide combines with to form carbonic acid in the soil
- Rain water leaches away alkaline ions
- Decaying of organic matter produces organic acids
- Fertilizer containing sulphur is added into the soil
- Weathering of acidic parent material

Effects of soil acidity on crop production

- Causes roots to deteriorate or stop growing
- Plant fail to absorb water and nutrients
- Loss of crop yield
- Acid lower the availability of nutrients

Ways to control soil acidification

- Add lime in the soil (adding calcium or magnesium to the soil)
- Avoid using acid fertilizers (use basic fertilizers such as **CALCITIC** or **DOLOMITIC AGRICULTURAL LIME**)
- Plant acid tolerant plants

SOIL ALKALINITY AND SALINITY

What is soil alkalinity?

- This are clay soil with a PH higher than 9
- It has poor structure
- Has low infiltration capacity
- Rich in carbonates (sodium carbonates)
- It is less soluble than acidic soil
- Found in arid or semi-arid region
- This soil is **BASIC** not **SALTY** (It has low sodium chloride concentration)

What is salinity?

- Is the concentration of salt in the soil or water
- Water with more salt is known as Brackish water (it has more salt than fresh water but not more than sea water)
- Soil with more salts is known as **brackish soil**
- This soil (contain solute salts such as **Na⁺**, **Ca²⁺** and **Mg²⁺**)

SALINE AND SODIC SOIL

Differences between saline and sodic soil

Saline soil / white brack

- Soil that is rich in soluble salts such as **sodium chloride** (table salt) and **calcium sulphate** (gypsum)
- Ph. lower than 8,5
- Parent material from which the soil weathers contain salts
- It can be a result of sea water in coastal areas

Sodic soil/ black brack

- Soil that contain excess **sodium carbonates**
- Ph. is higher than 8,5
- It contains much sodium that most crop will not grow in them
- It has reduced infiltration and water availability
- Surface waterlogging increases

Characteristics of saline or white brack soil

- It contains enough soluble salts to affects growth of most plants
- Contain no soluble carbonates
- Most common soluble salt are chlorides and sulphates of sodium
- Contain large amount of gypsum (calcium sulphate)
- Sodium and chloride present in large quantity
- Contain no soluble carbonates

Measuring salinity

Measured by testing the electrical conductivity of the soil solution. The more **SALT** in A SOLUTION, the greater the **conductivity**

Factors causing brackishness/alkalinity /saltiness

- Soil parent material
- Salty irrigation water
- Inorganic fertilisers
- Poor soil drainage

Effects of brack/alkaline/salinity on crop production

- Crops may wilt or die
- Uneven growth
- Salt at the root zone make extraction of water difficult

Method to prevent or control soil alkalinity/brackish or salinity

- Apply gypsum
- Apply green manure
- Irrigate to leach salt in dry areas
- Cover soil with mulch during summer
- Do not apply too much lime on the soil
- Test irrigation water

Ways to reclaim alkaline soil

- Identify the cause of alkaline
- Add organic matter to facilitate drainage
- Add gypsum to reduce the PH

Activity 51 (SOIL colloids)

1.1 Soil colloids both organic and inorganic are tiny soil particles which determine the fertility of the soil

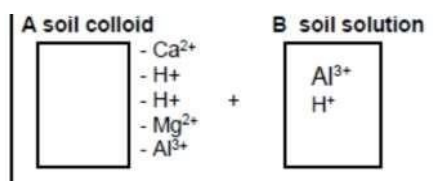
1.1.1 Give an example of organic colloid (1)

1.1.2 Differentiate between organic and inorganic colloid with regard to shape (2)

1.1.3 Explain how organic and inorganic colloids improves soil fertility (2)

Activity 52 (Soil colloids)

1.1 Cation absorbed on the surface of the colloid can be exchanged with cation predominant in the soil solution. The diagrams below show cations adsorbed on the colloid and in the solution



1.1.1 Identify the form of acidity labelled A and B (2)

1.1.2 Justify the answer in QUESTION 1.1.1 above (2)

1.1.3 Indicate the letter representing acidity that will have an effect on the plant growth (1)

1.1.4 Suggest a reason for the answer in QUESTION 1.1.3 above (1)

1.1.5 Give an appropriate term for the ability of soil to exchange cations with the soil solution

ACTIVITY 53 (soil colloids)

1.1

Soil reaction influences not only the nutrient content of the soil, but also the structure, drainage and microbial composition of the soil. All these aspects of soil have a direct impact on crop production. The pH of the soil is determined by the relative concentration of adsorbed cations on soil colloids.

The most common adsorbed cations include the following:

H^{+} , Ca^{+2} , K^{+} , Al^{+3} , Mg^{+2} and Na^{+}

1.1.1 From the list of ion above, select TWO (in each case), that influences the soil reactions below:

(a) Alkalinity (2)

(b) Acidity (2)

(c) neutrality (2)

1.1.2 Indicate TWO negative impacts of soil dominated by Al^{3+} on crop (2)

1.1.3 Suggest a method to control the problem stated in QUESTION 1.1.2 above (2)

Activity 54 (soil colloids)

1.1 Answer the following questions by using the elements in the following table

Ca^{++} , Mg^{++} , H^+ , Na^+ , Al^{+++} ,
 NH_4^+ NO_3^-

1.1.1 Which element makes the soil to be acidic (1)

1.1.2 Indicate the element which causes brack or alkaline soil (1)

1.1.3 Name the element(s) which cannot be adsorbed directly to the colloid (1)

1.1.4 State ONE element that causes neutral

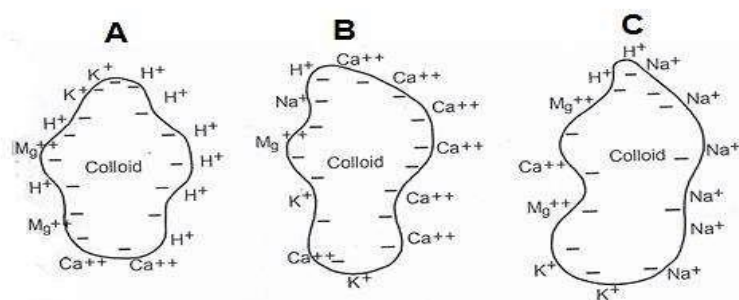
ACTIVITY 55 (soil colloids)

1.1 The following shows a comparison between the properties of organic and inorganic colloids

Property	Organic colloid	Inorganic colloid
Origin	1.1.1	1.1.2
Form	1.1.3	1.1.4
Element composition	1.1.5	1.1.6

Activity 56 (soil colloids)

1.1 The schematic representation below illustrates the cation adsorption on the surface of the colloids.



1.1.1 Indicate the type of acidity illustrated in the colloid labelled A. (1)

1.1.2 Give a reason for the answer in QUESTION 1.11. (2)

1.1.3 Name TWO factors that may be the cause of the colloidal condition labelled A

1.1.4 The colloidal condition labelled C causes the soil to be brackish. Justify this statement.

1.1.5 Name the chemical substance that can be used to reclaim brackishness in soil

1.1.6 comment on the fertility level of soils dominated by the following clay minerals:

- (a) vermiculite (2)
- (b) kaolinite (2)

Activity 57 (Soil alkalinity and salinity)

1.1 the table below shows TWO farms with different soil condition

FARM A	FARM B
☐ Upper layer of soil is black ☐ Soil particles dissociates ☐ Reduced water infiltration Poor seed germination due to dispersed particles blocking pores	☐ White layer of salt appears on the soil surface ☐ Water take long time to infiltrate the soil ☐ Crop appear wilted even after irrigation ☐ On hot days water evaporates leaving salt on the soil

1.1.1 predict the Ph. of souls in farm A and Farm B

1.1.2 Indicate the common terms used to describe the Ph. levels of farm A and Farm B

1.1.3 Name the salt that predominate in Farm A soil

1.1.4 Suggest Two measures in which the condition of soil in farm A can be corrected

Activity 58 (Soil alkalinity and salinity)

1.1 Compare in table form the saline and sodic soils with regard to the following:

- 1.1.1 (a) dominant salt (2)
- (b) colour (2)
- (c) corrective measures (2)

topic 3 SOIL ORGANIC MATTER

SOIL ORGANISM

- A good healthy soil is full of living organism
- Some of the soil organism are microscopic and they cannot be seen with the naked eye.
- Such soil organism breaks down organic matter to release nutrients
- They are known as decomposers
- The environment in which soil organism is determined by the physical and chemical properties of soil (soil provides living requirement as well as protection for soil organisms
- They are involved in chemical processes such **carbon** and **nitrogen cycle**

