UNDERSTANDING
O' LEVEL
COMBINED SCIENCE
STUDY PACK

M. GWENZI

APPROVED BY MINISTRY OF PRIMARY AND SECONDARY EDUCATION
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Contents

CELLS AND LEVELS OF ORGANISATION

Specialised cells

By the end of the topic, you should be able to;

- identify specialized cells
- draw and label specialised cells
- state the function(s) of the specialised cells in relation to structure
- use a microscope to observe cell structure

The cell is the basic unit of life.

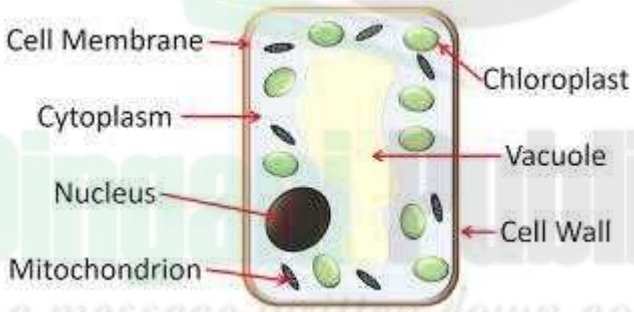
A specialised cell is a cell which is adapted to performing specific functions in **living organisms.**

Examples of specialised cells:

Reproductive cell, muscle cells, blood cells, brain cells, skin cells, xylem cells, root hair cells, palisade cells, sensory cells.

Palisade cell

Function: to photosynthesize

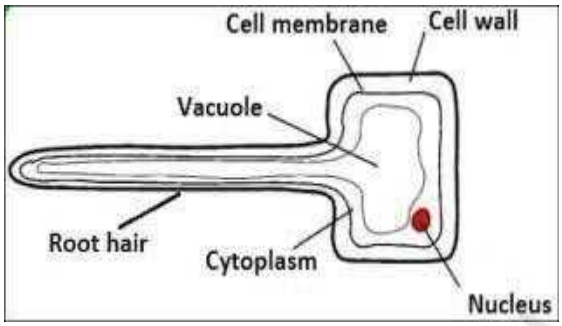


Adaptations:

- It is box shaped to increase surface area
- It has large surface area to maximize absorption of light
- It has chloroplasts which contain chlorophyll

Root hair cell:

Function: to absorb water and minerals from the soil

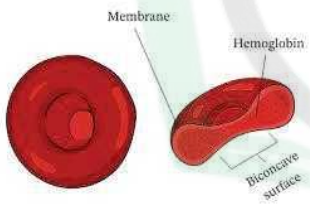


Adaptations:

It is elongated to **increase surface area**
It has large surface area to **increase area for absorption**
It has a lot of mitochondria to produce energy needed to absorb minerals

Red blood cells:

Function: to **transport oxygen** from lungs to body cells



Adaptations:

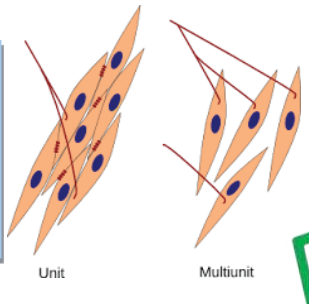
It has a red pigment called **hemoglobin** for absorbing oxygen
It is **bi-concaved** to increase surface area
It has **no nucleus** to increase area for hemoglobin

Muscle cell:

Function: to **contract and relax** in order to produce movement

Adaptations:

It is **elastic**.
Has a lot of **mitochondria** to produce energy.



Ecosystems

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

- Explain the term ecosystem
- List components of an ecosystem
- Explain natural ecosystem
- Construct food chains, food webs and pyramids of biomass.
- Explain how energy is lost in food chains and food webs
- Describe the carbon and nitrogen cycles
- Describe an artificial ecosystem
- Explain bio-diversity
- Identify problems caused by limited bio-diversity
- State advantages of biodiversity

What is an ecosystem?

Answer: It is a self-contained system of **interdependent** organisms and their physical environment.

State the two types of ecosystems

Natural ecosystem: an ecosystem where there is **no human interference**. Nature chooses who live and who dies. Organisms that are adapted to the environment will live while those that are not will die. Examples of natural ecosystems are forest, ocean, and lake. There is a lot of **biodiversity in these ecosystems.**

Artificial ecosystem: an ecosystem where there is **human interference**. Humans determine who lives and not live. Food grown there is for human consumption. There is little biodiversity. Examples include an orchard, garden and crop field

State the two components of an Ecosystem

- **Biotic**: (biological components) living organisms
- **Abiotic**: (physical factor) non-living environment Air, water, soil, rocks, and mineral salts

What is a food chain?

- Show the flow of energy in an ecosystem

Eg producer → primary consumer →secondary consumer → tertiary consumer.

A. Producers

- These are green plants

- They make their own food through photosynthesis

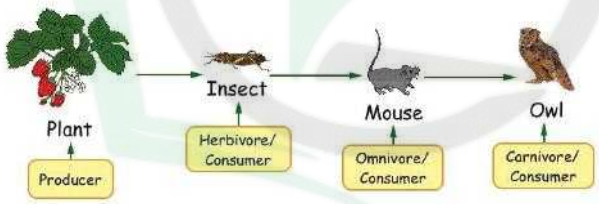
B. Consumers

Herbivores –animals which feed directly on plants such as giraffe, goat, cattle, sheep and hare.

Carnivores –animals that feed indirectly from plants / feeds on meat for example lion, hyena, cheetah, leopard, snake, vulture

Omnivore – feed on both meat and plants man, baboons and pigs are good examples of omnivores.

Example of a food chain



A food chain shows the path of energy from one living thing to another.
Decomposers like bacteria, are necessary for all food chains.

In a food chain/web what does the arrow mean?

The arrow points to the eater. It shows the flow of energy from one trophic level to the next.

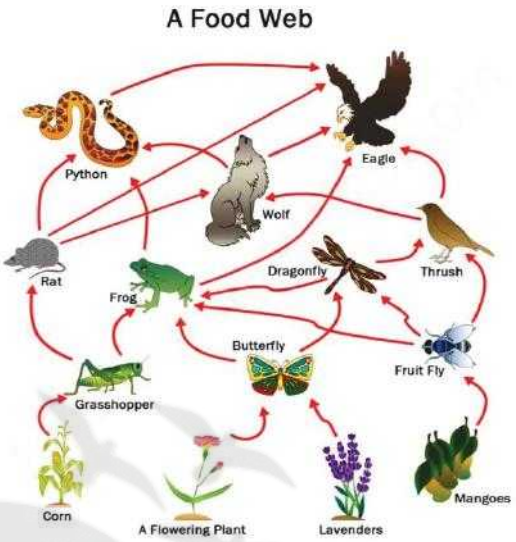
- Every food chain includes producers
- All producers are green plants
- Energy is lost at each feeding level. Energy is lost as wastes and heat.
- The energy is originated from the sun

Food web

It is a combination of more than one food chain. Energy is transferred from one organism to another during feeding.

Energy is lost as heat in the form of;

respiration
movement
excretion



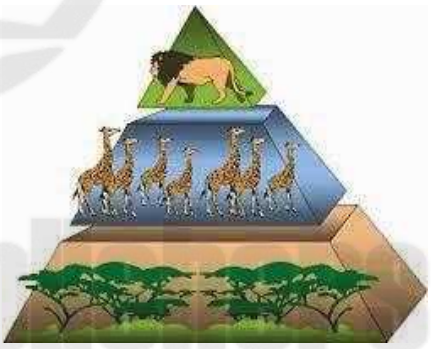
Food pyramids

Another way of showing feeding patterns.

Types of pyramids:

pyramid of biomass
pyramid of numbers
pyramid of energy

a. pyramid of mass/ biomass

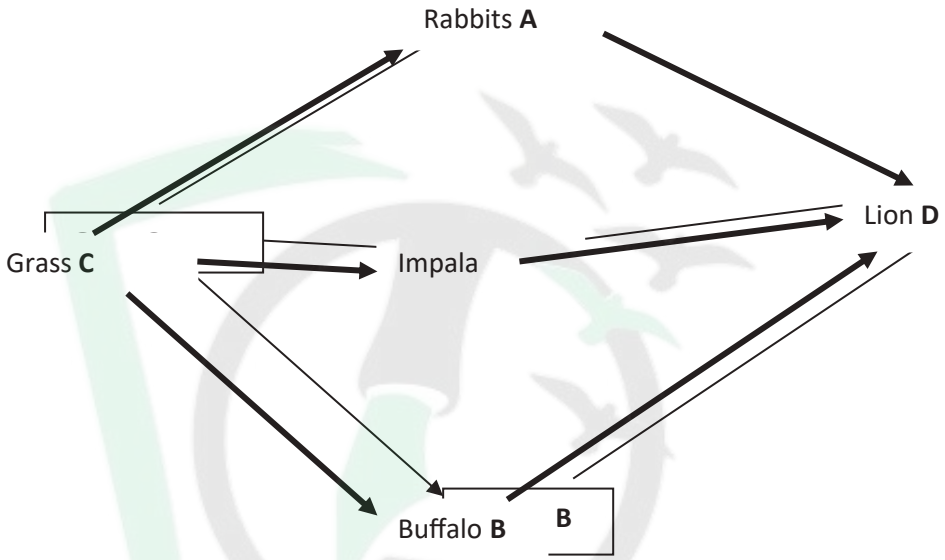


pyramid of numbers

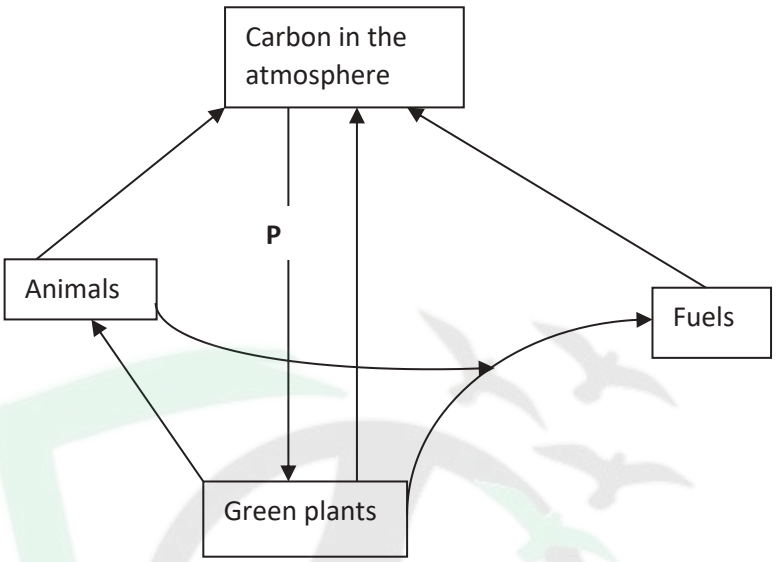
13. Which characteristic shows discontinuous variation in humans?

A. Sex
B. Shoe size
C. Weight
D. Height

14. The diagram shows a food web. Which group of organisms will be found in smallest numbers?



15. The diagram below shows part of the carbon cycle.

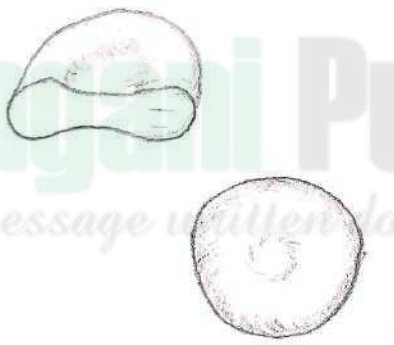


What is process **P?**

a. Respiration
b. Combustion
c. Photosynthesis
d. Fossilization

Section B

16. The diagram below shows a specialised cell found in animals.



a. Identify the type of cell shown. [1]
b. Describe any 3 adaptations of the cell to its function. [1]

17. The palisade cell is a specialised cell.

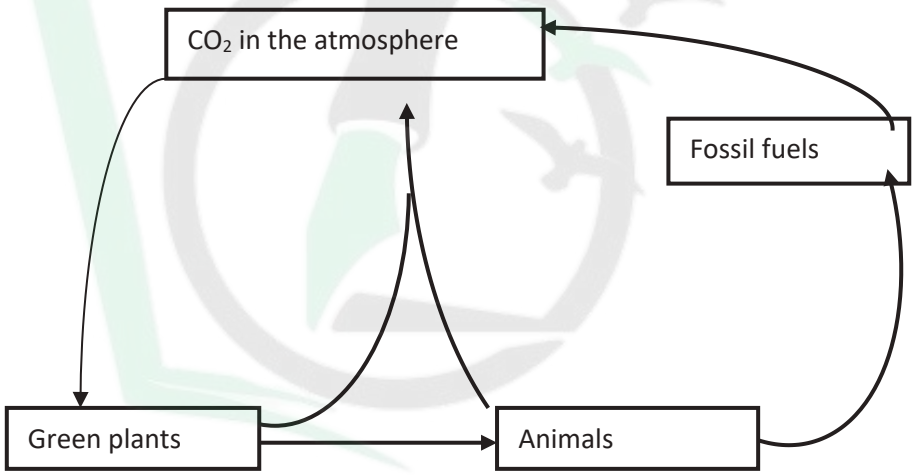
a. What is the special function of the palisade cell? [1]
b. How is the palisade cell adapted for its function? [3]

18. Define the term ecosystem and state 2 types of ecosystems?
a. Give 2 examples of each type of ecosystem.

19. There are different ways to represent the feeding patterns in an ecosystem.
a. What is a food chain?
b. Construct a typical food chain for a rain forest which has at least 3 trophic levels.
c. Why green plants are called producers in an ecosystem?
d. Explain why a food web is a better way to represent feeding patterns than a food chain.

