Supplementary Study Materials for Underperforming Schools

Integrated Science

JSS 3

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TEACHERS' GUIDE

Dear Teacher,

The integrated science syllabus covers a wide range of science subjects such as physics, chemistry, biology, agricultural science, earth science, home economics and mathematics.

The approach to teaching this subject is more of demonstration, problem solving and analysis such as experiment and field work.
This material is divided into thirty (30) units, which is a guide to problem solving, demonstrations, group work by the pupils and constant assessment. in the thirty (30) units.

The integrated science B.E.C.E paper is divided into three sections:
SECTION A- forty (40) objective questions to answer all.

SECTION B- six (6) essay assorted questions from the various subject components to answer four (4).

SECTION C- test of practical work divided into three different parts- part 1, part 11 and part 111 for students to answer only four (4) questions at least, one question from each part.

Sample question papers are printed at the back to help the teacher visualise the nature of the B.E.C.E assessment. This material will help you as a supplement to your approach to the syllabus.

The teaching and learning process should be a child centered and environment friendly using your science laboratory as the environment.

Diagrams should be well drawn and labelled. The illustrations guide you the teacher and the pupil to achieve this objective.

A special feature of this work is that it contains a lot of worked examples and ample supply of exercises that will help the pupils to understand the concepts and principles underlying each topic.

Misprints are a plaque to authors. Although every care has been taken to check mistakes and misprints, it is not too much to expect imperfections, especially when we are reminded of the phrase “to err is human”. All such imperfections when brought to our notice will be duly incorporated in the next revised edition

We wish you and the children well.

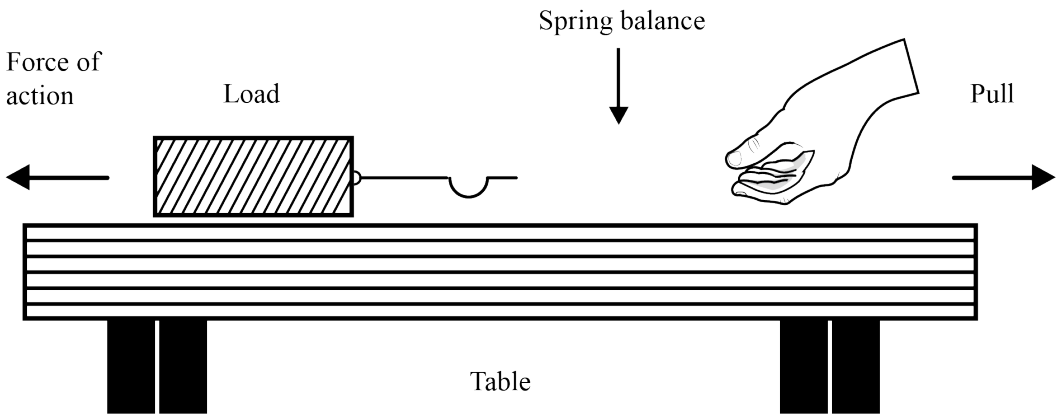
Table of Contents

UNIT 1 FORCE, WORK, POWER AND ENERGY

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Explain what is meant by the terms Force, Work, Power and Energy.
2. Describe the different types of force.
3. Demonstrate the effects of force on an object.
4. Outline the advantages and disadvantages of friction.
5. Calculate force, work, power and energy.



FORCE, WORK, POWER AND ENERGY

Force can be defined as a push or pull of an object or body.
Anything which tend to change the state of an object or body in motion or at rest in a straight line.

Effects of force on an object or body

Force can:

1. Set an object into motion.
2. Change the speed of an object.
3. Stop an object form moving.
4. Change the direction of a moving object.