Differences between soil micro-organism and macro-organism**Micro-organism**

Smaller than 0,2- 2mm in width

Cannot be seen with naked eyes

Macro-organism

Larger animals over 2 mm in width

Can be seen with naked eyes

Examples of soil organism**MICRO-ORGANISM**

- **Bacteria**
It has large variety including spiral, rod-shaped and round bacteria
- **Algae**
Multicellular organism.
- **Fungi**
This are spore-forming organism such as penicillin
- **Protozoa**
They are simple organism without any fixed cell shape

MACRO-ORGANISM

- Earthworm
- Mice and mole (**vertebrates**)
- Insects, mites, millipedes, ants and beetles (**arthropods**)

Condition needed for the survival of soil organism

- **Sufficient Soil moisture**
Micro-organism are more active in soil with moisture between 20% and 50%
- **Suitable Soil temperature**
Temperature between 25- 30 °C
- **Ideal Ph.**
Soil pH determine the type of organism in the soil

Importance soil organism (both micro and macro-organism)

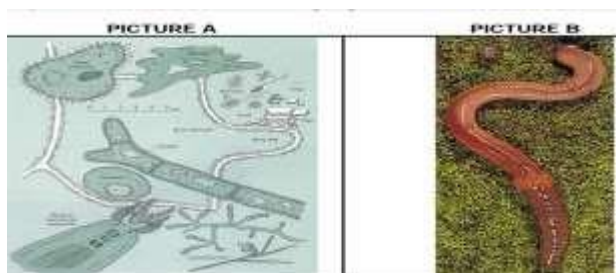
- Break down organic matter and release plant nutrients
- It improves soil structure (due to the formation of humus)
- Nitrogen fixation (They fix nitrogen from the atmosphere into microbial protein)
- They open up the soil to improve soil aeration

Negative effect of micro-organism in the soil

- Dairy products can be spoilt by certain fermentation fungi
- Micro-organism can cause disease
- Food poisoning may occur when rotting bacteria land in food

Activity 59 (living organic matter)**Living organism**

1.1 The pictures below show some living organisms found in soil.



1.1.1 Classify the organisms in pictures A and B. (2)

1.1.2 The organisms in the pictures above need certain conditions in order to survive. Mention THREE conditions needed for the survival of these organisms. (3)

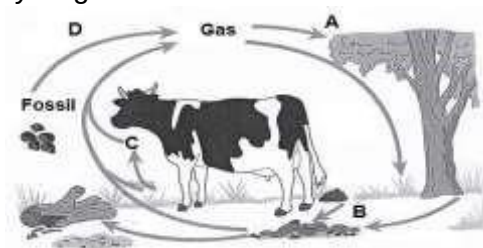
1.1.3 Explain how the organisms in the pictures above improve the following in the soil:

(a) Soil structure (2)

(b) Soil fertility (2)

Activity 60 (living organic matter)**Nutrient cycle**

1.1 Nutrient cycling is important in agriculture as it ensures availability of nutrients over and over again for the next cropping season. Analyse the illustration below showing nutrient cycling.



1.1.1 Identify the nutrient cycle illustrated above. (1)

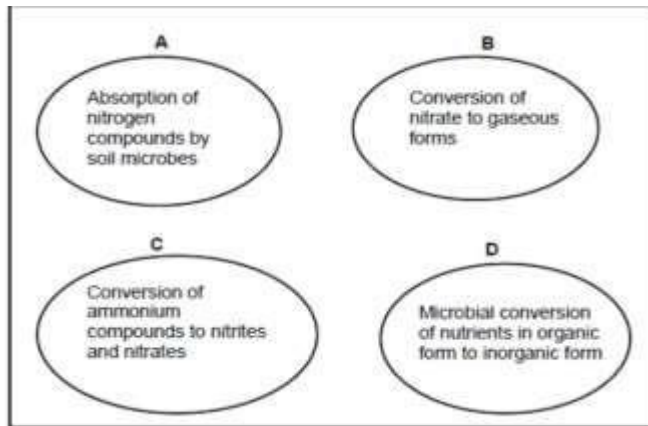
1.1.2 The processes labelled A and C ensure that the nutrient identified in QUESTION 1.1.1 reaches the living organisms. Name the processes in A and C. (2)

1.1.3 Indicate the processes in which the gas above is returned to the atmosphere as illustrated in label D. (1)

1.1.4 Explain the role of soil organisms in the cycle illustrated above (2)

Activity 61 (Living organism)**Nutrient cycle**

1.1

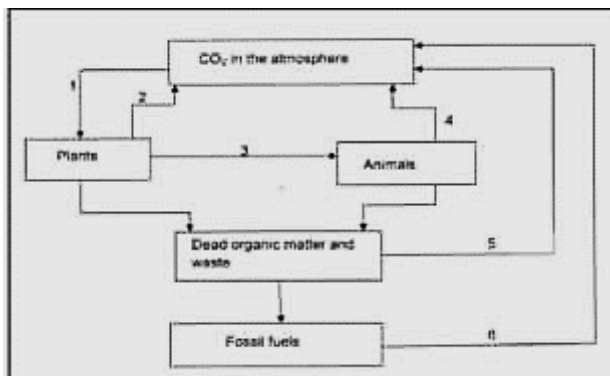


1.1.1 identify the processes labelled A, B, C and D

1.1.2 Name the soil condition favouring the process in B

Activity 4 (Living organism)**Nutrient cycle**

1.1 The schematic representation below illustrates the recycling of carbon dioxide from the atmosphere to the living organisms and back again



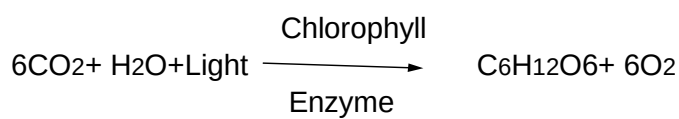
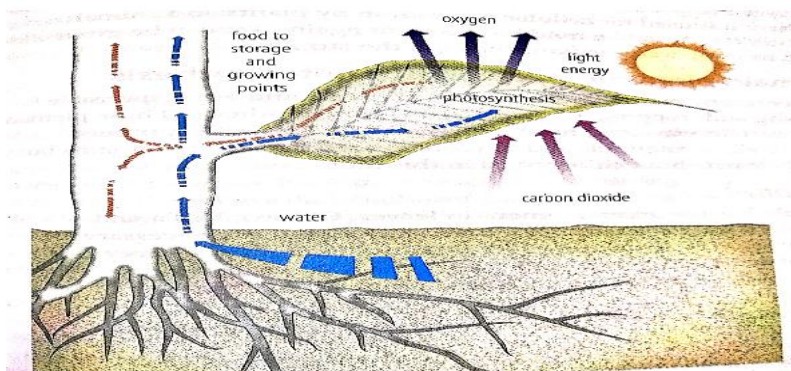
1.1.1 Provide labels for the process numbered 1, 3, 4, 5, and 6

1.1.2 Name TWO important soil micro-organism that play a role during the process labelled 5

1.1.3 State TWO requirements of the organism in QUESTION 1.1.2 above

PAPER 2**PLANT NUTRITION****PHOTOSYNTHESIS**

- Is the process of food production
- It is a chemical process taking place in green parts of plants
- It involves converting carbon dioxide into organic compound in the form of carbohydrates or sugar which is stored in plants as energy

**Schematic representation of photosynthesis**

- Carbon dioxide enters the leaves through the stomata
- Water is absorbed by roots and moves upwards through the xylem to the leaves
- The mesophyll tissue of the leaf contains chloroplast and enzymes
- The light energy is absorbed by the chlorophyll in the chloroplast
- Light, enzyme and chlorophyll change carbon dioxide into oxygen and carbohydrates
- Oxygen leaves the plant and enters the atmosphere
- Carbohydrates are stored in leaves and stem of plant

Differences between photosynthesis and respiration

Photosynthesis	Respiration
It is an anabolic process (building up process)	It is a catabolic process (breaking down process)
Occur during the day	Occur during the day and night
Carbon dioxide is absorbed from the atmosphere	Oxygen is absorbed from the atmosphere
Oxygen is released into the atmosphere	Carbon dioxide is released into the atmosphere

Phases of photosynthesis

- **Light phase**

Needs light to take place

It is light-dependent

Also known as **Hill's reaction**

Takes place in the **grana** of chloroplast During this phase the following occur:

- chlorophyll absorb radiant energy from the sun and convert it into chemical energy.
- Part of the energy is used to split water molecule into oxygen (gas) and hydrogen ions (this is called **photolysis**)
- The oxygen is released into the atmosphere and used for cellular respiration.
- The hydrogen ions combine with co-enzyme NADP to form NADPH which is used in the dark phase
- The energy is also used to transform **ADP** into **ATP**
- The remaining energy is used to produce energy carrier **ATP** (This is called **photophosphorylation**)
- ATP carries the energy to the **stroma**, in chloroplast, to build carbohydrates molecule.