20. Explain why food pyramids are wider at the bottom.

21. The diagram below shows a simplified Carbon cycle.



a. Describe the role of the following processes in the carbon cycle.
1. Photosynthesis.
2. Feeding
3. Combustion
4. Respiration.

22. A garden is an example of an artificial ecosystem.
a. Construct a food chain that can be found in a garden.
b. Describe any two characteristics of an artificial ecosystem.
c. What is biodiversity?
d. State any 2 disadvantages of limited biodiversity [2]

NUTRITION

Plant Nutrition

By the end of the topic, you are expected to:

Identify green plants as producers of an ecosystem
Define the term photosynthesis
Write down the word equation for photosynthesis
State factors which affect photosynthesis
describe experiments on factors which affect photosynthesis
describe the fate of end products of photosynthesis
identify parts of the internal structure of a leaf
describe how the leaf is adapted for photosynthesis

Why are green plants called producers?

This is because they **make their own food and food for the whole ecosystem**.

Green plants can convert light energy from the sun into chemical/stored/potential energy.

This is done through a process called photosynthesis.

Define the term Photosynthesis

- It is the process by which green plants manufacture their own food
- A process by why green plants make their own food using carbon dioxide and water in the presence of light energy and chlorophyll.
- Plants convert light energy using chlorophyll and convert it to glucose and oxygen.

Write down the word equation for photosynthesis.

$$\text{carbon dioxide + water} \xrightarrow[\text{chlorophyll}]{\text{sunlight}} \text{glucose + oxygen}$$

Raw materials of Photosynthesis

- Carbon dioxide
- Water

State the conditions necessary for photosynthesis to occur

- Chlorophyll
- Sunlight
- Carbon dioxide

Sources of raw materials for photosynthesis

Water – it is absorbed from the soil by the roots (osmosis) & transported up the stem to the leaf where it is used

Carbon dioxide– it moves into the leaf from the air by the process of diffusion through the stomata (tinny holes under the leaf).

Factors affecting the rate of photosynthesis

There are 4 factors affecting the rate of photosynthesis,

Amount of carbon dioxide – as concentration of carbon dioxide increases in the air, the rate of photosynthesis also increases.

Light intensity- as light becomes brighter, the rate of photosynthesis increases

Temperature – as temperature increases, so does the rate of photosynthesis. However a temperature above 38°C the high temperature kills the plant.

Amount of water available – adequate amounts of water are needed & any shortage will slow down photosynthesis.

Products of Photosynthesis

Main product- glucose

By- product- Oxygen

What happens to the products of photosynthesis?

Main product- glucose

- Some glucose is used by the plant for **respiration**
- Some is **converted to starch and stored** in storage organs like stem, leaves, fruits, tubers, bulbs and roots.
- Some glucose is used as **a building block** by the plant to make other
- complex compounds, like proteins, roughage,

By-product – oxygen

- Most of the oxygen **diffuses into the air.**
- Some of the oxygen is used by plants during **respiration**.

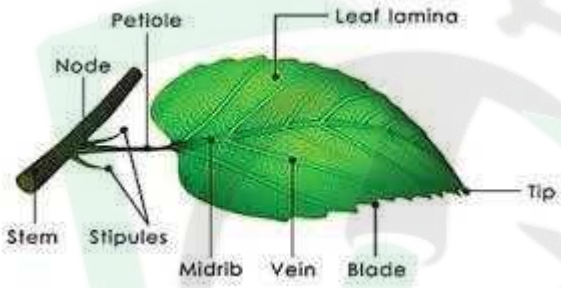
Where does photosynthesis occur?

All green parts of the plant photosynthesize.

Most of it occurs in **the leaves**.

Structure of the leaf

External structure

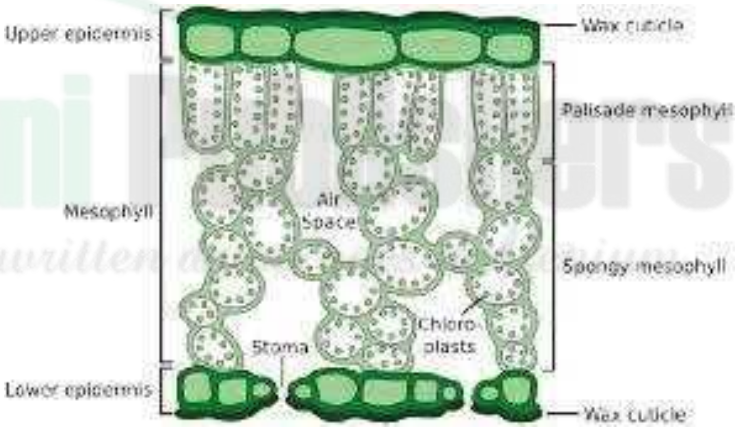


Internal structure

Cuticle - It is a thin waxy layer at the top of leaf which is transparent to allow light to pass through.

Upper epidermis - It is a layer of cells which protects the leaf.

Palisade mesophyll layer - These cells contain most of the chloroplasts and carries out the most of the photosynthesis.



Spongy mesophyll layer - It is a layer of cells with spaces in between them which allows diffusion of carbon dioxide and water. The layer carries out photosynthesis and stores nutrients.

Vascular bundle - It contains xylem vessels which carry water and phloem vessels which carry nutrients.

Lower epidermis - It is similar to upper epidermis but it contains small holes called **stomata**. These holes control the movement of carbon dioxide into the leaf and oxygen out of leaf. Special cells called **guard cells** controls the opening and closing of the stoma allowing the gaseous exchange.

What are the adaptations of leaves to photosynthesis?

- **leaves are broad** to increase surface area for trapping more light
- The leaves **are thin** to allow the penetration of sunlight and easy diffusion of carbon dioxide.
- The leaves are **green (have chlorophyll) to trap light**.
- **Spongy cells have airspaces** between them which allow easy gaseous exchange.
- The leaves have an extensive **network of veins** to supply water to the leaf and carry manufactured sugars to storage areas.

Importance of photosynthesis

It produces carbohydrates which are food for animals. The plants themselves also manufacture their own food. This is why plants are called Producers when looking at food chains and food webs.

Photosynthesis produces oxygen which is used by plants and animals during respiration.

Plants use carbon dioxide during photosynthesis which helps to reduce global warming.

Photosynthesis converts light energy into chemical energy. This chemical energy can be used for many processes in our everyday life such as burning and respiration.

Experiments

Experiment 1: Testing a leaf for starch

Method:

Step 1:

Boil the leaf in water for about 30 seconds

Reason: to kill the leaf/ to stop chemical reactions.

Observation: the leaf becomes soft

Step 2:

Boil the leaf in ethanol.

Reason: to decolourise the leaf/ to remove chlorophyll.

Observation: the leaf becomes white in colour and hard and brittle

NB: do not directly heat ethanol because it is highly flammable. Rather use a water bath. And switch off the burner.

Step 3:

Dip the leaf in hot water.

Reason: to soften the leaf

Observation: the leaf becomes soft.

Step 4:

Spread the leaf on a white tile. And add few drops of iodine solution.

Observation: the iodine solution becomes blue/black to show presence of starch.

Diagram

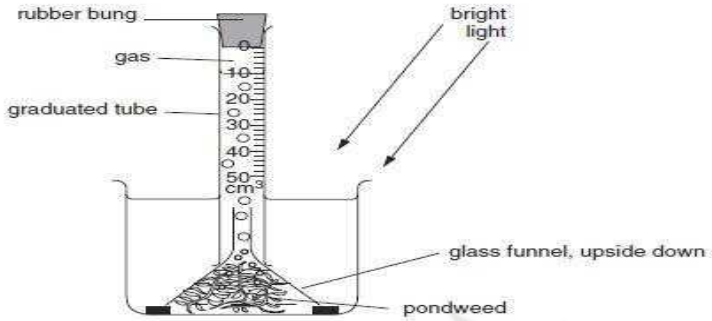


Fig. 4.1

Observations

Gas bubbles were seen coming from the weed and collecting in the test tube.

The collected gas increased with time pushing the water in the test tube.

When the test tube was removed without turning it, a glowing splint was put inside, the splint re-ignited.

Conclusions

The relighting of the glowing splint proves that the gas that collected was oxygen. Oxygen promotes burning.

Revision Test

1. Green plants are called
   B. Secondary consumers
   C. Decomposers
   D. Producers
   E. Tertiary consumers

2. Identify a correct statement about photosynthesis
   A. A process where green plants make their own food
   B. A process where plant lose water to the atmosphere
   C. A process where organisms die
   D. A process where plants take up minerals from the soil

3. The following are conditions necessary for photosynthesis to occur except____
   A. Water
   B. Carbon dioxide
   C. Chlorophyll
   D. Oxygen

4. Which one is a by-product of photosynthesis?
   A. Oxygen
   B. Carbon dioxide
   C. Glucose
   D. Water

5. When testing a leaf for starch, the leaf is boiled in water for 30 seconds in order to;
   A. Remove chlorophyll
   B. De-starch the leaf
   C. Stop all chemical reactions
   D. See if the leaf has starch

6. One precaution that should be taken when testing a leaf for starch is to avoid heating ethanol directly over a flame because;
   A. Ethanol vapour is highly flammable
   B. Ethanol is a good conductor of heat
   C. Ethanol produces a poisonous gas when heated
   D. Ethanol will explode

7. Which statement is **not** true about the fate of the end products of photosynthesis
   A. Glucose is converted to starch
   B. Some oxygen is released into the atmosphere
   C. Some oxygen is kept inside the plant
   D. Some glucose is stored in the leaves.

8. Which of the following is **not** an adaptation of the leaf for photosynthesis?

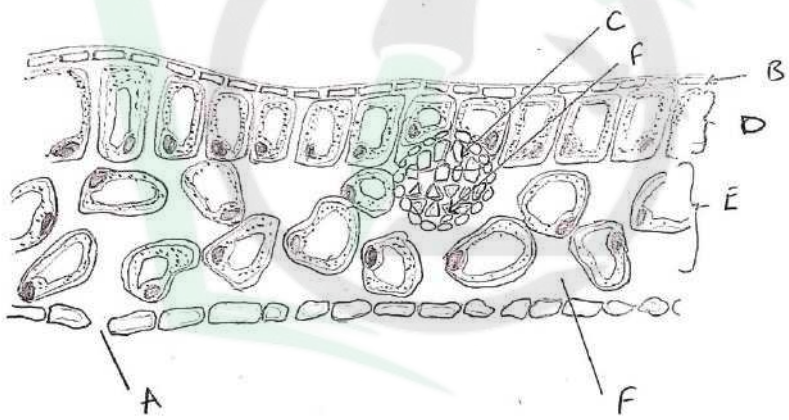
A. Large surface area
B. Presence of chlorophyll
C. Presence of stomata
D. Small surface area

9. The table below shows some gases used by biological processes. Which row is showing correct information?

	Uses carbon dioxide	**Uses oxygen**
A	Absorption	transpiration
B	Photosynthesis	Respiration
C	Respiration	Photosynthesis
D	Transpiration	Absorption

Section B

10. The diagram shows the cross section through a leaf.



(a) Label the parts A to F [6]

(b) State one function of structures A, C and F [3]

(c) Write down the word equation for photosynthesis [2]

(d) State the conditions necessary for photosynthesis to occur. [3]

(e) The products of photosynthesis are glucose and oxygen

i. State which one is by- product and which one is main product. [2]

ii. What happens to glucose and oxygen after photosynthesis [4]

10. The diagram below shows two blood vessels

X Y

a) Name the vessels X and Y [2]
b) Describe any three differences between the two vessels [3]
c) Describe the characteristics of a blood capillary [1]

REPRODUCTIVE SYSTEMS

Reproduction in Plants

Topic objectives

By the end of the topic, you are expected to be able to:

- explain the structures of wind and insect pollinated flowers
- describe advantages and disadvantages of different methods of asexual reproduction in plants
- identify methods of asexual reproduction in plants
- outline the differences between sexual and asexual reproduction in plants
- calculate percentage germination describe the process of germination

Reproduction is the process by which organisms make more of their kind.

There are two types of reproduction

a) Asexual reproduction and
b) Sexual reproduction.

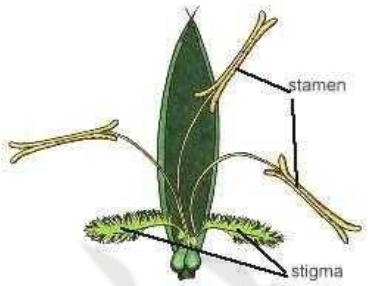
Sexual Reproduction

Sexual reproduction is the process involving the fusion of **male sex cells and female sex cells** to produce a new offspring.

The structure of a flower

In a plant, the organs which are responsible for sexual reproduction are the flowers. The diagram below shows a typical flower.