Instrument: spring balance

S. I. Unit newton (N)

CALCULATION OF FORCE

Worked Example

1. Calculate the force involved when a car of mass 250 Kg moves with an acceleration of 30m/s^2.

   Solution

   Force = mass x acceleration

   F = m x a

   = 250kg x 30m/s^2

   = 7500N

   Force = 7500N

2. Karim pushed a car of mass 500kg moving at a speed of 50m/s in 5 seconds. What force did Karim apply to move the car?

Solution

Assumption:

Where: U = initial velocity

V = Final velocity

t = time

Assumption: **u= 0 m/s**

F=m(v-u)/t

$$F = \frac{mass \times speed}{time}$$

$$= \frac{m \times s}{t}$$

$$= \frac{500Kg \times s50m/s}{5s}$$

= 5000N

Types of Forces

1. Force of gravity
2. Compressional force
3. Centrifugal force
4. Adhesive force
5. Electrostatic force
6. Contact force
7. Tensional force
8. Centripetal force
9. Magnetic force
10. Cohesive force
11. Frictional force

INERTIA – is the tendency of a body to resist being put into motion if at rest or to be put at rest when in motion.

FRICTION

Friction can be defined as:

- A force which prevents one surface of a body from moving or sliding over another body with a relative motion.

Two Types of Frictional Force

1. Static/Limiting friction
2. Dynamic/rolling/sliding friction

Advantages of Friction

Friction

1. Prevents us from falling whilst walking.
2. Is used in brakes of cars, lorries, bicycles.
3. Prevents skidding of vehicles on the road.
4. Is used in filing by gold smiths and carpenters.
5. Used in the sharpening of knives.
6. Helps us to hold clay and fragile materials firmly.

Disadvantages of Friction

Friction

1. Causes heat and noise.
2. Causes wear and tear(of parts that move over each other).
3. A lot of energy is wasted in overcoming friction before an object starts moving.
4. Smooth shoes cause falling
5. Smooth tyres cause accident
6. Slippery hands cause breakages of clay and fragile materials

Ways of reducing friction

1. By lubrication (oiling or greasing).
2. Using rollers and bearings.
3. Using ball and socket.
4. By planing and polishing wood surfaces.

Assignment

1. a) Define force.
   b) State three effects of force on objects.
   c) Write down any seven (7) types of force.
2. a) Write down the mathematical expression of force.
   b) Calculate the force needed to pull a 5000g bag of rice with an acceleration of 25m/s^2.
3. State two
   a) advantages of friction.
   b) disadvantages of friction.
   c) ways of reducing friction.

WORK, POWER AND ENERGY

WORK

1. Work is said to be done when a force moves an object through a distance in the direction of the effective force.

   OR

2. Work is the product of force and distance.

   Mathematically

   Work done (w)= Force(F) x distance(d

   W= F x d

S.I UNITS

Force- newton (N)

Distance- metre (m)

Work done- joule (J) or newton metre (Nm)

Worked Example

A force of 150N was applied to move a loaded wheelbarrow to a distance of 6m. calculate the workdone to move the wheelbarrow.

Solution

Work done= Force x distance

W= F x d

= 150N x 6m

=900J

Work done = 900J

POWER

Power can be defined as:
The rate of doing work(The time rate of doing work) or
Work done per unit time.

Mathematically

$$\text{Power} = \frac{\text{work done}}{\text{Time}}$$

$$\text{Power} = \frac{\text{force x distance}}{\text{time}}$$

$$\text{Power} = \frac{F \times d}{t}$$

S.I UNITS

Force- Nnwton (N)
Distance- metre (m)
Time- second (s)
Work done- Joule (J)
Power- watts (W) or joule per second (J/s)

Worked Example

1. A wheelbarrow loaded with stones, does 320J of work in 4 seconds. What is the power of the wheelbarrow?

Solution

$$\text{Power} = \frac{\text{work done}}{\text{time}}$$

$$= \frac{320\text{J}}{4\text{ s}}$$

$$= 80\text{ J/s}$$

$$= 80\text{ W (or watts)}$$

2. What is the power expended by a mass of 80N moving up a staircase of distance 15m in 20s?

Solution

$$\text{Power} = \frac{\text{Force x distance}}{\text{Time}}$$

$$= \frac{80\text{N x } 15\text{m}}{20\text{s}}$$

$$= 60\ \text{J/s}$$

Power = 60 W (or watts)

ENERGY

Energy is the ability or capacity to do work. S.I unit of energy is joule(J).