- **Dark phase**

Does not require light

It is light- independent phase

Also known as **Calvin cycle**

Take place in stroma of the chloroplast During this phase the following occur:

- Carbon dioxide, ATP and NADPH is used to produce energy-rich glucose

Storage of food in plants

Product of photosynthesis are stored in different parts of the plant.

- **Stems**

Potatoes (fleshy thicken underground stem)

Ginger (underground horizontal stem)

Onion (short underground stem)

Sugar cane (aerial stem)

- **Roots**

Sweet potatoes (fleshy lateral roots)

Carrot and beetroot (stored in tap root)

- **Leaves**

- Onion leaves
- Cabbage, spinach, lettuce
- **Seeds**
 - Sunflower seeds
 - Bean seed
 - Maize seed
- **Fruit**
 - Deciduous fruit and citrus fruit (fleshy fruit) Walnut
 - (dry fruit)

Factors influencing the rate of photosynthesis

- **Light intensity**
 - High light intensity increases the rate of photosynthesis
 - Low light intensity decreases the rate of photosynthesis
- **Temperature**
 - High temperature increase the rate of photosynthesis
 - Low temperature decreases the rate of photosynthesis
- **Carbon dioxide concentration**
 - High carbon dioxide concentration in the air increase the rate of photosynthesis
 - Low carbon dioxide concentration in the air decrease the rate of photosynthesis
- **water**
 - High soil water content increases the rate of photosynthesis
 - Low soil water content slow down the rate of photosynthesis

Ways to manipulate plants to increase photosynthesis

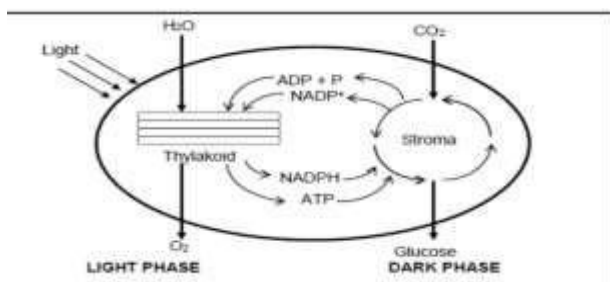
- **Trellising**
 - Keeping plants off the ground to ensure that the fruit bearing-shoots have maximum exposure to sunlight for maximum photosynthesis



- **Pruning**
 - Removing branches of trees to prevents overshadowing to give plants enough exposure to light for maximum photosynthesis
- **Greenhouses**
 - Have transparent roofs which enable plants to obtain maximum exposure to light for photosynthesis
- **Plant density**
 - Fruits and trees are spaced far apart to give leaves maximum exposure to light for photosynthesis

ACTIVITY 63 (PLANT NUTRITION)**PHOTOSYNTHESIS**

1.1 The sketch below shows the light phase and dark phase of photosynthesis



1.1.1 Indicate the part of a plastid where the following occur:

- (a) Light phase
- (b) Dark phase

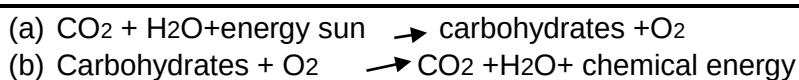
1.1.2 Predict the benefit of the processes in QUESTION 1.1 to mankind

1.1.3 Mention TWO storage organs of plant where excess products of the process in QUESTION 1.1 could be stored

1.1.4 Differentiate between photosynthesis and respiration with regard to energy use in both processes

Activity 64 (plant nutrition)**Photosynthesis**

1.1 two schematic representations of two chemical processes that take place in plants are indicated as follows:



1.1.1 Identify the process (a) and (b) in QUESTION 1.1 above

1.1.2 Comment on the differences between the two chemical processes under the following:

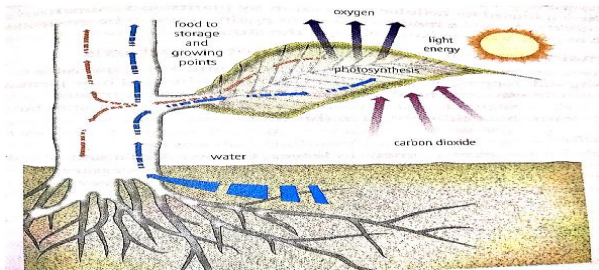
- (a) Energy
- (b) food

1.1.3 List TWO storage organs in which excess starch, sugar, lipids or protein are stored in plant

Activity 65 (Plant nutrition)

Photosynthesis

1.1 The illustration below indicates a very important process in plant studies



- 1.1.1 Critically examine the process in the illustration and tabulate TWO differences between the process above and respiration in plants
- 1.1.2 Suggest THREE factors that could increase the rate of the process illustrated in QUESTION 1.1 above
- 1.1.3 State THREE adaptation of plants to reduce the transpiration rate
- 1.1.4 Give the importance of the process illustrated in QUESTION 1.1 to all living organism (THREE reasons)
- 1.1.5 Recommend TWO ways to increase the rate of photosynthesis

WATER AND NUTRIENTS

Water

Importance of water in plants

- Water transport nutrients to the plant
- Water provides structural support to plant
- Water act as cooling agent
- It is a medium for chemical reactions (e.g. photosynthesis and respiration)

Movement of water from the soil to the roots

- Plants get their water and mineral nutrient through their roots from the soil
- The roots have root hairs which absorbs water and mineral salts
- Transport of water can be:

Passive uptake - needs no energy to transport water

e.g. Osmosis and Diffusion

Active uptake – needs energy to transport water

Differences between osmosis and diffusion

Osmosis

- Is the movement of water molecule from high water potential to low water potential through permeable membrane
- Water moves freely because of their own kinetic energy
- When water molecule contains dissolved substances it lowers its free energy

Diffusion

- Is the movement of molecule from high concentration to low concentration
- Movement will continue until the concentration of molecule between the two region is equal (we say it has reached a **dynamic equilibrium**)

Difference between hypertonic and hypotonic solution**Hypertonic solution**

- Solution that many contain dissolved substances
- This solution has low water potential

Hypotonic solution

- Solution that contain fewer dissolved substances e.g. pure water
- This solution has high water potential

Movement of water from the roots to the stem and the leaves

- Xylem tissue in the roots is responsible for the transport of water from the roots to the stem and leaves
- Upward movement of water from the roots to the stem and leaves is controlled by the following forces:

Root pressure

- As water moves into the root, the roots is filled with water and the osmotic pressure increase.
- The cell become turgid and root pressure develops in the xylem
- Root pressure pushes the water up the xylem vessel of the stem to the leaves.

Transpiration pull

- Is the upward pulling force exerted in water column in plants when water is lost through transpiration
- Water is pulled up the xylem vessel in the root and stem as a results of the evaporation of water vapour

Capillarity

- Upward movement of water in narrow tubes

Movement of water from the leaves to the atmosphere

- In the leave excess water is released into the atmosphere via evaporation
- The water evaporates through small openings on the surface of the leaf water in the leaf can be lost through:

Transpiration

- Loss of water in the form of vapour through the **stomata** of leaves
- It occurs during the day

Guttation

- Loss of water in the form of small droplets through the **hydathodes** on the edge of leaf
- It occurs during the night

Adaptation features of plants to reduce transpiration rate

- Thick cuticle
- Sunken stomata
- Hairy leaves
- Small leaves

Activity 66 (plant nutrition)

Water

1.1

A decrease in hydrostatic pressure in the upper parts of the plant, due to the diffusion of water out of stomata into the atmosphere, allows water to travel from the roots to the stem and leaves of plants. The process that enable water to move up a plant from the roots to the stems and leaves involve osmotic flow, root pressure and transpiration pull.