Structure of a flower - Diagram



1	Stigma	Receives pollen grains during the process of pollination
2	Style	Supports the stigma Provides pathway for pollen tube to the ovules
3	Ovary	Produces ovules Later develops into fruit after fertilization
4	Ovule	Are the female sex cells Develops into a seed after the process of fertilization
5	Petals	Attract insects for pollination by their bright colour and nice scent Their shape promotes pollination as they direct insects towards the nectarines
6	Sepals	Protects the flower bud
7	Anther	Produces pollen grains
8	Pollen grains	These are the male sex cells

Sex cells

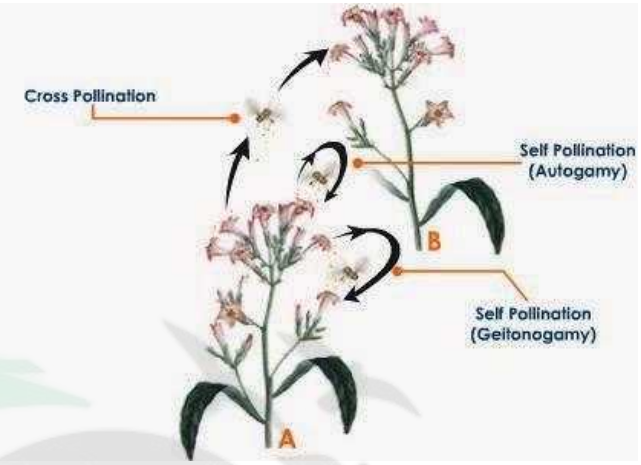
Sex cells are called **gametes**. The male gametes are produced by the anthers and are inside the pollen grains. The female gametes are produced by the ovary and are inside the ovules. Some flowers can produce both male and female gametes.

Define pollination:

Pollination is the transfer of **pollen grains** from the anthers to the stigma of a flower.

State the types of pollination:

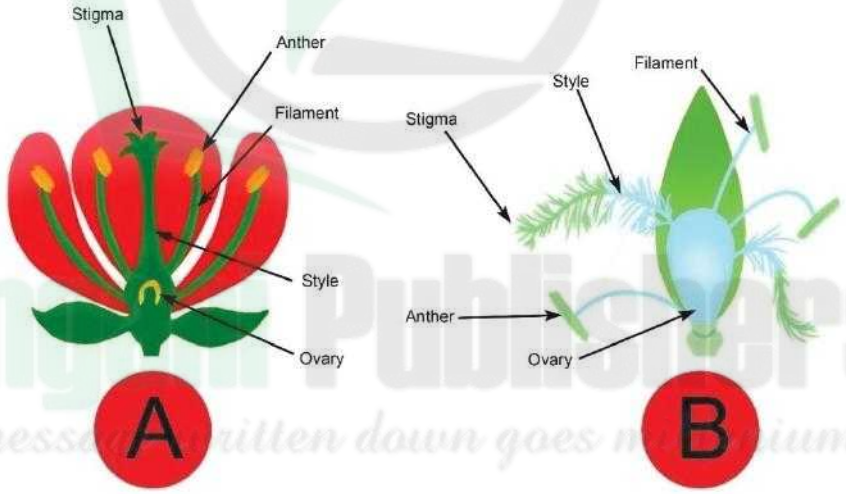
a. **Self-pollination:** transfer of pollen grains from anther to stigma of the same flower
b. **Cross pollination**: transfer of pollen grains from anther of one flower to stigma of another flower/plant of the same species.



Methods / agents of Pollination

There are two methods of pollination,

insect pollination
wind pollination.



Comparing wind pollinated and insect pollinated flowers

	Insect pollinated Flowers	Wind Pollinated Flowers
Petals	Petals are bright and produce a nice scent to attract insects	Dull coloured, usually green or brown and produce no scent as there is no need to attract insects
Size of pollen grains	Produce large sticky pollen grains	Produce small smooth pollen grains which are light enough to be carried by the wind
Quantity of pollen grains produced	Relatively small number of pollen grains as chances of pollination are high	Produces a large quantity of pollen grains to increase the chances of pollination
Position of stigma and anthers	Inside the flower	Are hanging outside the flower
Nectaries	They have nectarines which produce nectar to attract insects	No need for nectarines

Describe what happens after pollination

Pollen germination

When pollen grains land on the stigma, they germinate and grow a pollen tube down the style to the ovary. The male gamete travels down the tube and fertilises the ovule.

Fertilization

- The fusion/joining of the male and female sex cells to form a zygote.

After fertilisation

Zygote develops into a seed

Ovary develops into a fruit or seed pod

Petals, anther, stigma, style and filament dry up.

SEED DISPERSAL

This is the scattering of seeds away from the parent plant

Importance: it reduces overcrowding of plants

- Ensures that new colonies are reached
- Reduces competition for resources like air, water and food

State methods of seed dispersal

a. Wind dispersal occurs in plant with seeds which have wing like structures which allow the wind to carry them to new areas.

b. Some plants have small horns or thorns which enable them to stick to **anima**l skins and are carried to new areas.

c. Some plants produce fruits which are sweet and edible. Animals eat them and drop the seeds in their dung some distance away from the parent plant.

d. Some fruit split with great force throwing the seeds some distance away from the parent plant.

Seed Germination

Germination is the process by which a seed develops into a new plant. A seed remains dormant until it is put in suitable conditions to start growing.

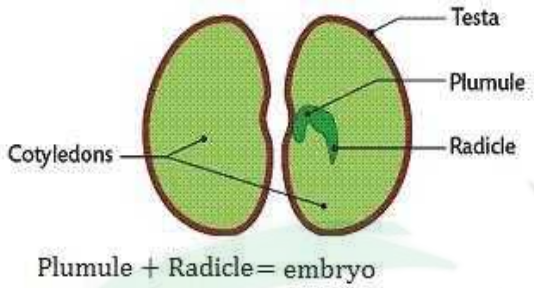
Question: State the conditions necessary for germination to occur?

a. Water(moisture)
b. Air (oxygen)
c. Suitable temperature(Warmth)

Types of Seeds

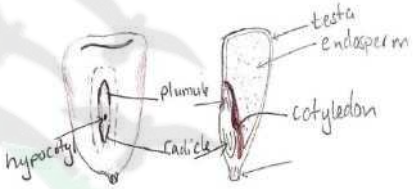
There are two types of seeds;

a. Dicotyledonous seeds e.g. bean seeds and
b. Monocotyledonous seeds e.g. maize seeds



Structure of a dicotyledonous seed and monocotyledonous seed

Diagram



Functions of Parts on a seed

Radicle -develops into the root system.

Plumule-develops to form the shoot, stem and leaves

3.Cotyledon -a store of food which is used during germination.

Endosperm-stores food which is used during germination.

Testa/Coat -protects the seed.

Micropyle- allows water and oxygen to enter the seed for germination to occur and also allows carbon dioxide produced during respiration to leave the seed.

Hilum-shows the place where the seed was attached to the ovary.

Differences between a maize seed and a bean seed.

	Bean Seed	**Maize Seed**
1.	Has two cotyledons	Has one cotyledon
2.	Does not have an endosperm	Has an endosperm
3.	Has a micropyle	Does not have a micropyle

Calculating percentage germination

% Germination = $\frac{number\ of\ seeds\ germinated}{number\ of\ seeds\ that\ germinated}$ **X 100**

In setup D above: ten seeds where planted and eight seeds germinated. The % germination is calculated as follows;

% Germination = $\frac{8}{10}$ **X 100**

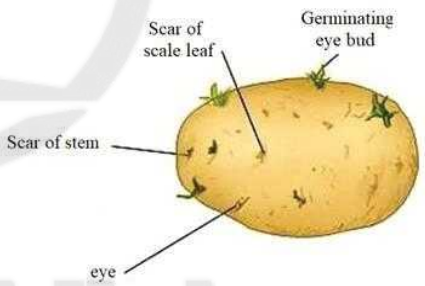
= 80 %

Vegetative reproduction / Asexual reproduction

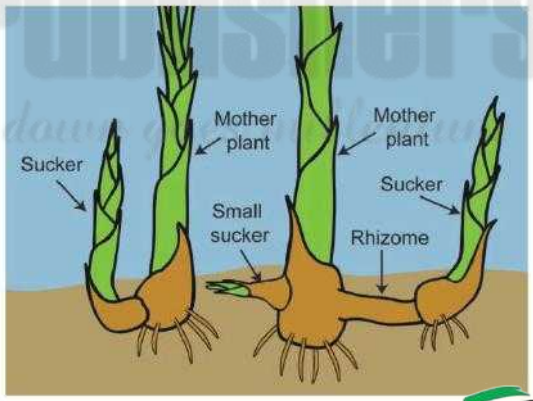
- Occurs when a piece of the parent plant is taken and used to grow a new plant.

No sex cells are used during this type of reproduction.

a. Tubers, e.g. potatoes. These are swollen parts at the end of an underground stem and they store food during photosynthesis. They have buds (eyes) which can develop into new plants.

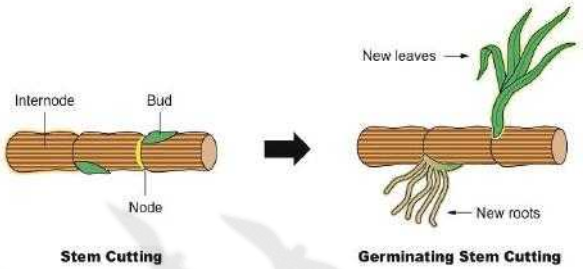


b. Rhizome e.g. strawberry plants, couch grass. An underground stem that grows horizontally underground or above and have nodes from which new



stems will develop towards the surface to produce new plants.

c. Cuttings. Such as sweet potatoes, sugar cane, cassava**.** Small parts of the plant are used to produce other plants. These portions of the parent plant are put into the ground in wet soil and will eventually grow into a new plant.



State the advantages of vegetative reproduction

- Good characteristics are maintained
- There is a higher chance of survival for the new plant.
- Plants mature much more quickly as there is no time wasted during germination.
- No need to find a mating partner and therefore it is quicker.

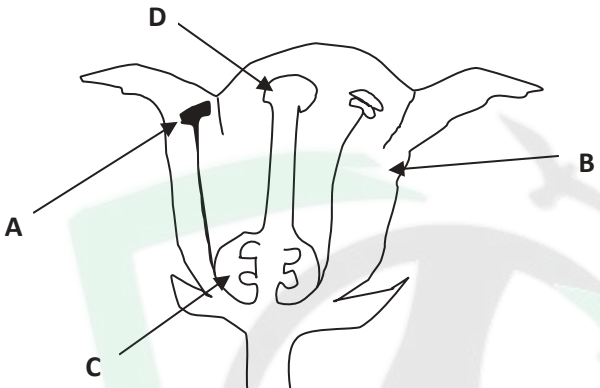
Disadvantages of vegetative reproduction

- No genetic variation
- Overcrowding leads to competition for nutrients, water, and light. This affects the growth of plants.
- Pests and disease spread quickly because of overcrowding.
- Not possible to obtain large number of plants in a short time compared with seeds.

Revision Test

Section A.

1. The diagram below shows a flower
Identify the part which produces pollen grains



2. Which one is **not** a characteristic of insect pollinated flowers?
- A. Large petals
- B. Presence of nectaries
- C. Exposed anther and stigma
- D. Scented petals

3. After fertilisation_____
- A. The ovary develops into a fruit/ seed pod
- B. Petals remain fresh
- C. Anthers produce more pollen grains
- D. Seeds germinate

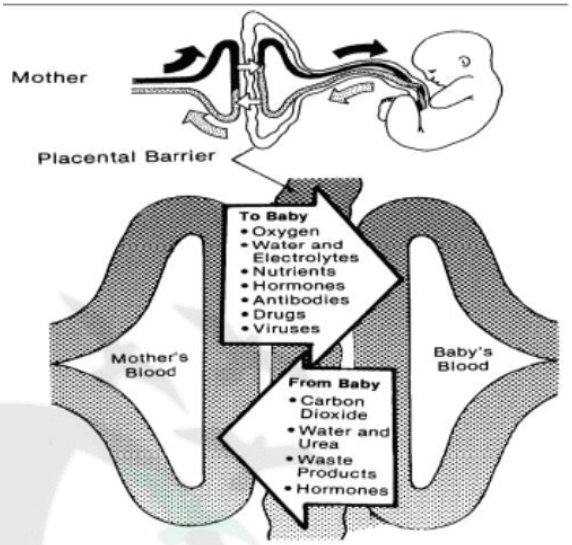
4. Which one is **not** an importance of seed dispersal?
- A. It reduces overcrowding
- B. It reduces competition for resources
- C. New territories are colonized
- D. It increases competition for resources

5. Which one is **not** a characteristic of asexual reproduction
- A. There is genetic variation
- B. It is fast
- C. Easy spreading of diseases
- D. There is no genetic variation

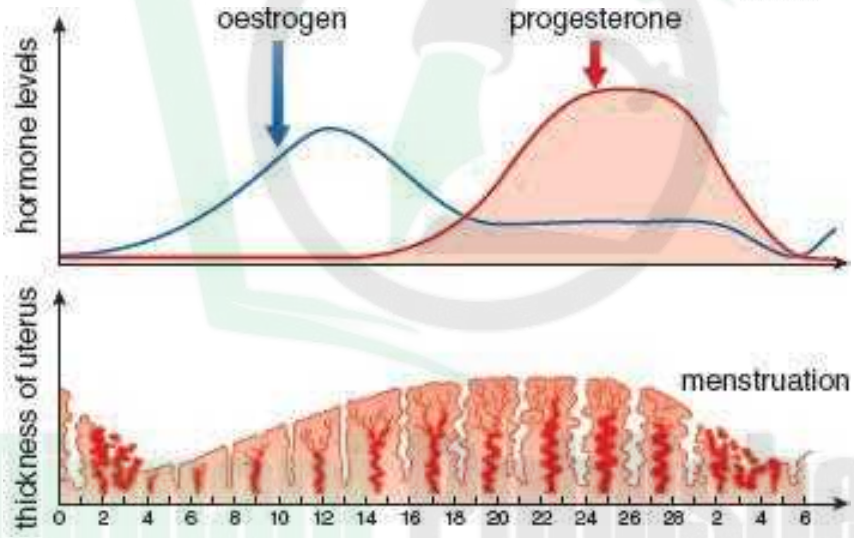
6. The following are conditions necessary for seeds to germinate except;
- A. Oxygen

Describe the role of the placenta during gestation.