SOURCES OF ENERGY

1. Sun
2. Food
3. Electricity
4. Battery
5. Wind
6. Fuel
7. Fire
8. Biogas
9. Tidal waves
10. Geothermal
11. Nuclear energy

FORMS OF ENERGY

1. Mechanical energy e.g Friction.
2. Chemical energy e.g food, fuel.
3. Solar energy e.g sun.
4. Light energy e.g sun, electricity.
5. Electrical energy e.g battery, hydroelectricity.
6. Sound energy e.g flutes, drums.
7. Heat energy e.g sun, fire, electricity.

8. Nuclear energy e.g nuclear waste and blasting of bombs in space.

TYPES OF ENERGY

Two types exist

1. Potential energy
2. Kinetic energy

POTENTIAL ENERGY

Potential energy is the energy a body or object possess by virtue of its position relative to other bodies, stress within itself or its electric charge.

Example:

a. A book on a table.
b. A fruit about to fall.
c. Water in a reservoir or dam.
a. A stationary car on a hill.

Mathematically

Potential energy= mass x force of gravity x height

P. E = m x g x h

Worked Example

1. A stone of mass 10 kg fell from a height of 80m. If the acceleration due to gravity is10m/s^2. Calculate the potential energy of the stone.

Solution

Potential Energy (P.E) = ?

mass (m) = 10kg

height (h) = 80m

gravity= 10m/s^2

P.E = m x g x h

= 10kg x 80m x 10m/s^2

= 8000 J

P.E = 8000J

Potential energy depends on:

a. The mass or weight of an object.
b. Acceleration due to gravity.
c. Height at which the object is.

KINETIC ENERGY

Kinetic energy is the energy a body possesses due to motion or when it is moving.
E.g

a. A moving car
b. A rolling stone
c. A flying bird
d. A fired bullet
e. A falling mango

The faster the object moves, the greater the kinetic energy.
Kinetic energy depends on

a. The mass or weight of an object.
b. The velocity or speed of the object.

where m = mass
v = velocity

Kinetic energy can be expressed as:

1. K. E= ½ mv^2 or K. E= $\frac{mv^2}{2}$

2. Mass(m) = $\frac{2 \times K.E}{V^2}$

3. $V^2 = \frac{2 \times K.E}{m}$

$V = \sqrt{\frac{2 \times kE}{m}}$

Worked Example

1. A bullet of mass 10kg was fired from a gun and moved with a speed of 20 m/s. what was the kinetic energy of the bullet?

Solution

Kinetic Energy, K.E =?
mass(m) = 10kg
velocity(v) = 20 m/s
K.E = $\frac{1}{2}$ x mass x $(\text{velocity})^2$

$$= \frac{1}{2} \times 10kg \times (20m/s)^2$$

$$= \frac{1}{\cancel{2}} \times \overset{5}{\cancel{10}} \times 20\cancel{m/s} \times 20\cancel{m/s}$$

$$= 2000J$$

Kinetic Energy= 2000J

2. A ball of mass 200g was released from a height with a velocity of 30m/s. find the kinetic energy of the ball.

Solution

Kinetic Energy K.E =?

Mass (m) = $\frac{200g}{1000}$ =0.2 kg

Velocity (v) = 30 m/s

$$KE = \frac{mv^2}{2}$$

$$= \frac{0.2kg \times 30\ m/s \times 30\ m/s}{2}$$

$$= 0.1 \times 30 \times 30$$

$$= 1 \times 3 \times 30$$

$$= 90J$$

Kinetic Energy= 90J

B. E. C. E 1999 Q 6a

3. A ball of mass 400g is dropped from a height with a velocity of 40 m/s. find the kinetic energy.

Solution

Kinetic Energy K.E =?

Mass (m) = $\frac{400g}{1000}$ = 0.4 kg

Velocity (v) = 40 m/s

$$= \frac{mv^2}{2}$$

$$= \frac{0.4kg \times 40\ m/s \times 40\ m/s}{2}$$

$$= 0.4 \times 40 \times 40$$

$$= 2 \times 4 \times 40$$

$$= 320J$$

Kinetic Energy= 320J

B.E.C.E 2001 Q5b

4. Calculate the velocity of a man whose mass is 180kg, has a kinetic energy of 4410 J and is moving at a constant velocity.