1.1.1 Identify TWO pressures in plants that allow water to travel from the roots to the stems and leaves from the scenario above. (2)

1.1.2 Differentiate between *root pressure* and *transpiration pull* in plants. (4)

1.1.3 Mention the part of the plant modified for the diffusion of water into the atmosphere. (1)

activity 67(plant nutrition)

water

1.1

The movement of water from the roots to the stems and leaves is very important. Water contains much-needed mineral nutrients. In this way the nutrients are transported to the different organs of the plant. Some of the processes take place through osmosis and diffusion.

1.1.1 Deduce THREE factors that influence the upward movement of water in plants. (3)

1.1.2 Summarise the role played by xylem vessels in the upward movement of water in plants. (2)

1.1.3 List TWO functions of water in plants. (2)

1.1.4 Distinguish between osmosis and diffusion. (4)

1.1.5 Name the part of the plant responsible for the following:

(a) transportation of water (1)

(b) absorption of water (1)

(c) transportation of nutrients (1)

MINERAL NUTRITION

DIFFERENCES BETWEEN MACRO AND MICRO MINERALS

Macro-mineral

- Minerals required by plants in large quantities
- They become deficient when taken in small quantities

Example: Nitrogen (N)
Phosphorus (P)
Potassium (K)

Micro mineral

- Mineral required by plants in small quantities
- They become poisonous when taken in large quantities Example: Iron (Fe)
Copper (Cu)
Zinc (Zn)
Cobalt

Form in which minerals are available to plants

Nitrogen

- NO_3^- (Nitrate) in soil water
- NH_4^+ (ammonia) in soil water

Phosphorus

- H_3PO_4 (Phosphoric acid)

Potassium

- K^+ (Potassium ion) in soil water

Deficiency of macro-minerals

Nitrogen

- Stunted growth
- Yellowing of leaving (chlorosis) □ Leaves become brown and die



Phosphorus

- Reduced growth
- Purple, discoloured leaves

**Potassium**

- Leaf scorch

**Plant nutrient uptake****Types of plant nutrient uptake**

- **Passive ion uptake**

Nutrient elements diffuse from soil water into the root down the concentration gradient: it requires no energy

- **Active ion-uptake**

Nutrient elements diffuse from soil water into roots against concentration gradient: It requires energy

Factors affecting the availability of nutrients to plants**Soil pH.****Leaching**

leads to draining of mineral salts from the topsoil to subsoil where unavailable.

Crop removal

clean clearing, deforestation or cutting down of harvested crops reduces soil nutrients

Erosion: removes soil nutrients.

Methods to determine nutritional status of soil**Soil sample analysis**

Soil sample analysis = usually done before planting:

contact analytical laboratory for questionnaires and packets

keep samples for each land unit, and topsoil (10) and subsoil (5) separate

draw representative sample from mixed sub-samples

place in clean bag (plastic, cloth or hessian), identify and deliver with questionnaire.

Plant or leaf sample analysis

Plant or leaf sample analysis = done when crop is already growing: leaf

sample taken to laboratory where it is washed, dried and stored

representative sample taken at a certain time of the year

pick 10–20 young, mature healthy leaves (at least 10 undamaged) before 10:00 do

not wash, place in clean plastic bag and deliver to laboratory immediately.

Activity 68 (plant science)**Mineral nutrition****1.1**

Some grade 11 learners tested the effect of different nutrient element on the formation of buds in a rose plant for six months. Their findings was recorded in a table as follows:

Nutrient element	Number of buds formed after three month
Zinc	8
Cobalt	5
Nitrogen	20
Boron	25
Potassium	15

- 1.1.1 Draw their findings using a bar graph and give an appropriate heading for the graph (5)
- 1.1.2 Tabulate the nutrient element used for the trial into micro and macro nutrients elements

Activity 69 (Plant science)**Mineral nutrition**

1.1 The following plant nutrient deficiency symptoms occur in some vegetable crops:

- (a) Growth of whole plant is stunted and restricted
- (b) Leaf margins and ends become brown and necrotic
- (c) Poor leaf development

1.1.1 Match the mineral elements in the table that show the deficiency symptom mentioned in 1.1

Sulphur Calcium, Nitrogen Potassium
--

Activity 70 (plant sciences)**Mineral nutrition**

1.1

The difference between micro-elements and macro-elements is only in the quantities required by plant. Nutrients element requirements differ between the element as well as between plant species
--

1.1.1 Tabulate the following plant nutrients into macro and micro element:

Boron
Potassium
Zinc
Nitrogen

1.1.2 indicate ONE function of boron to plants

1.1.3 state TWO ways in which mineral nutrient uptake occurs in plants

Activity 71 (Plant science)**Mineral nutrition**

1.1 mineral nutrients are very essential for the growth and development of crops.

However, there are several factors that affect the availability of nutrients or mineral element to plants

1.1.1 indicate FOUR factors that affect the availability of mineral nutrients to plants

1.1.2 state TWO method that could be used to determine the nutritional status of soil

ORGANIC AND INORGANIC FERTILISERS**Differences between organic and inorganic fertilizers****Organic fertilizer**

Fertilizer composed of decayed organic matter

In-organic fertilizer

chemical preparations consisting of inorganic salts applied to soil

IN-ORGANIC FERTILIZERS**EXAMPLES OF INORGANIC FERTILIZERS**

- **Nitrogen fertilizers**

LAN (Lime ammonium nitrate)

UREA $\text{CO}(\text{NH}_2)_2$

AMMONIUM SULPHATE $(\text{NH}_4)_2\text{SO}_4$

Phosphate fertilizer

ROCK PHOSPHATE

SUPERPHOSPHATE

Potassium fertilizer

POTASSIUM CHLORIDE (KCL)

POTASSIUM SULPHATE (K_2SO_4)

FERTILIZER MIXTURE

Mixture of nitrogen (**N**), phosphorous (**P**) and potassium (**K**):

Each type is designated by a number, e.g. **2:3:2 (24)** meaning the ratio of N to P to K is 2:3:2 and 24 kg out of 100 kg are **minerals**.

Calculation of the percentage plant nutrient in mixed fertilisers

Example: Calculate the percentage of nitrogen in the fertiliser mixture 2:3:2 (24).

Answer:

The total quantity of all three nutrients together in 100 kg of the mixture is 24 kg.

The sum of the parts of each nutrient is $2 + 3 + 2 = 7$.

Mass of N in 100 kg mixture = $\frac{2}{7} \times 24 = 6,8$ kg or 6,8%

Mass of P in 100 kg mixture = $\frac{3}{7} \times 24 =$ Mass

of K in 100 kg mixture = $\frac{2}{7} \times 24 =$

Impact of inorganic fertilisers on the environment

- release substances that contribute to acid rain and greenhouse effect
- cause water contamination
- does not add any organic material into the soil, thus organic material is depleted by soil micro-organisms
- contain sulphuric acid and hydrochloric acid which increase soil acidity

AGRICULTURAL LIME

Two forms of agricultural lime:

Calcitic lime

Dolomitic lime

ORGANIC FERTILIZER

Main types of organic fertilisers

Manure

- Green manure (decomposing crop residue).
- Farm manure consist of dung or faeces from domestic animal and leaves from plants)

Compost = organic matter that has been decomposed

Factors affecting composition of farm manure

Type and age of animal from which manure obtained

Type of ration fed to animals

Type and amount of bedding incorporated

Storage and handling of manure.

Ways of applying fertilizers to the soil

1. Soil applications

Broadcasting

Uniform distribution of fertiliser over planting area (top-dressing)

Band placing

Fertiliser can be placed in a 'band' close enough to supply young plants with nutrients efficiently, but not cause salt burns to roots

2. Foliar application

Application of soluble fertiliser as fine spray or mist onto leaves

3. Aerial application of fertiliser

Involves aircraft that apply granular fertilisers (aircraft hire is costly)

4. Fertiliser application through irrigation

Applied by means of irrigation water or specially designed implements:
irrigation systems can be used, micro-jet or drip irrigation are best

Activity 72 (plant science)

organic and in-organic fertilisers

1.1 A bag of compound fertiliser contain three nutrients in the following ratio:
3:2:5

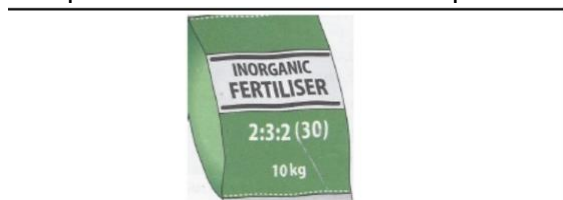
1.1.1 Calculate the percentage of nitrogen, phosphorus and calcium in the mixture of the compound fertiliser (4)

1.1.2 State ONE use for gypsum for grain farmer (1)

Activity 2 (plant science)

Organic and in-organic fertiliser

1.1 The picture below shows an example of a bag of inorganic fertiliser



1.1.1 Classify the type of fertilizer in the picture above (1)

1.1.2 Justify your answer to QUESTION 1.1.1 (1)

1.1.3 Calculate the percentage of nitrogen in the bag of fertiliser (4)

1.1.4

Activity 73 (plant science)**organic and in-organic fertilizers**

1.1 organic matter in the soil are all substances that once lived, but have died and can decompose or rot in the soil. Many farmers believe that it is the most important fraction of the soil because it has both physical and chemical effects on the soil.