The placenta is used to exchange substances between the mother and the foetus. The mother's blood brings in nutrients, oxygen, hormones, and immunity which will diffuse from the mother's blood into the foetus blood. Blood from the foetus will bring waste salts, waste substances and carbon dioxide which will diffuse into the mother's blood.



Menstrual cycle:



Important processes

Menstruation: peeling of the uterus lining. Occurs from day 0 to 4.

Ovulation: occurs around day 14. Release of the ovum by the ovary

Fertile period: is the period where sexual intercourse will most likely result in pregnancy. It is from day 11 to 16.

Contraception

Methods of birth control

1. **Natural Methods**
   b. **Abstinence**: don't have sex at all
   c. Rhythm method: It involves avoiding sex during the fertile period and having it only during the "safe period" (it involves keeping a record of the menstrual cycle and a record of body temperature so as to identify the fertile period. It tracks such characteristics as body temperature, cervical mucus and symptoms of ovulation pain.

Advantages

- It is free
- Accepted by religious and cultural groups
- Both partners participate

Disadvantages

- High failure rate
- Unreliable for women with irregular periods
- Requires training for one to learn how to identify the fertile period
- It needs motivation and discipline to record signs daily
- Imposes restrictions on sexual activities

Side effects

- Sexual frustration

d. **The Withdrawal Method**

This method involves withdrawal during sexual intercourse before ejaculation

Advantages

- It is free
- Accepted by religious and cultural groups
- Both partners participate

Disadvantages

- High failure rate as partners may get carried away.

- Some sperm may already have been deposited in the vagina before withdrawal.

2. Chemical Methods/ Hormonal Methods

b. **Contraceptive pill**: there are two types – the mini-pill contains progesterone which affects the uterus and makes implantation difficult, and the combined pill which contains oestrogen and **progesterone** (synthetic progesterone) and prevents ovulation.

Advantages

- Very effective (99,6% - 99,8%)
- Easy to use
- It is reversible
- It does not interfere with sexual activity
- Menstrual bleeding is lighter, shorter, and regular and there are fewer cramps.

Disadvantages

- Must be taken daily.
- May suppress the production of breast milk in some women
- Slightly increases the risk of a heart attack especially for women above 35 years.
- Increases chances of the formation of blood clots.

Side Effects

- Causes weight change
- Causes mood changes
- It causes breast tenderness in some women.
- It also causes spotting in the middle of the cycle.

c. **Injection (Depo-Provera)**

It prevents release of the egg from the ovaries and causes thickening of cervical mucus which disturbs the movement of sperms.

Advantages

- It is very effective (99,8%)
- It is convenient and private
- It is reversible

- It does not interfere with sex
- Improves breast feeding
- It does not interfere with other medication

Disadvantages

- Requires a doctor or nurse to administer Causes delays in returning to fertility
- It disturbs the menstrual cycle.
- Some people are scared of injections

Side Effects

- Headaches
- Weight changes and mood swings
- Causes a bloated feeling and may interfere with sexual desire.

d. **Spermicide**: a chemical applied as a gel, cream or foam to the vagina and it kills sperms. It is very unreliable on its own but makes barrier methods of contraception more effective.

Advantages

- It does not require a prescription
- Does not need medical supervision
- It is easy to use and has few side effects
- It improves the effectiveness of condoms and other mechanical methods.

Disadvantages

- It has a higher failure rate if used on its own. 60% -95% effectiveness
- It has to be used with every sex act
- It causes a mess
- Must be applied at least 3minutes and not more than 30minutes before sexual intercourse.

Side effects

- Can cause irritation to the penis or vagina.

3. Mechanical Methods/Barrier Methods

b. Male **and Female Condom**: thin rubber covering over penis, it protects from impregnation and STDs, used by man and women. It prevents sperms from entering the vagina

Advantages

- No need for prescription
- Provides protection against STIs
- May be used as extra protection with other methods
- It is reversible

Disadvantages

- Must be used with every sexual act before contact of sexual organs.
- There is a risk of bursting if used incorrectly
- Reduces sensation.
-

c. **Diaphragm/Dutch Cap**: it is a rubber cap or dome which is placed into the vagina to cover the cervix and prevent entry of sperms into the uterus. Must be used together with spermicide. It must stay in place 6 hours after sex and needs a correct size.

Advantages

- The cap can be reused for up to 2 years
- No health concerns

Disadvantages

- Needs training for proper use
- Has to inserted before every sex act
- May not work effectively after 2 or three natural deliveries
- Less effective if wrong size is used.

Side Effects

- Possible discomfort due to the size of the cap
- Possible irritation from spermicide..

d. **Loop (Intra uterine Device) IUD**

- It is a small plastic coated copper coil placed inside the uterus and prevents the embryo from implanting in the uterus.
- It has a string which is used to remove it.
- It can be left inside for months or even years.
- It is very effective (97% to 98%)

19. Immunity is the body's defence against infection.
    a. State two types of immunity. [2]
    b. Describe the role of the following in immunity
        i. Lymphocytes.
        ii. Phagocytes
        iii. Blood platelets. [6]
    c. Describe how infants obtain immunity. [3]
20. Cholera is one Some diseases are classified as STIs
    a. What is an STI? [1]
    b. Describe any 2 symptoms of gonorrhoea. [2]
    c. Describe any 2 symptoms of syphilis. [2]
    d. HIV/AIDS is also classified as an STI
        i. What is the meaning of HIV? [1]
        ii. Describe how the HIV virus affects the body. [3]
    e. Describe how the spread of STIs can be prevented. [4]
21. Drug abuse is now a world crisis among the youth
    a. State any 3 short term effects of drinking alcohol. [3]
    b. Describe the social effects of alcohol consumption. [2]
    c. What are the long term effects of smoking marijuana? [3]

CHEMISTRY

Separation techniques

By the end of the topic, you should be able to;

Describe the processes of distillation and fractional distillation

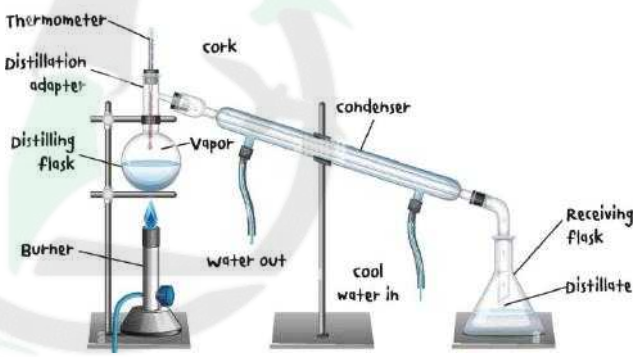
Describe paper chromatography

State the application of paper chromatography

Simple distillation

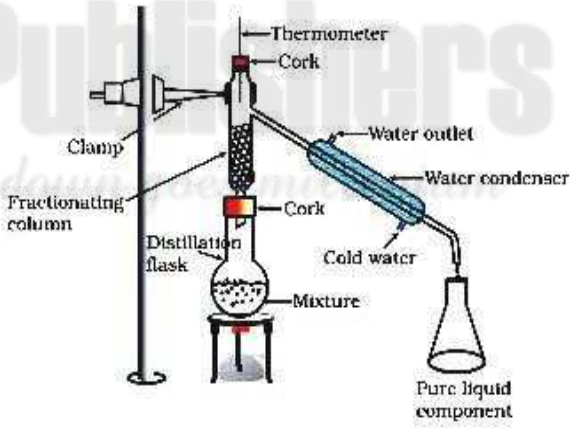
This is a method used to separate a mixture of a solute and a solvent, especially if the solute is a solid at room temperature. The mixture is heated until the solvent evaporates and is condensed in a condenser and collected as a distillate. The solute crystallises.

Application: obtaining pure water from tap water.



Fractional distillation

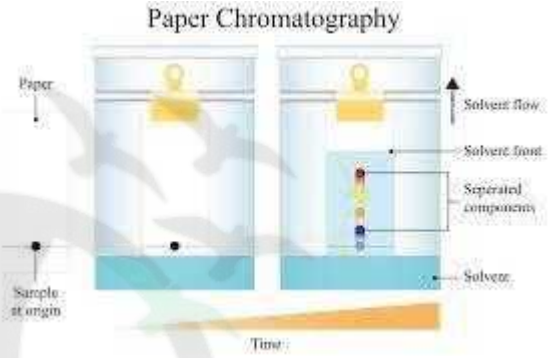
This is a separation technique that is used to separate mixtures based on their boiling points. The mixture is made up of two or more substances that have different boiling points. An example is the separation of an ethanol solution. Ethanol boils at 78°Cwhile water boils at 100°C. The mixture is heated to 78°C and ethanol will evaporate. Any water that evaporates below 100°C is condensed and sent back by the glass beads in the fractional column.



Application: purification of ethanol; fractional distillation of ethanol; petroleum processing.

Chromatography

This is a method of separating a mixture of dyes that have different solubilities. A line is drawn near one end of chromatography or filter paper using a non-soluble material like pencil. Then a dot of ink or substance is applied on the line. The line is called the starting point. The paper is then put in a solvent material such that the ink is slightly above the solvent as shown by the diagram.



As time progresses the solvent will move up the filter paper passing by the ink. The ink will dissolve in the solvent and travel up the paper, but the components or dyes in the ink will travel at different rates. This will create a separation. The distance travelled by the solvent is called the solvent front. The Retention factor (R_f) value can be calculated by the formula:

$$R_f = \frac{distance\ moved\ by\ the\ ink}{distance\ moved\ by\ the\ solvent}$$

This value obtained can be compared with values from the data booklet to identify the ink.

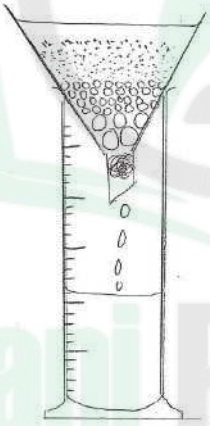
Applications of paper chromatography:

- To identify substances used in the food manufacture
- Testing athletes for banned substances (doping)
- In forensic investigation
- In DNA testing

1. What changes of state occur during fractional distillation of ethanol solution?

A. Liquid → gas → liquid
B. Gas → liquid → solid
C. Liquid → gas → liquid
D. Solid → liquid → gas

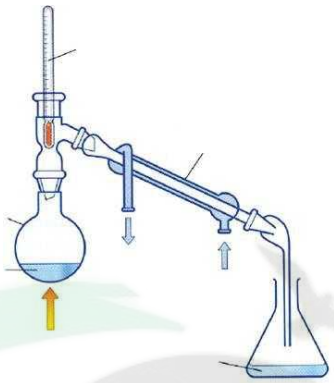
2. After fermentation, ethanol is separated from the mixture by
   A. Distillation
   B. Condensation
   C. Evaporation
   D. Fractional distillation
3. Chromatography is used to separate dyes because of their difference in _____
   A. Solubility
   B. Density
   C. Particle size
   D. Colour
4. A student accidentally spilled salt o the ground. Which row shows the correct steps to recover the salt crystal?
   A. Dissolving; filtration; evaporation
   B. Filtration; evaporating; dissolving
   C. Dissolving; evaporating; filtration
   D. Filtration; dissolving; evaporation
5. The diagram below shows a method of separation. Which mixture can be separated trough this method?



   A. Grain and chaff
   B. Salt solution
   C. Muddy water
   D. Mixture of dyes
6. Air is a mixture of gases. The mixture can be separated by fractional distillation because
   A. The components have different densities
   B. The components have different particle size

C. The components have different boiling points
D. The components have different solubilities.

7. The diagram shows a distillation apparatus



Which of the following mixtures can be separated by this method?

A. Air
B. Sea water
C. Muddy water
D. Grain and chaff

8. Which of the following does not affect the rate of dissolving of sugar in water?

A. Particle size
B. Temperature of water
C. Stirring
D. Adding all salt at once

9. The diagram shows a fractional distillation of ethanol solution.

a. Which characteristic is used to separate dyes? [1]
b. Which dye is (are) common in inks A, B, and C? [2]
c. Why did dye Y not move? [1]
d. Why is the starting line drawn in pencil? [1]
e. State two applications of paper chromatography. [2]

MATTER

By the end of the topic, you should be able to;

Name the sub-atomic particles
State the relative charges and masses of sub-atomic particles
State relative position of sub-atomic particles within the atom
Name the first 20 elements in the periodic table stating their symbols
Write the electronic configuration of the first 20 elements
Describe ionic and covalent bonding
Define relative mass/mass number
Define the proton number/atomic number
Calculate the number of neutrons from given data
Define the avogadro number
State the relationship between the mole and molecular mass (mr) or

Define the term matter.

Matter is anything that occupies space and has a mass. They are all substances that have mass and take up space because they have volume.

States of Matter

Matter exists in three physical states as all things in the universe exist as **solid, liquid or gas**.

The Kinetic Theory of matter

This theory states that *matter is made up of small particles which are in a constant state of motion.* The energy that causes the particles to move is kinetic energy.

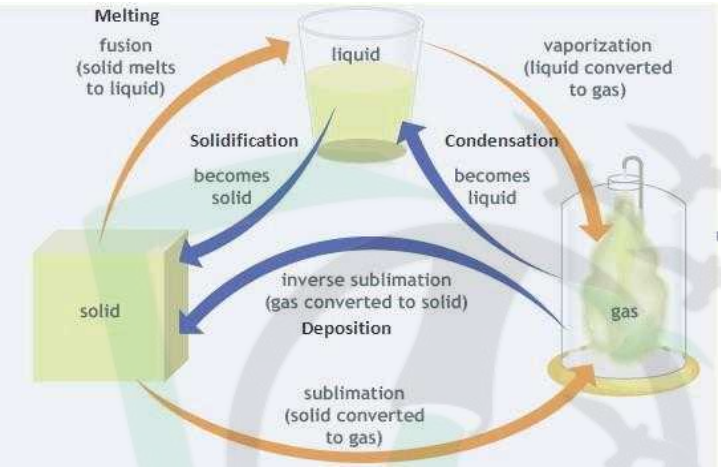
In solids, the particles are **vibrating** around their fixed positions and have a small amount of kinetic energy.