Solution

Velocity (v) =?

Mass (m) =180 kg

Kinetic energy (K.E) = 4410J

$$V = \sqrt{\frac{2 \times kE}{m}}$$

$$V = \sqrt{\frac{2 \times 4410}{180}}$$

$$V = \sqrt{49}$$

Velocity = 7 m/s

THE LAW OR PRINCIPLE OF CONSERVATION OF ENERGY

The law or principle of conservation of energy states that in a closed system energy can neither be created nor destroyed but can be changed or transformed from one form to another.

Examples of energy transformation include:

A. Switching on a television

Mechanical energy⟶Electrical energy⟶sound energy⟶Light energy⟶ Heat energy

B. During photosynthesis

Light energy (solar energy)⟶ chemical energy

C. Switching a torch on

Chemical energy⟶Electrical energy⟶Light energy⟶Heat energy

D. A falling mango

Kinetic energy⟶potential energy

This principle or law means energy before reaction or change is equal to energy after reaction or change.

Assignment

1. Classify the following into potential or kinetic energy:
   i. A stone from a catapult.
   ii. A mango that is about to fall.
   iii. A ball thrown by a goalkeeper.
   iv. A hammer on a table.
   v. A player that is driven with a ball.
   vi. A boy that is climbing a hill.
   vii. A book on a shelf.

2. A body of mass 5g is lifted through a height of 10m. Calculate the potential energy of the body if the force of gravity is 10m/s2.

3. A body of mass 10g is moving with a speed of 2m/s. What is the kinetic energy of the body?

4. State the law of conservation of energy.

5. State the energy transformation that takes place in the follwing:
   a. Switching on a flash light.
   b. Ringing a school bell.
   c. Heating water with an electric kettle.

Learning Outcomes

UNIT 2 MEASUREMENT

At the end of the lesson, pupils should be able to:

1. List some common physical quantities.
2. Identify and use appropriate instruments to measure different physical quantities.
3. Identify and use the appropriate SI units for different physical quantities.

MEASUREMENT – S. I. UNITS

Quantities		S.I. Units
1. Force	-	newton (N)
2. Mass	-	kilogramme (Kg)
3. Acceleration	-	metre per second (m/s2) or ms–2
4. Speed	-	metre per second (ms-1 or m/s)
5. Time	-	second (s)
6. Energy	-	joule (J)
7. Distance/Length/Height	-	metre (m)
8. Work done	-	joule (J)
9. Power	-	watts (W)
10. Mechanical Advantage	-	No unit
11. Velocity Ratio	-	No unit
12. Efficiency	-	percentage (%)
13. Quantity of heat	-	joule (J)
14. temperature	-	kelvin (K)
15. Voltage	-	volt (v)
16. Resistance	-	ohm
17. Current	-	ampere/amps (A)
18. Density	-	kilogram per metre cube (K/gm3 or Kgm–3)
19. Volume	-	cubic metre/metre m3
20. Area	-	metre square (m2)

INSTRUMENTS AND WHAT THEY MEASURE

Instruments		Quantities
1. Spring balance	-	weight
2. Beam balance	-	mass
3. Clock/stop watch	-	Time
4. Metr e rule/Tape measure/	-	distance/height/ length Surveyors tape
5. Thermometer	-	Temperature
6. Calorimeter	-	Heat
7. Ammeter	-	amount of Current
8. Galvanometer	-	detect passage of current
9. Voltmeter	-	voltage
10. Ohmmeter	-	Resistance
11. Rain gauge	-	Rainfall
12. Hygrometer	-	humidity
13. Barometer	-	Atmospheric pressure
14. Stethoscope	-	Blood pressure
15. Photometer	-	light intensity
16. Telescope	-	Observe distance objects
17. magnifying glass	-	observe tiny object
18. Microscope	-	observe objects which cannot be seen by the naked eye
19. Micrometer screw gauge	-	diameter of tiny wire/tiny object
20. Vernier calipers	-	Inner/outer diameter of circular object
21. Measuring cylinder/ calibrated beaker pipette/burette	–	volume of liquid
22. Wind vane	–	wind direction
23. Anemometer	-	wind speed
24. pH meter	-	Acidity/alkalinity/ pH of solution

UNIT 3 DENSITY, WEIGHT AND VOLUME

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Measure weight, mass, volume and density.
2. State the differences between mass and weight.
3. Determine the volume of regular and irregular objects.
4. Calculate the density, mass and volume of objects.