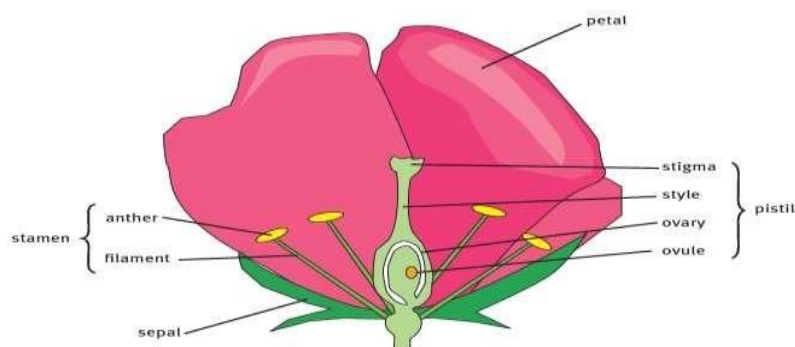
- 1.1.1 identify THREE physical effect of organic matter on garden bed
- 1.1.2 state THREE factors that influence the composition of farm manure
- 1.1.3 state THREE negative impact of inorganic fertilizer on the environment

Activity 74 (Plant science)**Organic and in-organic fertilizer**

Organic fertilizers are made up of decayed organic matter, such as plants that have decomposed or have been digested by organisms. A debate was organised in your class, and you were called to argue in favour in favour of the use of organic fertilisers in the school garden

- 1.1.1 Give THREE reasons in favour of use of organic fertiliser in your school garden in your school
- 1.1.2 Suggest THREE characteristic of crops that could be used for green manure

PLANT REPRODUCTION

Sexual reproduction in plantsStructures and functioning of the main parts of a flower**Female reproductive organ and functions:**

- Known as **pistil**
- **stigma** is hairy and/or sticky to trap pollen
- **ovary** produces eggs or ovules.

Male reproductive organ and function:

- known as **stamen**
- **Anther** produces pollen.

Non-sexual parts:

- **Petals** (collectively referred to as the **corolla**)
 - **Sepals** (collectively referred to as the **calyx**)
- Functions

Sepal/calyx protects the ovary

Petal/corolla attracts insects to the flower

Pollination

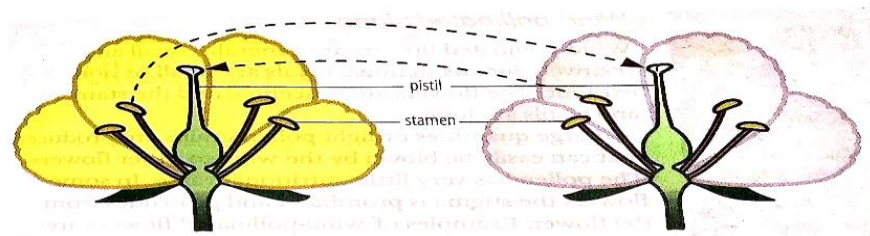
process by which pollen from anther to stigma, enabling fertilisation

process of pollination

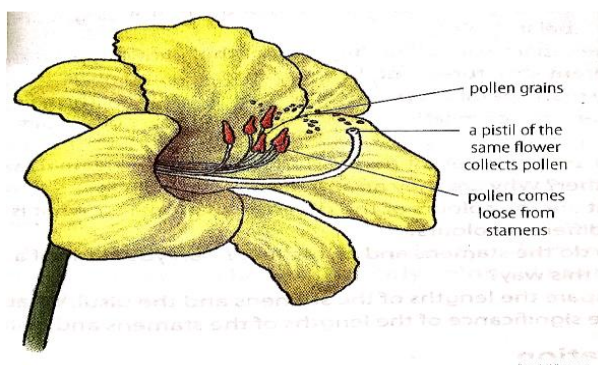
- Pollen moves from the anther to the stigma
- Pollen grain grows downwards towards the ovary and fertilizes the ovum
- Ovary forms the fruit
- Fertilised ovum develop into seed

Types of pollination

Cross pollination – movement of a pollen from the anther of one plant to the stigma of another plant



Self-pollination – movement of a pollen from the anther to the stigma of same plant



Agents of pollination

□ Insects

Flowers attract insects by **producing nectar**, strong **smell** and **bright petals** birds, **bats and mice**

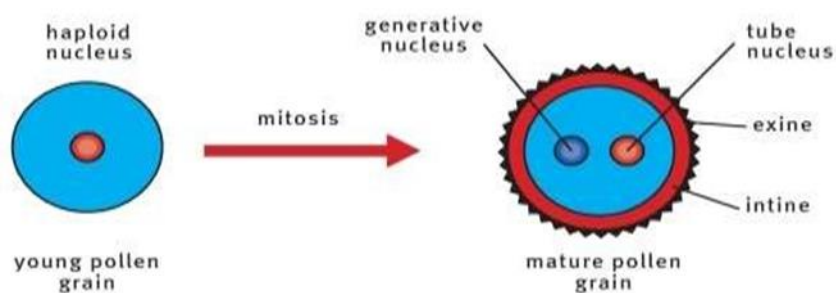
- **wind**

no nectar, strong scent or bright petals

- **water**

no nectar, strong scent or bright petals

Development of matured/ripe pollen grain

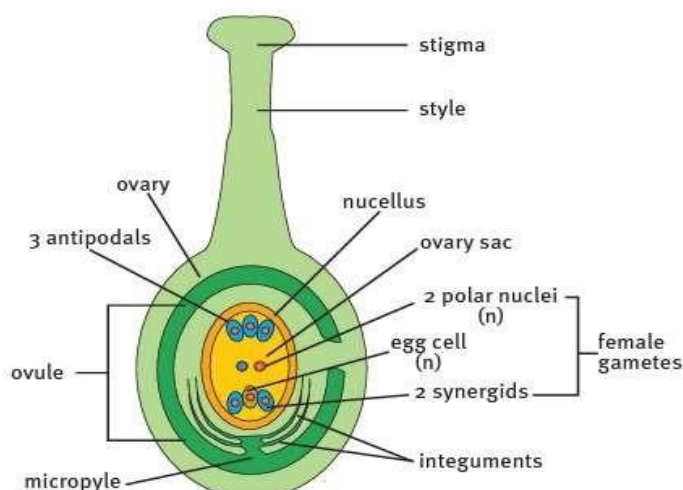


- Haploid nucleus of the young pollen grain divides by mitosis to form two nuclei known as generative nucleus and vegetative nucleus (pollen tube nucleus)

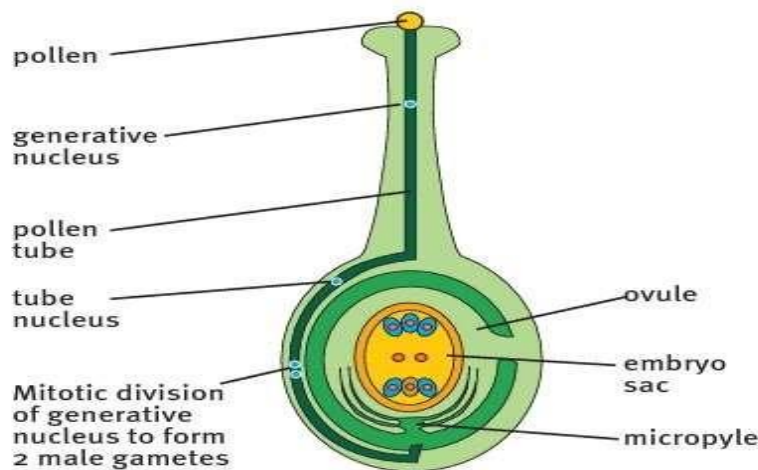
- Result in the formation of matured pollen grain that has a double wall which consists of a tough outer wall called exine and inner membrane called intine