In **liquids**, the particles contain more kinetic energy and are therefore **further apart**. The particles are free to move but are not independent of each other.

In **gases**, the particles have **maximum kinetic energy** and move about more freely.

Change of state

The changes in state are summarized in the diagram below;



Elements Compounds and Mixtures

Definition of terms

Atom: is the smallest particle of matter which takes part in chemical reactions

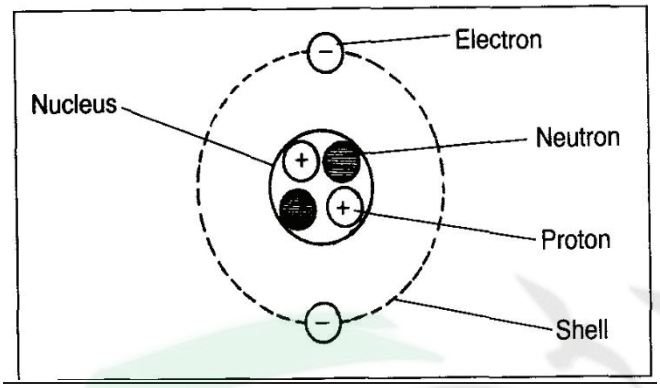
Molecule: a combination of two or more atoms that are chemically joined

Element: a pure substance made up of only one type of atoms

Compound: a substance made up of 2 or more elements that have been chemically joined

Structure of atoms

The structure of a helium atom



An atom is made up of protons, electrons and neutrons.

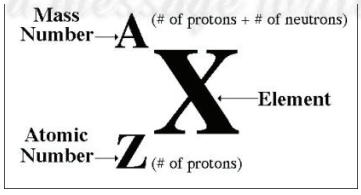
	Relative location	Relative charge	Relative mass (amu)
Proton	Nucleus	Positive (+)	1
Neutron	Nucleus	Neutral (0)	1
Electron	Shells	Negative (-)	0 or $\frac{1}{1840}$

The periodic table

It is a table showing information about elements that have been discovered. The table is made up of rows and columns. The columns show the group numbers, from Group 1 to 8. The Group number indicates the number of valency electrons. The rows show period numbers, which is the number of shells an atom has.

Nuclide notation

This is a way of showing information about a particular element.



A- Mass number is the total mass of the whole atom. It is proton number + neutron number. It is also called the **nucleon number**

X- chemical symbol of the element

Z- proton number. It is also used as the number of electrons.

Proton number = electron number

DATA SHEET
The Periodic Table of the Elements

Group I	II											III	IV	V	VI	VII	0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

Key: (a above, X centre, b lower left)

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

Stoichiometry is the study of quantities involved in chemical reactions. One of these quantities is the MOLE. A mole is a unit used in chemistry to measure the amount of a substance used. The mole can be expressed in 4 ways.

a. Molar mass
b. Molar gas volume
c. Avogadro number
d. Molar concentration.

Molar mass.

One mole of a substance has a mass equivalent to its A_r or M_r expressed in grams.

Example:

mole of CO_2 has a mass of 44g

0,5 moles of $H_2O$is 9g

n(Mol) = $\frac{mass\ of\ substance}{Mr\ of\ substance}$

Exercise:

Calculate the number of moles in the following

a. 2,8g of Fe
b. 1g of $CaCO_3$
c. 27g of H_2O
d. 19,6g of H_2SO_4

$\frac{Mass}{Mr}$

nŏ of moles

Molar gas volume

This is the volume occupied by one mole of a gas at Room temperature and Pressure (rtp). One mole of any gas occupies a volume of $28dm^3$ at rtp.

2 moles of CO_2occupies $56dm^3$

0,1 moles of methane occupies $2,8dm^3$

nŏ of moles = $\frac{volume\ of\ gas}{28}$

Exercise

Find the volume occupied by the following at room temperature and pressure

a. 0,01 moles of CO_2
b. 3 moles of H_2
c. 1,5 moles of methane
d. 0,0625 moles of Xe

If we have volume of a gas, we can find the number moles. Then we can also find the mass gas.

Example: find the mass of $7dm^3$ of O_2.

step 1: find the number of moles; n(Mol) = $\frac{vol}{28}$

= $\frac{7}{28}$

0,25 mol

Step 2: find mass of the moles: n(Mol) = $\frac{mass}{Mr}$

M_r of CO_2 =12 +2(16)
= 44

0,25 mol = $\frac{mass}{44}$

Mass = 0,25 x44

= **11g**

In the same way, if you have the mass of a gas, you can find its number of moles and then find its volume.

Example: find the volume occupied by 0,8g of methane (CH_4) at rtp.

Step 1: find the number of moles: n(Mol) = $\frac{mass}{Mr}$

= $\frac{0,8}{16}$

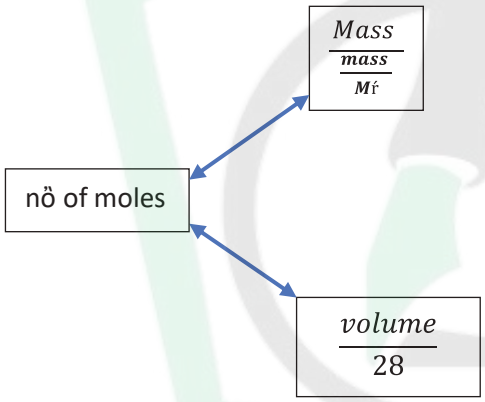
= 0,05 mol

Step 2. Find the vol using n(Mol): n(Mol) = $\frac{vol}{28}$

0,05 = $\frac{vol}{28}$

Vol = 0,05 x 28

= 1,4 dm^3



If you are given mass, first find n(Mol), then go to Vol.

Whatever you're given, first find number of moles.

Exercise

1. Find the mass of the following volumes of gas
   a. 1,4 dm^3 of CO_2
   b. 21dm^3 of CH_4
   c. 0,7dm^3 of O_2
2. Find the volume of the following masses of gases
   a. 1g of H_2
   b. 4g of O_2
   c. 7g of N_2

Avogadro number

This is the number of particles (molecules/ atoms) found in 1 mole of any substance. 1 mole of any substance has the same number of particles (**6 x 10^{23} particles)**.

One mole of any substance has **6 x 10^{23} particles**

So 2 moles have 12 x 10^{23} particles.

0,1 moles have 0,6 x10^{23}

Concentration of solutions

Concentration of a solution is amount of substance per unit volume of solvent.

$$\text{Concentration} = \frac{amount\ of\ substance}{volume\ of\ solute}$$

The amount of substance can be expressed as number of moles or as a mass. The volume is expressed in dm^3.

$$\textbf{Concentration} = \frac{n(Mol)}{volume}$$

Volume is expressed in dm^3. If it is put in cm^3 just divide by 1000 to get dm^3

Therefore; n(Mol) = conc x vol.

Example: find the number of moles of NaCl in a 250cm^3 solution of concentration 0,20 mol/dm^3.

Answer: n(Mol) = conc x vol

$$= 0{,}20 \times \frac{250}{1000}$$

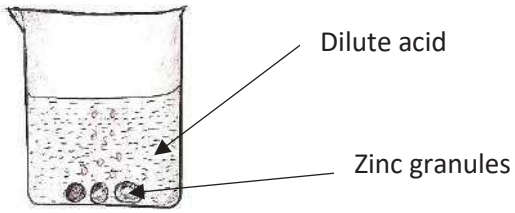
$$= \mathbf{0{,}05mol}$$

Example: find the concentration when an 8g of $CuSO_4$ dissolves in 500cm^3 of water.

Answer: conc = $\frac{n(Mol)}{vol}$

M_r of $CuSO_4$ = 160

9. A student set up the following experiment to investigate some factors which affect the speed of chemical reactions.



a. State the factor being investigated. [1]
b. Explain why the same mass of zinc was used. [1]
c. Explain the relationship between size of particles and surface area.[2]
d. What would be the effect of using a concentrated solution of acid?

10. Define the term endothermic reaction.
b. State one example of an endothermic reaction. [2]
c. Some reactions are reversible.

11. Some reactions are said to be reversible
a. Define the term reversible reaction.
b. Draw the sign used to indicate a reversible reaction.
c. Name one reaction in industry which is reversible. [3]

INDUSTRIAL PROCESSES

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

- Outline the production of nitrogen and oxygen
- Define electrolysis
- Label the general components of an electrolytic cell
- Describe anode and cathode reactions for electrolysis of molten lead bromide
- State observations for the electrolysis of molten lead bromide
- Describe the electrolysis of water
- State the products formed during the electrolysis of water
- State the uses of oxygen and hydrogen
- State the cathode, anode and electrolyte
- Explain the cathode process
- State reasons for electroplating materials
- List the raw materials used to manufacture ammonia
- Describe the manufacture of ammonia
- State the conditions needed for the production of ammonia
- State the industrial uses of ammonia
- List the raw materials used to manufacture sulphuric acid
- Describe the manufacture of sulphuric acid
- State the conditions needed for the production of sulphuric acid
- State uses of sulphuric acid

Air: production of nitrogen and oxygen

DESCRIBE THE LIQUIFICATION OF AIR

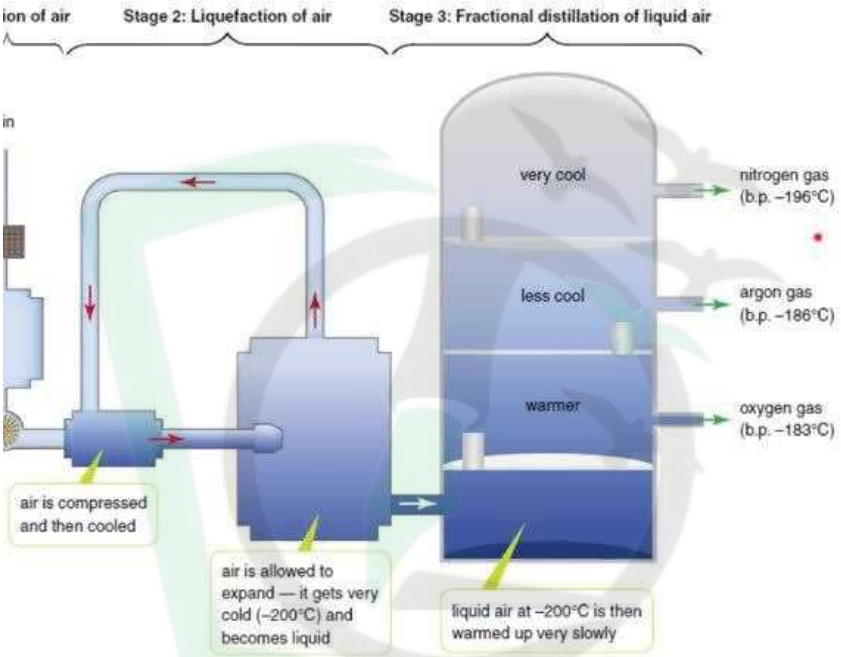
STEP1. Air if piped and filtered to remove solid and dust particles

Step 2: air is cooled to -78℃ and carbon dioxide and water are removed as dry ice

Step 3: The remaining gases are further cooled by repeated expansion and contraction until the temperature reaches -200℃. At this temperature the mixture is now liquid air

Describe the fractional distillation of liquid air

Liquid air is pumped into a fractional column and heated slightly. Nitrogen vaporises first because it has a lower boiling point, BP, of -196°C. Nitrogen gas is collected at the top of the furnace. Liquid oxygen is removed at the bottom. Its BP is -183°C.



What are the industrial uses of nitrogen and oxygen?

Uses of nitrogen

To make ammonia
To make fertilisers
Food preservation
Inerting of Volatile Industrial Environments. ...
Gas for Tire Inflation. ...
Elimination of Volatile Organic Compounds (VOCs) ...
Mining Safety. ...
Electronics and Metal Manufacturing. ...
Pharmaceutics. ...
Nitrogen Gas Membranes.

Uses of oxygen

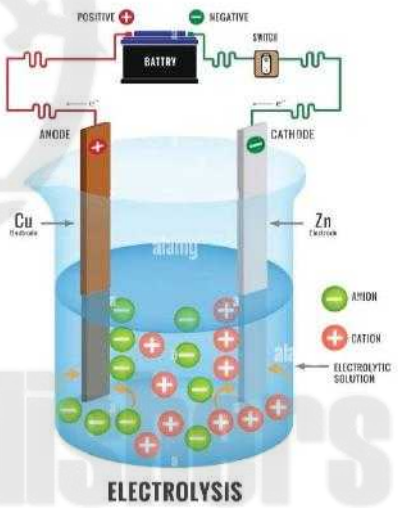
In hospital life support
In welding
In manufacture of sulphuric acid
In steel manufacture
Spacecraft fuel

Electrolysis

Define electrolysis:
This is the **breaking down of ionic** compounds using electric current.
Ionic compounds can conduct electricity if they are molten or if they are in solution.

Electrolytic cell

An electrolytic cell is a simple cell used to break up ionic compounds using electric current



Electrolyte- is a liquid which allows current to flow through it. It contains positive ions (**cations**) and negative ions (**anions**).

Electrodes- are metal or carbon rods which are used to transfer current into a liquid. The electrode connected to the positive terminal is called the **anode**. The electrode connected to the negative terminal is called **cathode**.