MASS – Is the quantity of matter in an object.
The SI unit of mass is kilogramme (Kg) and the instruments used to measure mass is the beam balance, chemical balance, lever balance and electronic balance.
Mass is constant everywhere.

WEIGHT – Is the measure of the force of gravity on the mass of a body.
Weight is the gravitational pull on a body on earth.
The force of gravity tends to pull objects towards the centre of the earth.
Weight is not constant. It can change from place to place due to change in the magnitude of acceleration due to gravity, g.
From the Equator to the Poles of the Earth, g is greatest at the Poles than at the Equator.

a. An object weighs more on the North and South poles than at the Equator because the Equator is farther from the centre of the earth.
b. An object weighs less at sea level than down a deep well.
c. An object weighs more at sea level than up a mountain.
d. An object weighs less on the moon than on the earth.
e. An object weighs nothing in space because it is very far away from the gravitational pull of the earth.

The SI unit of weight is **newton(N)** and the instruments used to measure weight is **SPRING BALANCE.**

DIFFERENCES BETWEEN MASS AND WEIGHT

Mass	Weight
1. Is the quantity of matter in a body or substance	1. Is the gravitational pull on the body or object
2. Instrument used to measure mass is the beam balance	2. Instrument used to measure weight is the spring balance
3. SI Unit is kilogramme	3. SI Unit is newton
4. Mass is constant	4. Weight varies from place to place
5. Is a scalar quantity – has only magnitude (size)	5. Is a vector quantity – both magnitude (size) and direction

Density – Is defined as the mass per unit volume of a substance. The formula of density is

A. Density $= \frac{mass}{volume}$

B. Volume $= \frac{mass}{density}$

C. Mass = density x volume

SI Units

Mass = kilogramme (Kg)

Volume = mere cube (m^3)

Density = kilogramme per metre cube (Kgm^{-3})

Worked Examples

1. A plank of wood has a mass of 75.6kg and a volume of $39m^3$.
   Calculate the density of the plank of wood.

Solution

$$\text{Density} = \frac{mass}{volume}$$

Where Mass = 75.6kg

Volume = $39m^3$

Density =?

$$\therefore \quad \frac{75.6kg}{39m^3} = 1.94\ Kg/m^3$$

Density of plank of wood = $1.94kg/m^3$

2. A piece of stone 60g was dropped in a measuring cylinder containing water. The level of water increased from the $50cm^3$ mark to $78cm^3$ mark. Find the density of the stone.

Solution

Mass of stone = 60g

volume of water displaced = $(78 - 50)cm^3$

$= 28cm^3$

Volume of stone = volume of water displaced

$= 28cm^3$

$$\text{Density of stone} = \frac{mass\ of\ stone}{volume\ of\ stone}$$

$$= \frac{60g}{28cm^3}$$

$= 2.14g/cm^3$

3. Calculate the mass of a book whose density is 4.5 kg/m^3 and volume $2.6m^3$

Solution

Density = 4.5 Kg/m^3

Volume = 2.6m3

Mass = ?
Mass = Density x volume
= 4.5 Kg/m3 x 2/6m^3
= 11.7 kg

4. What is the volume of iron bar whose density is 1.5g/cm^3 and mass of 60g?

Solution

Density = 1.5g/cm^3
mass = 60g
volume = ?

$$\text{Volume} = \frac{mass}{density}$$

$$= \frac{60g}{1.5g/cm^3}$$

$$= 40cm^3$$

Determination of Density

REGULAR OBJECT

- Find the mass of the object using the beam balance.
- Calculate the volume of the object using its dimensions.
- Use the formula: Density = $\frac{\text{mass}}{\text{density}}$

IRREGULAR OBJECT

- Determine the mass of the object using the beam balance.
- Determine the volume of the object using the displacement of water in a measuring cylinder or overflow can.
- Use the formula: Density = = $\frac{\text{mass}}{\text{density}}$

IMPORTANCE OF DENSITY

1. Aeroplanes, moving parts of engines, bodies of buses, cars, boats and ships must be strong with respective volumes being greater than their corresponding masses.