The exine protects the pollen grain against harsh conditions

Receptive stigma



The germination of ripe pollen grain on a receptive stigma until fertilisation



- When the anther ripens, the wall between the pollen sac burst open and ripe mature pollen grains are ready to be dispersed
- Ripe pollen grain that contain the male sex cell (male gametes) is transferred by pollination agents from the anther to the receptive stigma of a flower
- The ripe pollen grain germinates
- The exine softens and split open
- the intine grows and form a pollen tube
- Pollen grain land on stigma and germinates, forming a pollen tube
- Tube nucleus controls its growth
- Generative nucleus travels down the pollen tube and undergoes mitosis
- Pollen tube moves through the micropyle into the ovule to start fertilisation

Fertilisation in plants

Fertilisation – is the fusion of male gamete (pollen) and female gamete (ovum) to form a zygote

- For fertilisation to be successful the anther must produce viable pollen and the stigma must be receptive
- Male gamete (n) and female gamete (n) fuse to form a zygote (2n)

Double fertilisation

Two male gamete are released into embryo sac;

one fuses with egg nucleus to form a diploid zygote (2n) that will develop into embryo

The other One fuses with the diploid endosperm to form triploid endosperm cell ($3n$)

Endosperm is a nutrient-rich tissue that nourishes developing embryo.

Ablactation

Is the dropping of flowers or fruitlets within the first ten days after flowering

Factors cause or influence ablactation

1. Biological factors

- When there is no fusion of male and female gamete (when female flower are not pollinated by male flowers)
- When little pollen is produced
- When pollen has low germinating power

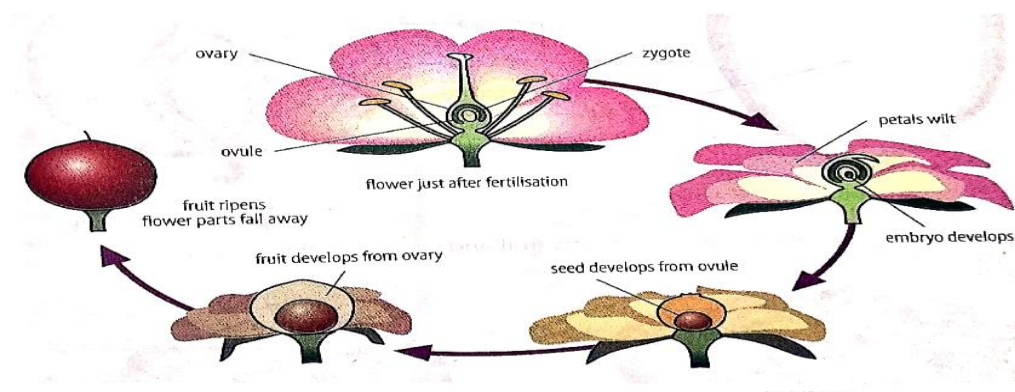
2. Soil factors

- Shortage of essential nutrients in the soil
- Water shortage in the soil

3. Climatic factors

- Cold temperatures affect germination of seeds
- Frost will damage flower
- Excessive rain prevent pollen from being transported
- Wind may inhibit the ability of insect and birds to transfer pollinating agents

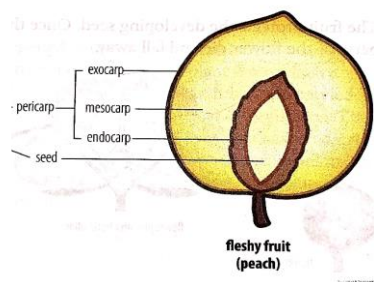
Development of fruits



Fruit setting is the development of fruits from the ovary of flowers

- Fruits are produced by flowering plants
- The wall of a fruit is called pericarp
- Pericarp is divided into:
 - Exocarp is the outer layer
 - Mesocarp is the middle layer

- Endocarp is the inner layer



Different types of fruits

1. Simple fruits

- Fruits that develop from a single ovary

Divided into:

- **Succulent fruits**

Fruits that are fleshy, juicy, sweet and brightly coloured

The fruit wall (pericarp) is fleshy

Example: berries (grapes and tomatoes)

Stone fruit (peaches plums and apricots)

- **Dry fruits**

Fruits that have hard dry pericarp around the seeds

Example: legumes (peas and beans)

: Nuts (acorns, peanuts, hazelnuts)

2. Compound fruit

Develops from several ovaries in the single flower

Compound fruits are divided into: **aggregate fruit** e.g. strawberry, raspberry

Multiple fruit e.g. pineapple mulberries

3. Accessory fruit

Fruit that develop from ripened ovary and some other parts of the flower

Example: apples

Parthenocarpy

- Is the natural or artificial production of fruits without fertilisation of ovules
- Fruits are normally seedless normally (if seeds are present, they are not viable and cannot germinate)

- It occurs mainly in plants with many ovules e.g Bananas pineapple and oranges

Types of Parthenocarpy

Vegetative Parthenocarpy

- Plants do not need pollination to produce fruits
- Result in the development of seedless fruit
e.g. banana and seedless cucumber

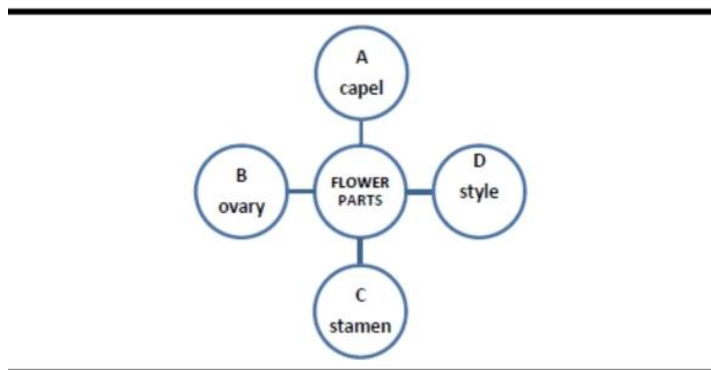
Simulative Parthenocarpy

- It needs pollination to produce fruits
- It occurs when pollen tube does not reach the ovule or sometimes embryo abort after fertilisation
e.g. seedless grape

Activity 75 (Plant science)

Plant sexual reproduction

1.1 The circle below represents flower parts of a dicotyledonous plant. Match the letters (A to D) to the description below



- 1.1.1 male organ
- 1.1.2 modified floral leaves which form the pistil
- 1.1.3 a part of the pistil that produces egg cell
- 1.1.4 a tube connecting the stigma to the ovary
- 1.1.5 define the underlined description in 1.1

Activity 2 (PLANT SCIENCE)**Plant sexual reproduction**

1.1

Bees are stinging winged insect which collect nectar and pollens, producing wax and honey. They usually live in large communities and are found flying from mostly during the spring and summer season



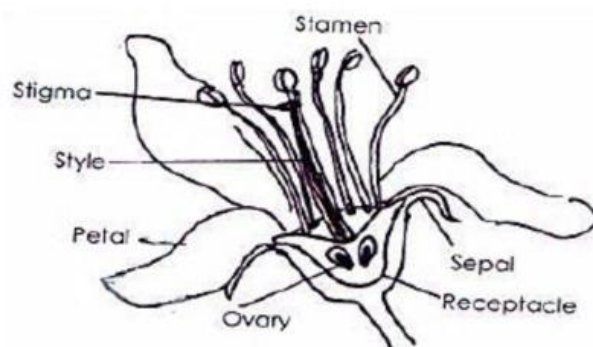
1.1.1 Deduce the process in 1.1

1.1.2 Mention TWO other agents that perform the process in 1.1

1.1.3 Define the process in question 1.1.1

Activity 77 (plant science)**Plant sexual reproduction**

1.1 the illustration below shows the parts of a flower



1.1.1 identify the parts that will develop into a fruit

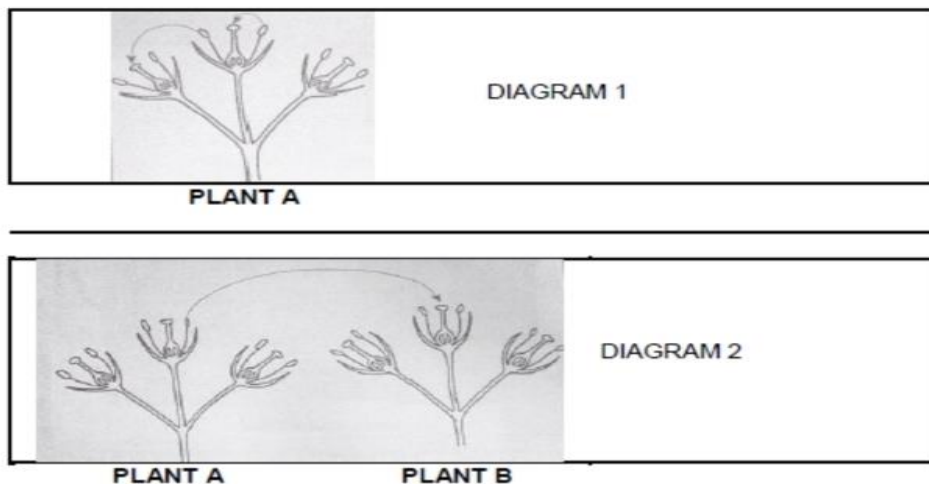
1.1.2 indicate the part that receives pollen grain during fertilisation