Power source: source of dc electricity. Eg a battery.

When current is passed, the cations (+ve ions) are attracted to the cathode, while the anions (-ve) are attracted to the anode.

At the anode there is oxidation and at the cathode there is reduction.

Electrolysis of water

Electrolyte- acidified water. Pure water does not conduct electricity so few drops of acid are added to improve conductivity.

Electrodes- carbon electrodes are used because they are inert.

Describe what happens when current is passed

Water dissociates into the ions H^+ and OH^-. When current is switched on, H^+ are attracted to the cathode and the OH^- are attracted to the anode.

Anode: oxidation- OH^- lose electrons to form H_2O and Oxygen gas

Equation: $4OH^- \longrightarrow H_2O + O_2$

Observation: gas bubbles are observed

Cathode: reduction- H^+ gains electrons to form H_2

Equation: $2H^+ + 2e^- \longrightarrow H_2$

Observation: gas bubbles are evolved

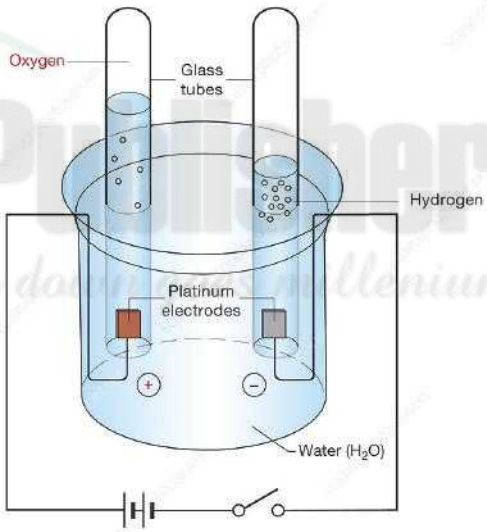
Overall equation

$2H_2O \longrightarrow 2H_2 + O_2$

Water ——————

hydrogen + oxygen

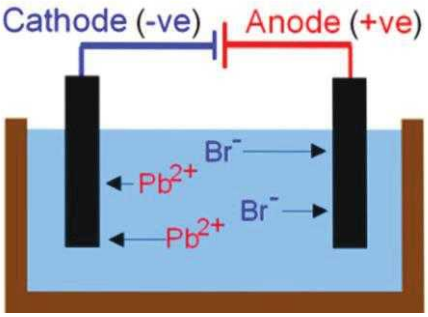
The volume of gas produced is twice as the volume of oxygen. This is because from the equation, 2 moles of water produce 1 mole of oxygen and 2 moles of hydrogen.



Testing for gases

Oxygen: use a glowing splint it will relight

Hydrogen: use a burning splint and a popping sound is heard.



Uses of hydrogen

- To make margarine
- Ammonia synthesis
- As fuel for jet

Electrolysis of lead bromide

Electrolyte is molten lead bromide (solid lead bromide does not conduct electricity)

Electrodes are platinum or carbon, because they are **inert**.

When current is passed, Pb^{2+} ions are attracted to the cathode where they are oxidised to form lead metal. Br^{-} ions are attracted to the anode where they are reduced to form bromine gas.

Anode: oxidation

$2Br^{-} \longrightarrow Br_2 + 2e^{-}$

A brown gas is produced

Cathode: reduction

$\mathbf{Pb^{2+} + 2e^{-} \longrightarrow Pb}$

A silvery liquid metal forms below the cathode

Electroplating

This is applying a layer of metal on a piece of metal using electric current.

State the reason for electroplating metal object

To beautify the objects

To prevent rusting

To increase the value of objects like jewellery

In electroplating, the anode is the **substance used to plate**, the cathode is the **object to be plated** and the electrolyte **contains ions of the metal** at the anode.

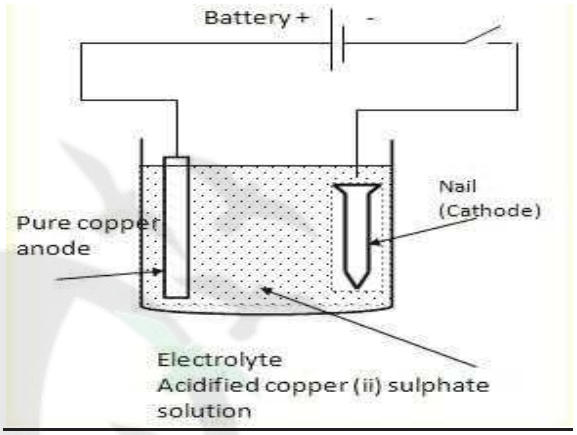
Copper plating

Anode – copper metal

Cathode – object to be plated

Electrolyte copper sulphate solution

When current is switched on, copper atoms are transferred from anode to cathode.



Give the electrode reactions and observations

Anode: copper loses electrons to form Cu^{2+}

$Cu \longrightarrow Cu^{2+} + 2e^-$

The anode becomes smaller

Cathode: copper ions are deposited.

$Cu^{2+} + 2e^- \longrightarrow Cu$

The cathode becomes coated with a brown layer.

MANUFACTURE OF SULPHURIC ACD

It is made using what is called the **contact process** at Zimphos near Harare.

Raw materials

a. Oxygen
b. Sulphur or iron pyrites

Sources of raw material

a. Oxygen- from fractional distillation of air
   - From electrolysis of water
b. Sulphur –from natural occurring sources
   From crude oil

Step 1: oxidation of sulphur or iron pyrites

Sulphur is burnt in air to produce sulphur dioxide

Sulphur + oxygen ⟶ sulphur dioxide

Iron pyrites are roasted in air to produce sulphur dioxide

Iron sulphide +oxygen ⟶ iron oxide + sulphur dioxide

Step 2: Contact

Sulphur dioxide is mixed with excess air and fed into the reaction chamber where they react to produce sulphur trioxide. A temperature of 450°C and vanadium oxide catalyst are used. The reaction is exothermic and reversible

Sulphur dioxide + oxygen ⇌ (vanadium (V) oxide; 450°C) sulphur trioxide + heat

$$2SO_2 + O_2 \rightleftharpoons 2SO_3 \quad \text{(vanadium (V) oxide; 450°C)}$$

State the Optimum conditions in the production of Sulphuric acid

- temperature 450°C
- Vanadium (v) oxide, a catalyst.
- Pressure of 1 atm

13. Which is a reason for using yeast in the fermentation of sugars to produce ethanol?

A. Yeast contains bacteria needed for fermentation
B. Yeast contains enzymes needed for fermentation
C. Yeast is the enzyme needed for fermentation
D. Yeast is the bacteria needed for fermentation.

Section B

14. Define the following terms;

a. Homologous series
b. Functional group
c. Hydrocarbon

15. Draw the structure of the following alkanes and alkenes and write their molecular formulae.

a. Methane
b. Ethane
c. Propane
d. Butane. [8]

16. Explain why alkenes are more reactive than alkanes. [2]

17. State any 3 uses of alkanes and alkenes. [3]

18. Alcohols are also part of organic compounds.

a. Name and draw the structure of an alcohol with 4 carbon atoms. [3]
b. State any 2 uses of alcohols. [2]

19. Biogas is a very good source of energy.

a. Describe any advantages of using biogas as a source of energy.[3]
b. State any 2 raw materials that can be used in the production of biogas. [2]
c. Describe the optimum conditions of a Bio-digester. [4]
d. Write down the word equation for biogas production. [2]
e. State any 3 uses of biogas. [3]
f.

PHYSICS

Measurements

By the end of the topic, you should be able to;

- Measure physical quantities accurately using appropriate instruments
- Read instruments scale to the nearest fraction of the division
- Determine density of liquids
- Express derived quantities in terms of base units

Base quantities: these are physical quantities that cannot be defined in terms of other quantities.

Quantity	Measuring instrument	SI unit	Other units
Length	Ruler	Metres (m)	mm, cm, km, miles
Mass	Scale	Kg	g, tonnes
Time	Stop watch	Seconds (s)	Minutes, hours
Temperature	Thermometer	Kelvin (K)	
Electric current	Ammeter	Amperes (A)	mA

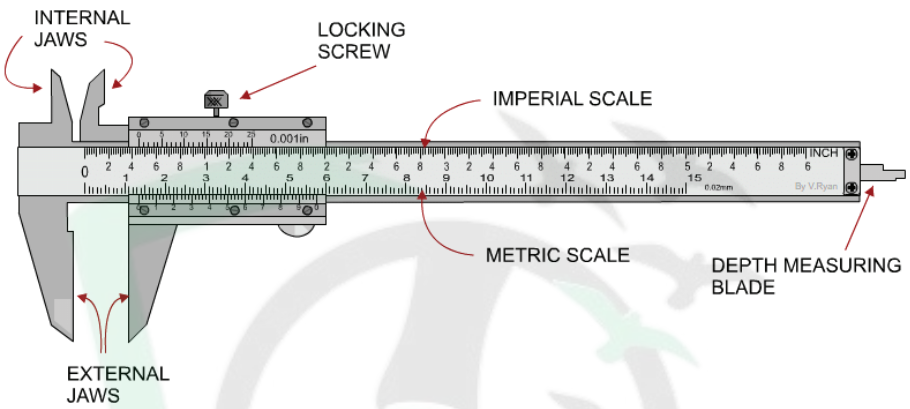
Derived quantities: these are quantities that are defined in terms of other quantities.

Quantities	S.I. unit	Other units
Volume	m^3	Cm^3, litres,
Velocity	m/s	Km/h
Force	N	
Density	Kg/m^3	g/mm^3
Energy	Joule	Nm

Vernier calipers

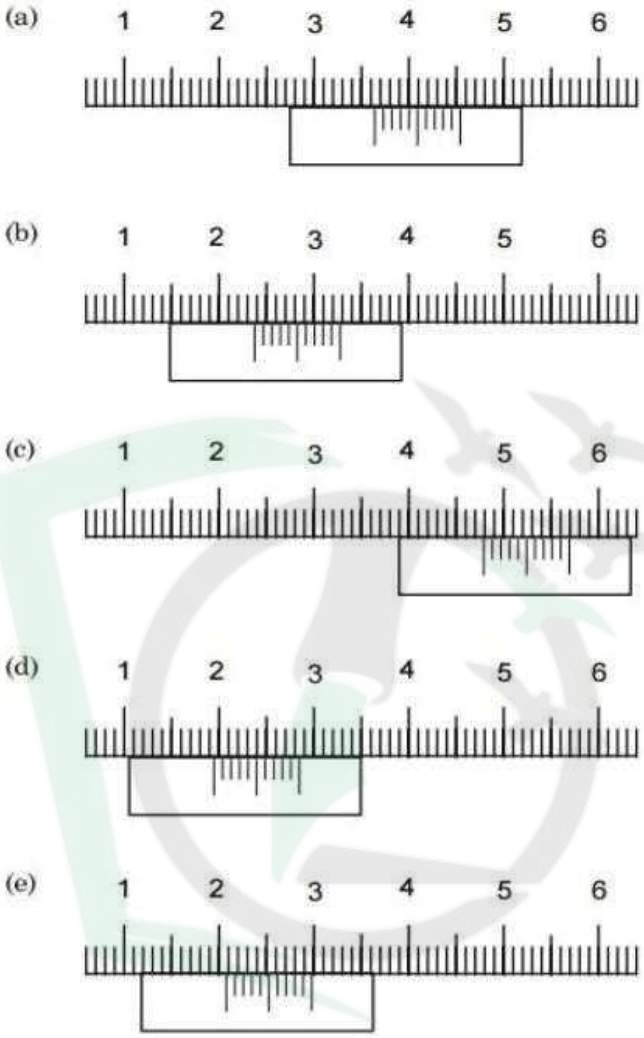
This is an instrument used to measure small lengths, like the internal diameter of a pipe.

It has an accuracy of up to 0,01cm.



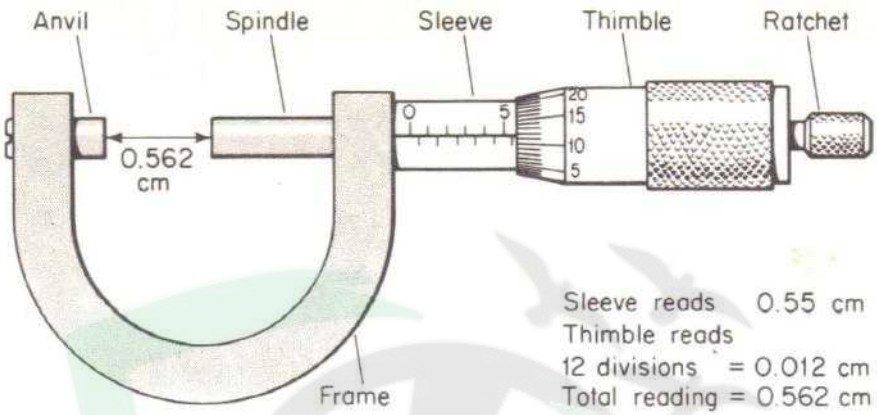
How to read a vernier caliper;

- measure the object and lock vernier
- record the mark on the main scale which is just before the first mark of the vernier scale
- record the reading on the vernier scale which is in line with a mark in the main scale, the vernier reading should be recorded to 2 decimal places.
- Add the 2 numbers and put cm.