2. Engineers making a bridge or tall building calculate the total height from the densities and volumes of the materials used.
3. Helps pure substances and mixtures to be distinguished.
4. A knowledge of density helps in the discovery of new elements.
5. Buoyancy helps us to know what substances will float or sink when placed in water.
6. Buoyancy also helps us to calculate the mass of a substance if its density is known.
7. Helps determine fluid flow in pipes if the density of liquid is known.

VOLUME

Volume is the amount of space that is occupied by a substance. Volume can also be defined as the internal space of an object such as a cup, a flask, a pipe, a box. The SI unit of volume is metre cube/cubic metre (m^3). Other units may include cubic centimeter (cm^3) cubic decimeter (dm^3) or cubic millimeter (mm^3).

A litre is not SI unit.

Instrument used to measure volumes of:

Liquid:

i. Pipette ii. Calibrated beaker iii. Measuring cylinder iv. Burette

Irregular solids:

i. calibrated beaker ii. Measuring cylinder

Solids (regular):

Metre rule

Two Types of Solids

1. Regular solid
2. Irregular solid

1. How to measure the volume of a regular solid.
    a. Measure and record the length (L)
    b. Measure and record the breadth (B)
    c. Measure and record the height (H)
    d. Use the formular to find the volume

    V= L X B x H (cm^3 or m^3)

2. How to measure the volume of an irregular solid.

Two methods commonly used.

A. Using a measuring cylinder

i. Pour enough water into the measuring cylinder which can cover the object (stone) when dropped into it later.
ii. Read the water level at the lowest point of the MENISCUS (curved line) as V1.
iii. Tie a string or thread round the object (stone).
iv. Lower the object carefully into the measuring cylinder. The water will rise tona level ,\V2
v. Leave some of the string hanging out of the cylinder.
vi. Shake it gently to remove the air bubble
vii. Read the final water level at the lowest point of the meniscus and then find the volume.

Volume = Final water level–Initial water level = V_2-V_1 (cm^3)

B. Using an overflow can and a measuring cylinder

i. Use a beaker and carefully pour some water into the overflow can until it is completely full (no water will flow out of the snout).
ii. Wait until no more water flows or drops out of the snout.
iii. Tie a string or thread around the solid.
iv. Put a measuring cylinder under the snout.
v. Carefully lower the solid into the bottom of the water in the overflow can.
vi. Leave some of the string hanging out.
vii. Observe the excess water flowing into the measuring cylinder.
viii. Wait until no more water flows out and read the volume of water in the measuring cylinder.

This volume of water in the measuring cylinder is equal to the volume of the solid.

- Repeat and find the average volume of the solid.

UNIT 4 MACHINES

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Explain the term, machine.
2. Identify simple machines.
3. Name and describe some types of simple machines.
4. Explain the terms, Mechanical Advantage, Velocity Ratio and Efficiency of machines.

Machine

A machine is defined as:

- a device by means of which work can be done easily and conveniently.
- any device by which a force is applied at a point to overcome another force at another point.

Types of machines

There are two types of machines.

1. **Simple machine** made up of few parts. A simple machine includes:
   a. Screw/car jack
   b. Inclined planes
   c. Levers
   d. Wheel and axle
   e. Pulleys

2. **Complex machines** are made up of a combination of two or more simple machines eg. car, aeroplane, bicycle, ship, wheelbarrow etc. A wheelbarrow comprises more than one machine. Including inclined plane, single pulley and wheel and axle.

SIMPLE MACHINES

A. Screw jack

- a simple machine that reduces the force needed to lift a car.
- it takes less effort or force to push down on the jack than it would take to lift the car by hand.

B. Pulleys

- Is a wheel with a groove and a rope attached. Pulleys are used for lifting loads .
- Builders use it to move heavy loads to higher floors.
- Used in loading and offloading goods on a ship.
- Used in raising and lowering flags.