1.1.3 suggest the term for the part that consist of stigma, style and ovary

1.1.4 state TWO important role of petals in sexual reproduction

Activity 78 (Plant science)**Plant sexual reproduction**

1.1 the diagrams below show the germination of a dicotyledonous and monocotyledonous plant



- 1.1.1 Deduce the process that is taking place in DIAGRAM 2
- 1.1.2 Explain briefly THREE ways in which plants are adapted to wind pollination
- 1.1.3 State the THREE other agents of pollination apart from wind

Activity 79 (plant science)**Plant sexual reproduction**

1.1

Before seeds and fruits are formed, fertilisation should take place. In some cases, double fertilisation take place. The fertilised flower gives rise to sees and fruits. The ovule develops into a seed which feeds and protect embryo. The ovary itself develops into a fruit. The fruit protect the seed amongst other functions

- 1.1.1 differentiate between *fertilisation* and *double fertilisation*
- 1.1.2 deduce ONE function of a fruit from the scenario
- 1.1.3 state TWO basic requirement for seed germination

ASEXUAL REPRODUCTION

What is asexual reproduction?

Is the reproduction of plant from a piece of a parent plant other than the seeds

Types of asexual reproduction

Natural asexual reproduction

- Is the natural process that take place without seed formation
- Different parts of a plant such as the **stem**, **leaves** and **roots** are used to grow new plants.
- Only one parent is involved and there is no fusion of male and female gametes

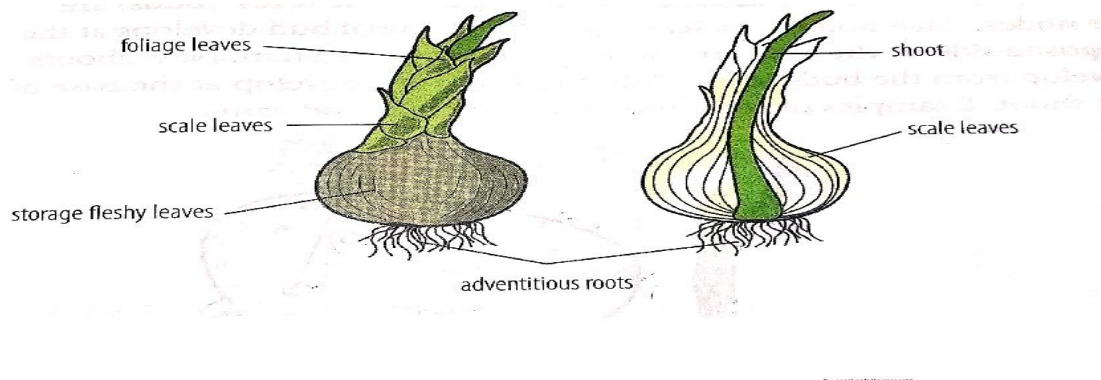
Artificial propagation

- It does not occur naturally
- It involves use of methods such as **budding** and **grafting** to grow new plants
- Different plant parts are used to grow new plants asexually

Method of asexual reproduction

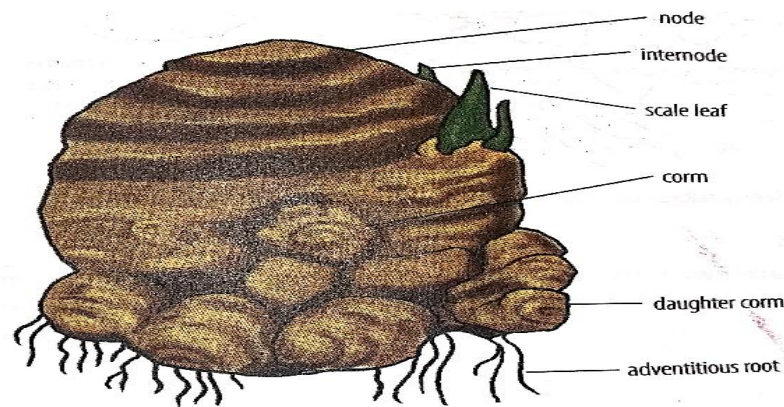
Bulbs

- This are swollen underground stems covered by fleshy scale leaves that store food
 - Adventitious root grows at the bottom end of the stem
 - Green leaves grow from the bulb
- e.g. Onions, garlic



Corns

- They are short, thick, round underground stem that store food.
 - They are covered by dry scaly leaves
 - Buds at the bottom scale-like leaves grow into new plants
- e.g. freesia and gladiolus



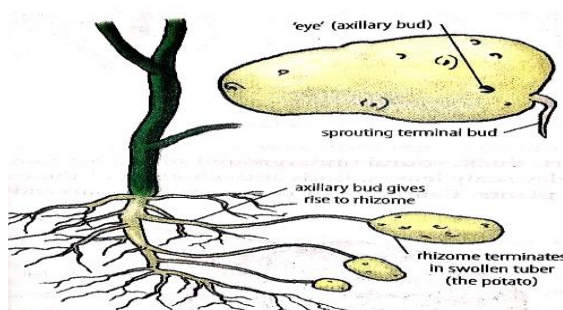
Tubers

This are modified plant parts (stem and root) that are used for asexual reproduction

Stem tubers

- Is a swollen underground modified stems with nodes and internodes?
- They serve as food storage organ
- The eye bud are the nodes
- Shots develops from the eye bud
- Adventitious roots develop at the base of the shoot

e.g. potatoes and yams



Root tubers

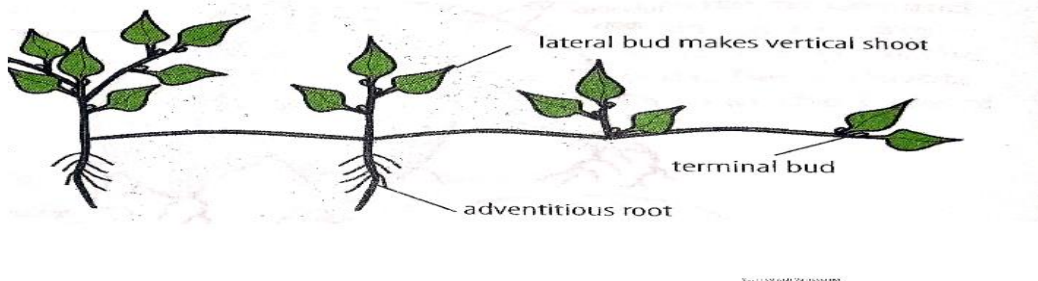
- This are swollen adventitious roots in which food is stored
- New plants grow from the buds

e.g. sweet potatoes

Runners

- Stems that grows in the surface of the soil
- When it bends over and touches the ground, new adventitious roots develop and new plant arises

- As soon as the shoot root, it eventually separates from the parent plant
- Runner grows out from the base of main stem of the parent plant
e.g. strawberry and grass



Rhizomes

- Is the thickened underground stems that grow more or less parallel with the surface of the soil
- At the nodes, adventitious root develops and new plant grows from the terminal bud at the tip of the rhizome
- New plant can be cut from the rhizome and planted separately
e.g. ferns, grasses and ginger

Types of artificial asexual reproduction in plants

Cutting

It is taken from stem, leaves or roots of parent plant and grow into new plants

Stem cutting- stem must have few nodes and buds and must be cut at an angle.

when stem is planted into develops roots and shoots

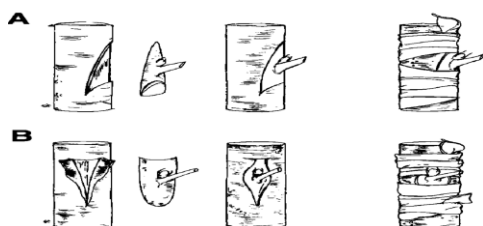
Leaf cutting- consist of aa leaf with a leaf stalk. When placed in the soil they develop

Roots and shoot

Root cutting- planted horizontally in well-drained soil where they develop into a shoot

Budding

In budding, a single bud from a plant with good characteristic is inserted into an opening in the bark of well-developed plant.