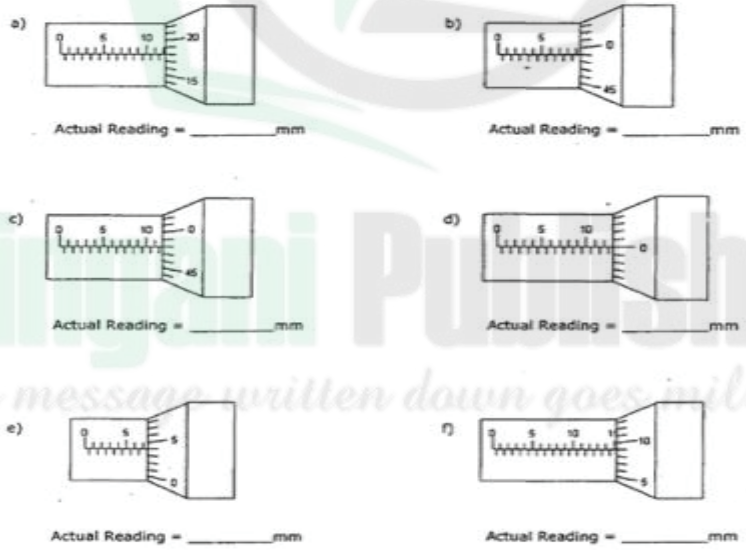
Micrometer screwgauge

It is used to measure very small diameters, like diameter of a thin wire, with a greater precision. Its precision is up to 0,001cm or 0,01mm.



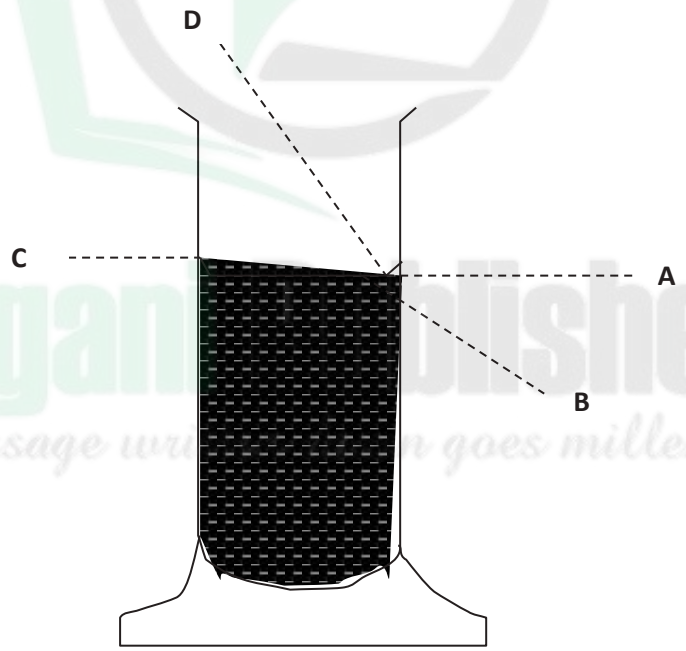
How to read a micrometre

Place your object between the spindle and the anvil.
Turn the ratchet until it makes a rattle sound.
Record the reading on the sleeve.
Add the reading on the thimble.

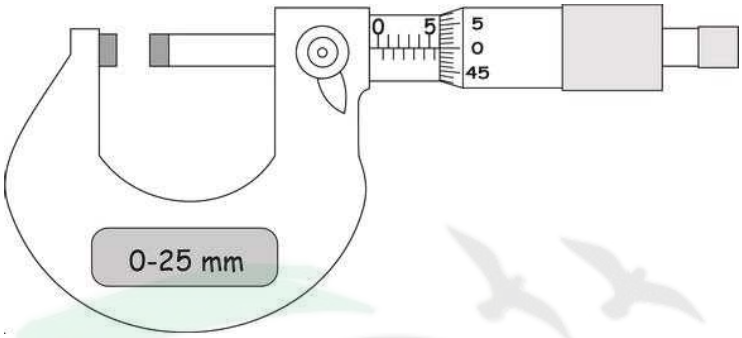


Revision test

1. Name the instrument used to accurately measure the internal diameter of a pipe
   A. Micrometer screw gauge
   B. Vernier callipers
   C. Ruler
   D. Tape measure
2. Which of the following is a base quantity?
   A. Mass
   B. Velocity
   C. Density
   D. Pressure
3. The **SI** unit of volume is
   A. cm^3
   B. mm^3
   C. m^3
   D. dm^3
4. The diagram below shows a student taking a measurement of the volume of water. What is the correct eye level?



5. The diagram shows a measuring instrument.

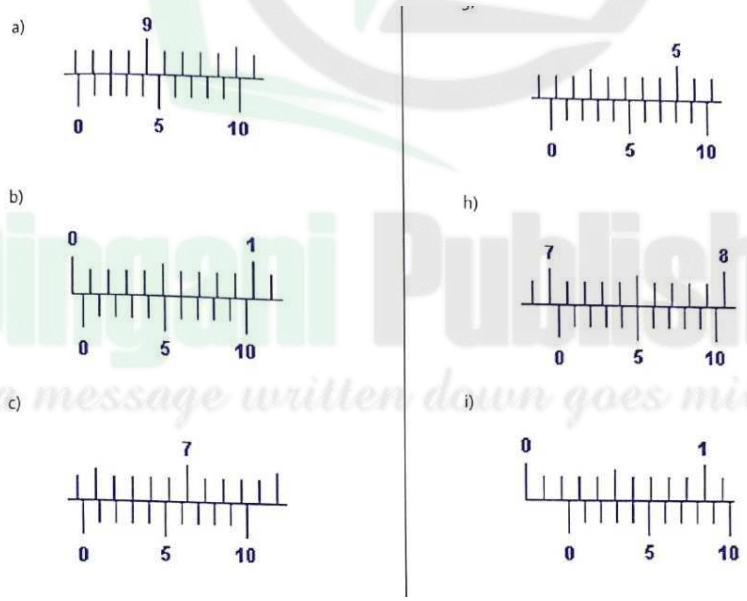


Which measurement can be taken using this instrument?

A. Diameter of a thin wire
B. Length of a wire
C. Internal diameter of a wire
D. Length of any object

Section B

6. Find the readings for the following vernier calipers



a. Describe the power stroke of the petrol engine. [4]
b. State any 3 differences between petrol and diesel engines [3]
c. State the function of the following in a carburettor;
    1. Air filter
    2. Choke
    3. Fuel filter
    4. Fuel jet. [4]
d. Describe any four advantages of modern engines over old engines. [4]

ENERGY

By the end of the topic, you should be able to;

Give an account of heat transfer
Explain convection in terms of the kinetic theory
State good and bad reflectors, absorbers and emitters of heat
Describe the functions and designs of a solar cooker and a solar water heater

Methods of heat transfer

Heat is transferred in one of the following ways;

Conduction – heat moves from one particle to the next in a substance. Conduction is most effective in solids-but it can happen in fluids.

Convection – heated particles move carrying heat as they move for example, air in a fridge is cooled by convection and a hot cup of tea loses heat by convection.

Radiation – The movement of heat energy through space. E.g. heat from the sun reaches the earth through radiation. A person sitting in front of a fire or a heater feels the heat by radiation.

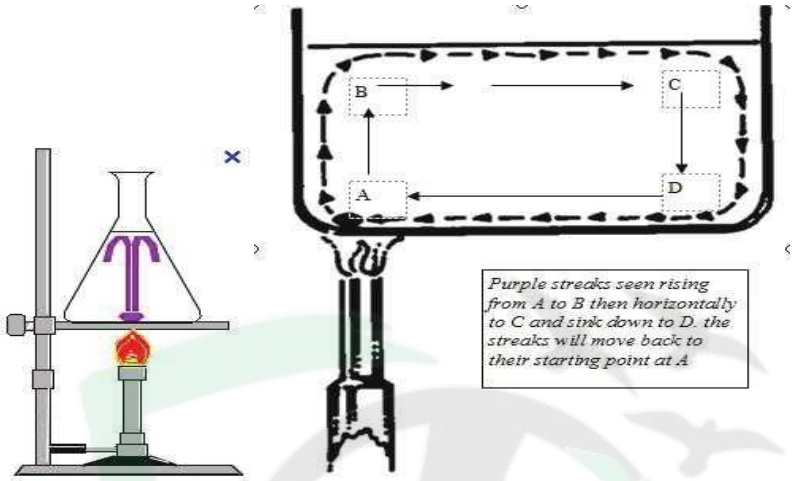
In solids, heat is transferred by conduction, in liquids and gases by convection and through space by radiation.

Experiment

Aim: to observe the transfer of heat in liquids by convection.

Materials: beaker, water, potassium permanganate crystals or small, burner and stand.

Diagram



Method

1. Fill the beaker with water to almost ¾ full
2. Drop a small crystal of potassium permanganate to the bottom edge of the beaker. (a small leaf can be used instead of potassium permanganate)
3. Heat the water around the crystal or leaf as shown in the diagram

Observations

As heat is applied around the crystal, purple-coloured streaks are seen rising from point A to point B, then horizontally to point C and the trickles sink back down to D from where they go back to A.

Eventually all the water turns purple.

Explanation

h. As water around A is heated, it becomes less dense and rises to the surface. Cold water from D moves in to replace the rising warm water and convection currents are formed as shown by the arrows.

Purpose of the potassium permanganate

The purple streaks make the convection currents visible.

Purpose of burner

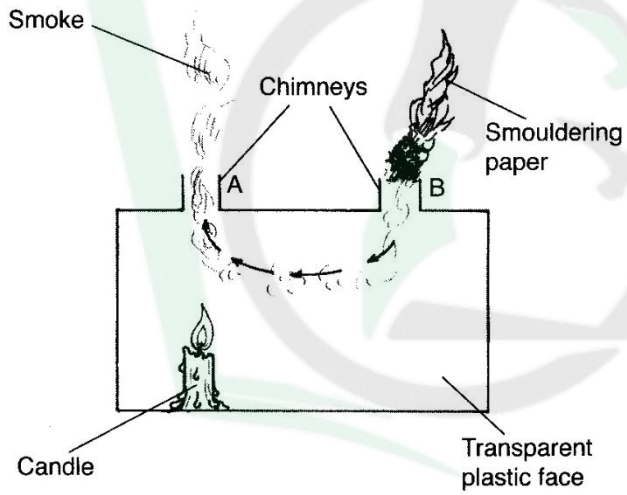
To heat up the water so as to start the convection currents

Experiment

Aim: To observe the transfer of heat in the air by convection.

Materials: burner/candle, cardboard box, plastic paper, torch paper

Diagram



Method

Set up the apparatus as shown in the diagram and light up the candle.
Light the brown paper (torch paper) and bring it closer to the chimney A.
Observe what happens

Observations

Before putting the smouldering paper over chimney, A, smoke was moving vertically into the air. (Smoke rising into the air is evidence of heated particles moving upwards carrying heat by convection)

When the smoking paper was put over chimney A, the smoke moved into the box through A and out of the box through B.

Explanation

The candle under chimney B heats the air around it causing it to expand and become less dense. The air rises and escapes through chimney B.

Cooler, denser air moves in through chimney A to replace the warm air which has escaped. This creates convection currents shown by the arrows in the diagram which are made visible by the smoke.

Purpose of smoke

The smoke makes the convection currents visible but the currents are there even in the absence of the smoke.

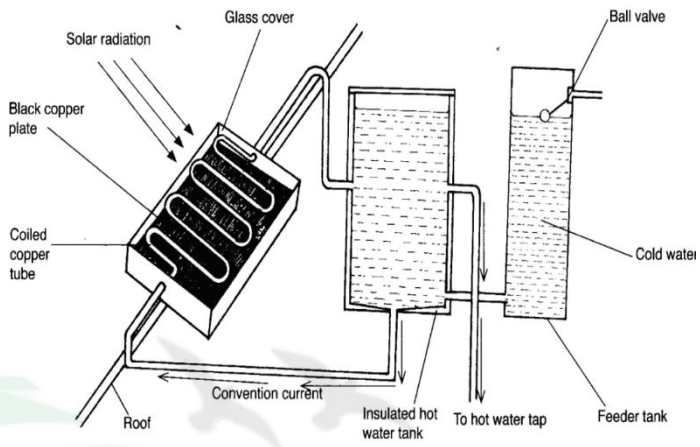
Purpose of the candle

It heats up the air creating the convection currents.

The solar water heater

It consists of a glass covered panel mounted on the roof of a house and it is designed to trap energy from the sun and use it to warm water.
The panel contains thin, black copper pipes mounted on a thick black copper plate.
The pipes are thin to minimize amount of water passing through the panel so that it warms up quickly.
The thin pipes and plate are made of copper because copper is a good conductor of heat.
The plate and pipes are painted black to increase absorption of heat as black is a good absorber of heat.

Loss of heat by conduction to the roof surface is prevented by insulating the panel with expanded polystyrene



The glass prevents heat loss by convection and traps heat energy inside the panel through the greenhouse effect.

The solar water heater is placed on the roof to trap as much sunlight as possible.

The best position for the panels on a building in the southern hemisphere is on a north facing roof.

The solar Cooker

A solar cooker is an easy and cheap way of harnessing the energy from the sun for cooking.

It uses **a curved shiny surface** to capture solar energy and **focus** it into one position.

The rays are focused onto a **black pot** or a pressure cooker. Black is a good heat absorber

Why is the dish shiny?

i. To reflect or change the direction of radiation energy without absorbing it.

Why is the dish curved?