Two types of pulleys exist:

1. Fixed pulley (Block)
- Fixed at one place and makes work easy by changing the direction of the force.

Double pulleys are called Block and Tackle

2. Movable Pulley (Tackle)
- is not fixed but can move up and down with the load. It makes work easy by reducing the effort needed to lift the load.

C. Inclined plane

- A simple machine consisting of a strong sloping plank, through which a load can be pulled or pushed.
- a simple machine with a flat surface that is higher on one end

The less steep the slope the less effort required and less energy and force is used. The longer the distance moved on an inclined plane, the less effort needed. This explains why roads are built around hills and mountains instead of straight up the sides since less effort would be needed to climb.

Examples of inclined planes are:

- sloping boards used to roll heavy objects such as barrels or drums of oil, bales of cloth onto a lorry or a truck
- slanting road
- path of a hill
- ramp
- staircase
- ladder used for climbing

D. Levers: A lever by definition is:

- A rigid rod free to turn about a fixed turning point called pivot (fulcrum).

A lever has three (3) main parts. These are:

ii. Load (weight to be lifted).
iii. Effort (force applied).
iv. Fulcrum (pivot-turning point).

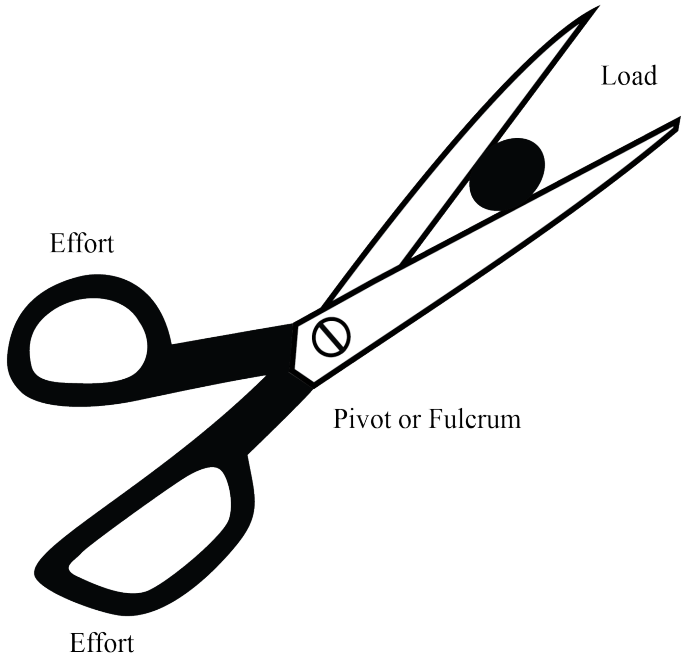
CLASSES OR ORDERS OF LEVERS

There are three (3) classes or orders of levers, depending on the relative position of the load fulcrum and the Effort.
These are:

1. **First Class Lever:**
   Are levers in which the fulcrum is between the load and the Effort (E).

   Example:

   A pair of scissors, crowbar, hammer, pliers, pincers, see-saw.

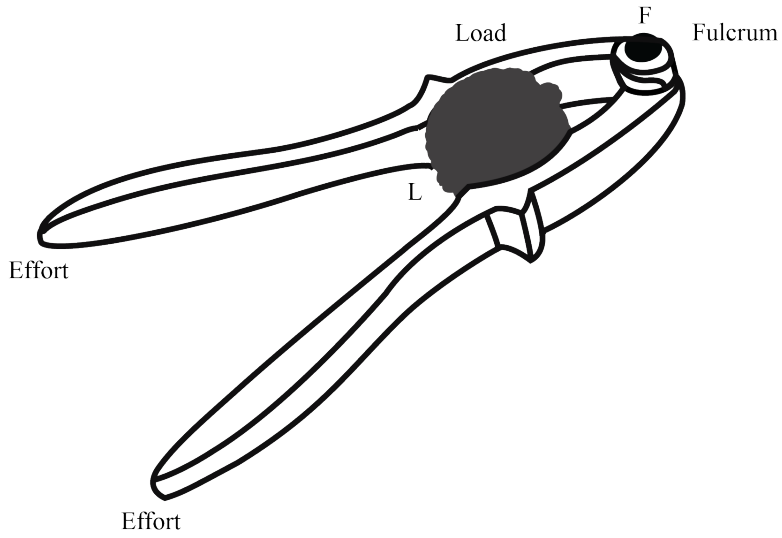


scissors

2. **Second class Lever:**
   Are levers in which the load (L) is between the Fulcrum (F) and the Effort (E).