Grafting

In grafting, a whole section with several buds is inserted to plant with well-developed characteristics



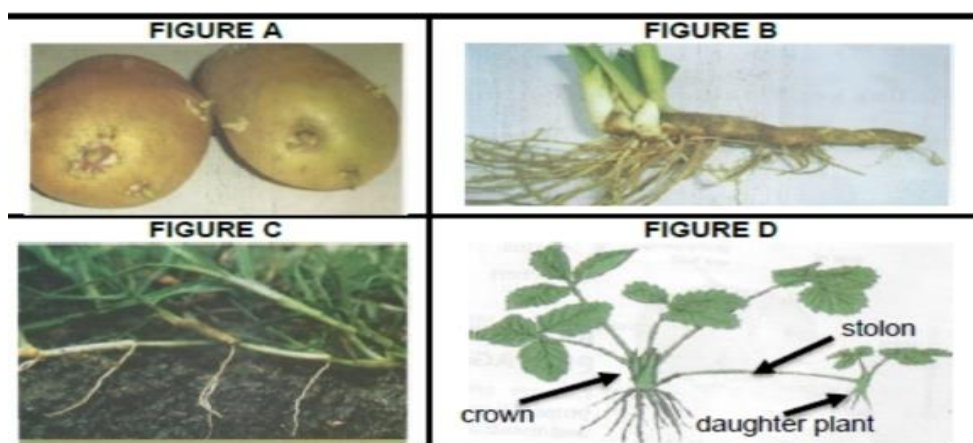
Advantages of using asexual reproduction methods in plants

- It is faster than sexual reproduction
- Large number of offspring can be produced fast
- New plants can be produced from existing plants without using seeds
- No fertilisation needed
- Seed germination is not necessary

Activity 80 (plant science)

Plant asexual reproduction

1.1 different plants parts may be used for vegetative reproduction. Some plant parts are shown in the illustration below



1.1.1 identify the type of asexual reproduction in figure A, B, C and D

1.1.2 list TWO disadvantages of using the method in FIGURE A for propagation

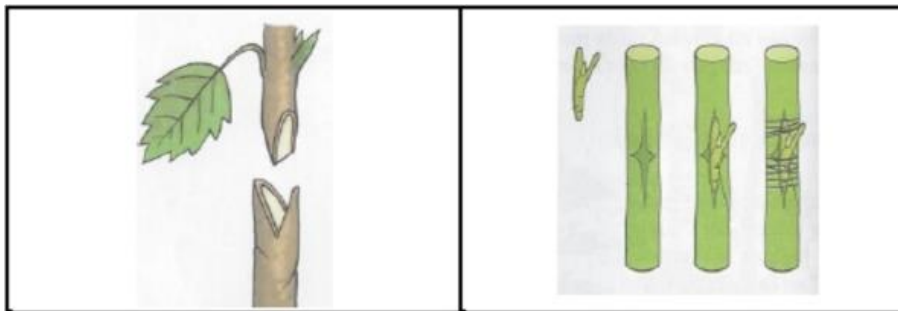
1.1.3 outline the difference between sexual and vegetative reproduction plants

activity 81 (plant science)**plant asexual reproduction**

1.1

A

B

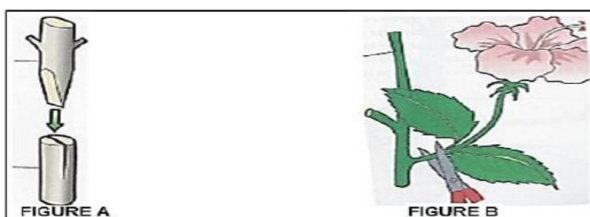


1.1.1 Determine the type of asexual reproduction technique in A and B above

1.1.2 give THREE reason to justify the use of asexual reproduction in plants propagation

Activity 3 (plant sciences)**Plant asexual reproduction**

1.1 farmers use different methods of plant propagation on their farm. Two of the propagation methods are shown in the illustration below



1.1.1 identify the propagation method in FIGURE A and FIGURE B

1.1.2 recommend THREE reasons to convince emerging farmer to practice the methods in

1.1

Activity 4 (plant science)**Plant asexual reproduction**

1.1

Asexual or vegetation propagation is of great importance in crop production, especially in horticultural crop production. This can be divided into natural or artificial propagation

1.1.1 categorise the following into natural and artificial vegetative method of asexual propagation:

Stolons	budding
Layering	Corns

1.1.2 State TWO advantage s of vegetative propagation

Activity 5 (plant sciences)

Plant asexual reproduction

The storage organ is a part of plant which is modified to store or retain carbohydrates or water. Most storage organs are often found below ground level where they protected

1.1.1 Supply THREE parts of plant modified as storage organ

1.1.2 Indicate ONE chemical process that result in the formation and storage of carbohydrates in plants

1.1.3 State TWO requirement for the process indicated in 2.1

1.1.4 Identify ONE product of the process indicated in 2.1.1 that is stored in plants

Plant improvement and biotechnology

Plant breeding

It involves the development of new plant varieties

Plants are bred for desired characteristic with the aim of improving crop production

It is done through genetic variation of plants.

Plant breeding method:

1. Selection

- method of choosing plants with desired characteristic for breeding purpose

Characteristic of plants to be considered when selecting animals for breeding:

- Productivity
- Better taste
- Resistance
- Adaptation to environment
- Efficient use of water and nutrient

2. Hybridisation

- Different desired characteristic from different plants are combine in one plant
- Two different but related plant species are crossed

Mutation

The aim of mutation is to improve crop quality by improving genetic variation

Mutation can be introduced artificially by using agents such as radiation and chemical

The desired mutants will be selected to interbreed to produce new crop variety

Aim of genetic mutation

- It contributes to food security
- It provides additional income to farmers
- To increase production
- Introduce plants that are resistant to disease

Biotechnology

Is the application of technology to modify plant or make new plants

Genetic modification (GM)

- Is the technique of changing the characteristic of a plant by introducing gene from another plant
- It is carried out in the laboratory
- Plant whose characteristics are changed is called GMO
- It does not occur in nature

Characteristics of genetically modified organism (GMO)

Resistance to diseases and pest

Resistance to drought

Improved taste

Higher nutritional value

Increase crop yield

Long shelf life

Disadvantages of GM crop

Causes unknown disease

It is too expensive

Cause food allergies

Have negative impact on biodiversity

Examples of genetically modified crops in S.A

Maize

Cotton

soybean

PLANT PEST/ PARASITES AND DISEASE

Weed control management

What is weed?

- It is an unwanted plant that usually have a negative impact on agricultural soil.
- They are small herbaceous plant
- They compete with crop for **light**, **nutrients** and **water**
- It interferes with normal growth of a crop and weakens productivity of plant

Adaptation features of weeds that allow them to grow successfully

- Grow on disturbed environment where soil is damaged
- They produce large amount of seed that can easily disperse
- It can persist in the soil for years
- They can thrive in harsh environmental conditions

Agents of weed dispersal

- **Birds** – They eat fruits and seeds from weeds and carry seeds elsewhere
- **Human** – They disperse weed seeds when they are stuck on their clothes and **shoes**
- **Animals** – They spread weed seed when they are stuck on their fur
- **Wind**

Harmful effects of weeds

- They compete with cultivated crops for space, light, nutrients and water
- Slow growth of plants
- They carry disease that reduce quality of crops
- Increase food shortage

Weed control

Mechanical control

It includes:

- physically uprooting of weed
- burning of field to destroy weed

Chemical control

It includes:

- spraying herbicides to the soil

Biological control

It includes:

- use weed natural enemy

Integrated weed control

It includes:

- combination of two or more weed control methods

- using both physical, chemical and biological control at the same time