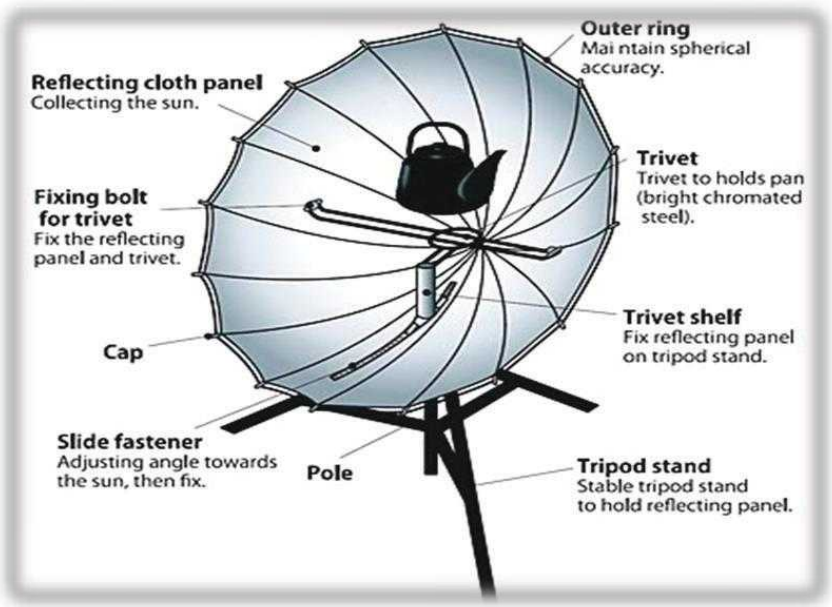
j. To focus the reflected energy onto a single point, a black pot or a pressure cooker.

k.

Why is the pot painted black?

To ensure that most of the heat is absorbed and used for cooking purposes.

Black surfaces are good absorbers of heat.



Heat reflection, absorption and emission

Heat absorbers- black and dull surfaces are good heat absorbers

Heat reflectors – white and shiny surfaces are good heat reflectors.

Heat emitters- black and dull surfaces are good heat emitters.

Advantages of using solar energy

l. It is renewable
m. Easy to mount and maintain

Disadvantages of using solar

n. It is affected by bad weather
o. Not ready to be used at night.

REVISION TEST.

Section A

1. Solar energy reaches the earth by

A. Radiation
B. Conduction
C. Connection
D. Convection

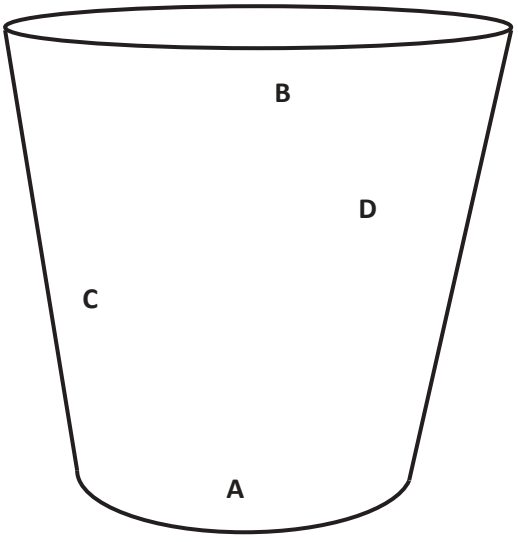
2. Which row shows the surfaces that are best heat absorbers and best heat emitters?

	Best heat absorbers	**Best heat emitters**
A	White and shiny	Black and dull
B	Black and shiny	Black and shiny
C	Black and dull	White and shiny
D	Black and dull	Black and dull

3. A rock falls from a cliff to the ground. What energy changes occur to the rock?

A. Potential → sound → kinetic
B. Kinetic → potential → sound
C. Sound → kinetic → potential
D. Potential → kinetic → sound

4. A student intends to heat water using an electric heater, where can she place the heater element in order to heat water fastest?



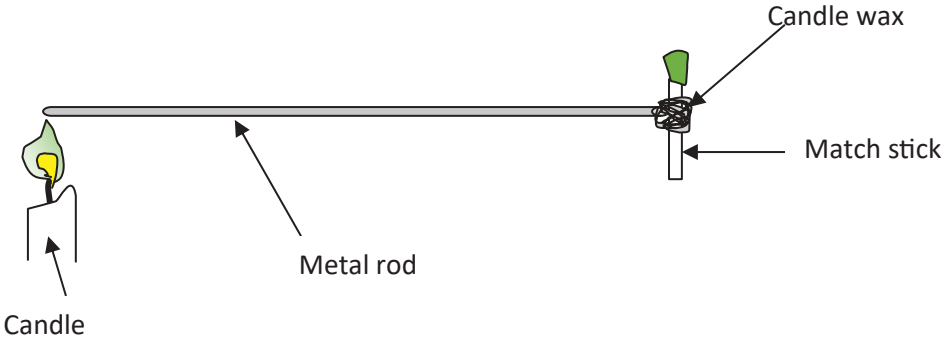
5. Why do solar cookers have a shiny curved surface?

A. To emit heat to one point
B. To absorb heat to one point
C. To reflect heat towards one point
D. To reflect heat towards many points

6. A solar water heater has thin black tubing because

A. Black is a good absorber of heat
B. Black is a good emitter of heat
C. Black is a good reflector of heat
D. Black is a good insulator of heat

7. The diagram shows a matchstick attached to a metal rod which is being heated on the other end.



The match stick will fall because

A. Heat travelled by convection through the rod and melted the wax
B. Heat travelled through convection currents through the air and melted the wax
C. Heat travelled by conduction through the rod and melted the wax
D. Heat travelled by radiation and melted the wax

c. State any 2 disadvantages of using photovoltaic cells. [2]

TELECOMMUNICATIONS

Transmission of signal

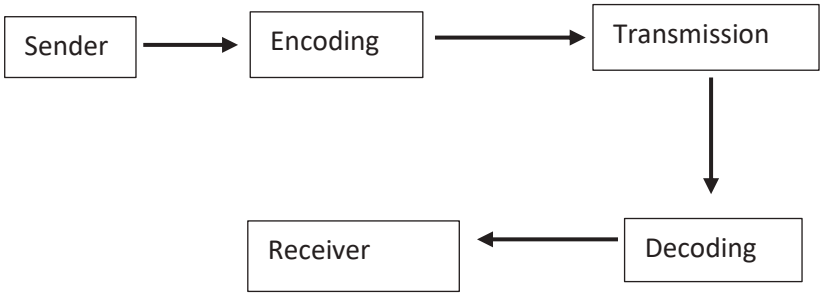
The sender is the machine or person who inputs the information. The sender must encode the information.

Encoding entails converting the message into a form that can be transmitted through a medium.

Transmission: the message travels through a medium from the sender to the receiver.

Decoding: this means converting a message from transmission signals into a format that can be understood by the receiver.

Receiver: is a person or device to whom/which a message is intended.



Transmission media.

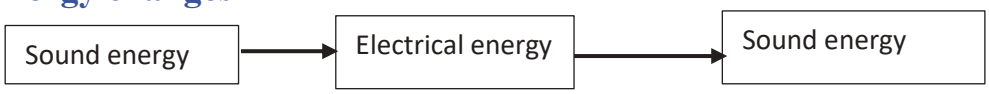
These are channels through which the information travels from the sender to the receiver. There are two types of transmission media;

- Guided transmission media
- Unguided transmission media

a. Guided transmission media

It is also known as wired media. The transmitter and the receiver are connected through a cable/ wire. Information travels in the form of electric signals. Examples are printer cables, telephone, telegraph, Ethernet connections etc.

Energy changes



Unguided transmission media

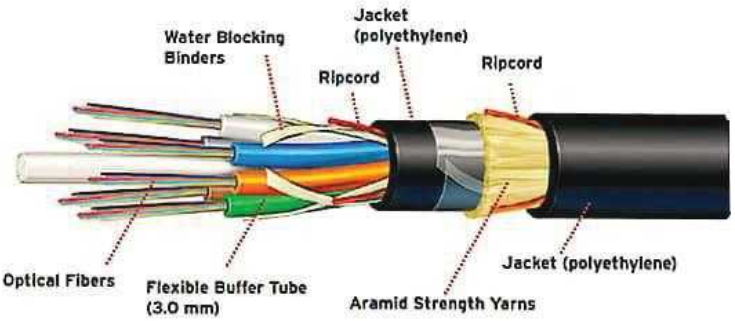
- It is also known as wireless media.
- The transmitter and the receiver are not connected by a cable. The transmitter uses an antenna which converts electric signals from the sender into radio waves.
- The radio waves travel through the air to the receiving antenna which converts the radio waves into electrical impulses/ signals. Examples of unguided media are cellphones, radios, televisions, and internet.

Cellphones

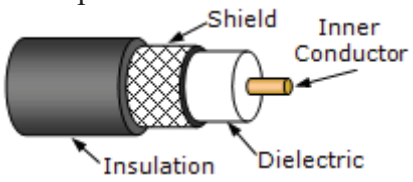
Cellphones are small communication gadgets. They are transivers, which means that they are transmitters and receivers at the same time. Information that can be sent by cellphones include: text, audio and video messages. When information is encoded into the cellphone, it is converted into electrical signals which are transmitted by the antenna in the form of electromagnetic waves to the transmitting tower. The transmitting tower will send the signal to the receiving tower which will locate the receiving phone. The receiving phone will convert electromagnetic waves into electrical signals which are decoded to human language.

Guided transmitter cabled

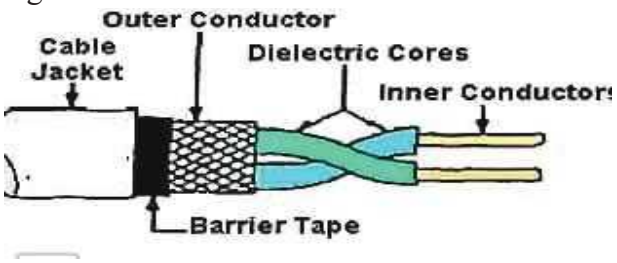
1. Optic fibre: is made up of the core; cladding and jacket. The core is made up of thin glass or plastic strands. The strands are covered by cladding and the cladding is covered by jacket. Information travels through the strands in the form of light energy. It is used worldwide in internet connections.



2. Coaxial cables: a copper wire is covered by an insulation casing called a di-electric. A foil wraps the di-electric and is covered by a mesh of small wires. On the outside there is a jacket. The wire mesh and, foil and di-electric protect the signal in the copper core from noise/interference. Examples are satellite dish connector or LNB cable.



3. Sheathed pair cables: they are made up of a copper wire covered with insulation. The insulated wires are twisted usually in pairs and covered with an overall foil. This protects the information from noise/interfering signals.



Wireless connection

Wi-Fi is an example of wireless connection. Computers can be connected into a Local Area Network (LAN) for a small area. The LAN can be connected into WAN (Wide Area Network). LAN computers can be connected across the world into the Worldwide Web (www).

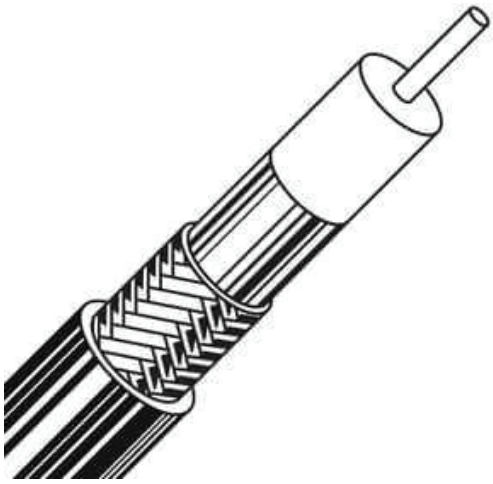
REVISION EXERCISE

Section A

1. Which of the following is not a type of guided media
   A. Coaxial cable
   B. Fibre optics
   C. Twisted pair cable
   D. Internet connection

2. Which of the following is not an advantage of cellphone?
   A. It is portable
   B. The battery allows it to be carried around
   C. It needs expertise to operate
   D. It can transmit different kinds of media

3. The diagram below shows a type of transmission media.



Which type is shown?
   A. Coaxial cable
   B. Sheathed pair cable
   C. Twisted pair cable
   D. Fibre optics

4. What is the function of an antenna in telecommunications?
   A. To change electric signals into electromagnetic waves
   B. For decoration purposes
   C. Encoding and decoding
   D. For displaying messages

5. The function of the wire mesh and foil in a coaxial cable is

i. Protect the cable from noise
ii. Prevent corrosion of the cable
iii. Prevent the cable from getting wet
iv. Decoration

Section B

6. Why a cellphone is called a transiver? [2]

7. State any two types of guided transmission media. [2]

8. Describe the energy changes that occur during a phone call. [4]

9. State the types of media that can be transmitted through a cellphone. [3]

10. State any 3 advantages of using cellphones. [3]

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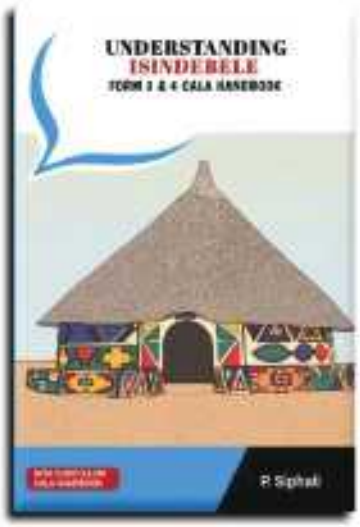

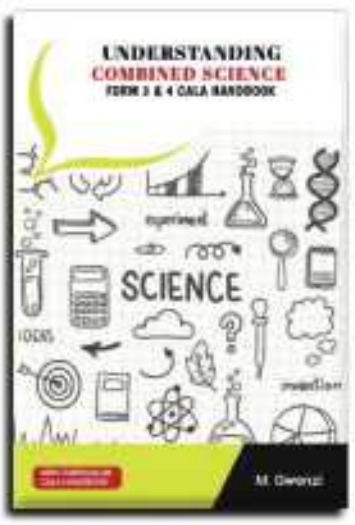

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