   Examples:

   nut cracker, bottle opener, paper cutter, oar used in canoes.



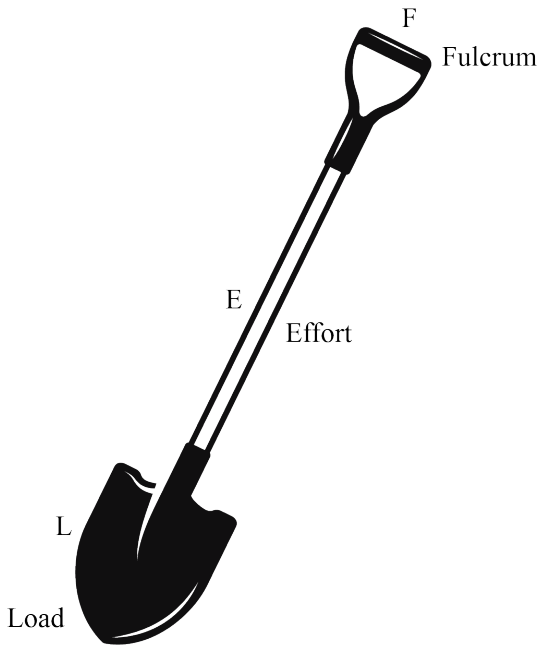
nut crackers

3. Third Class Levers

Here, the effort is between the fulcrum and the load.

Example

Fishing rod, tweezers, tongs, forceps, human arm, spade, shovel.



shovel

E. Wedges

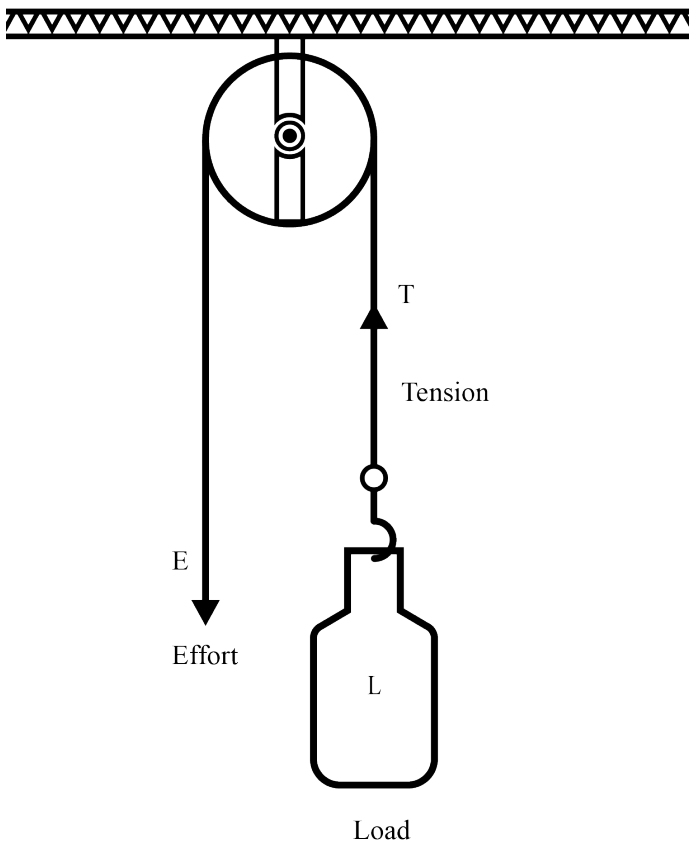
- are two inclined planes fastened together back to back to form a sharp end. It is used to push two objects apart. Examples:
- a chisel blade used by carpenters.
- an axe blade used to split wood
- the blade of a knife, forks, nails etc.
- metal or wooden wedge used to split fire wood or log.

WHEEL AND AXLE

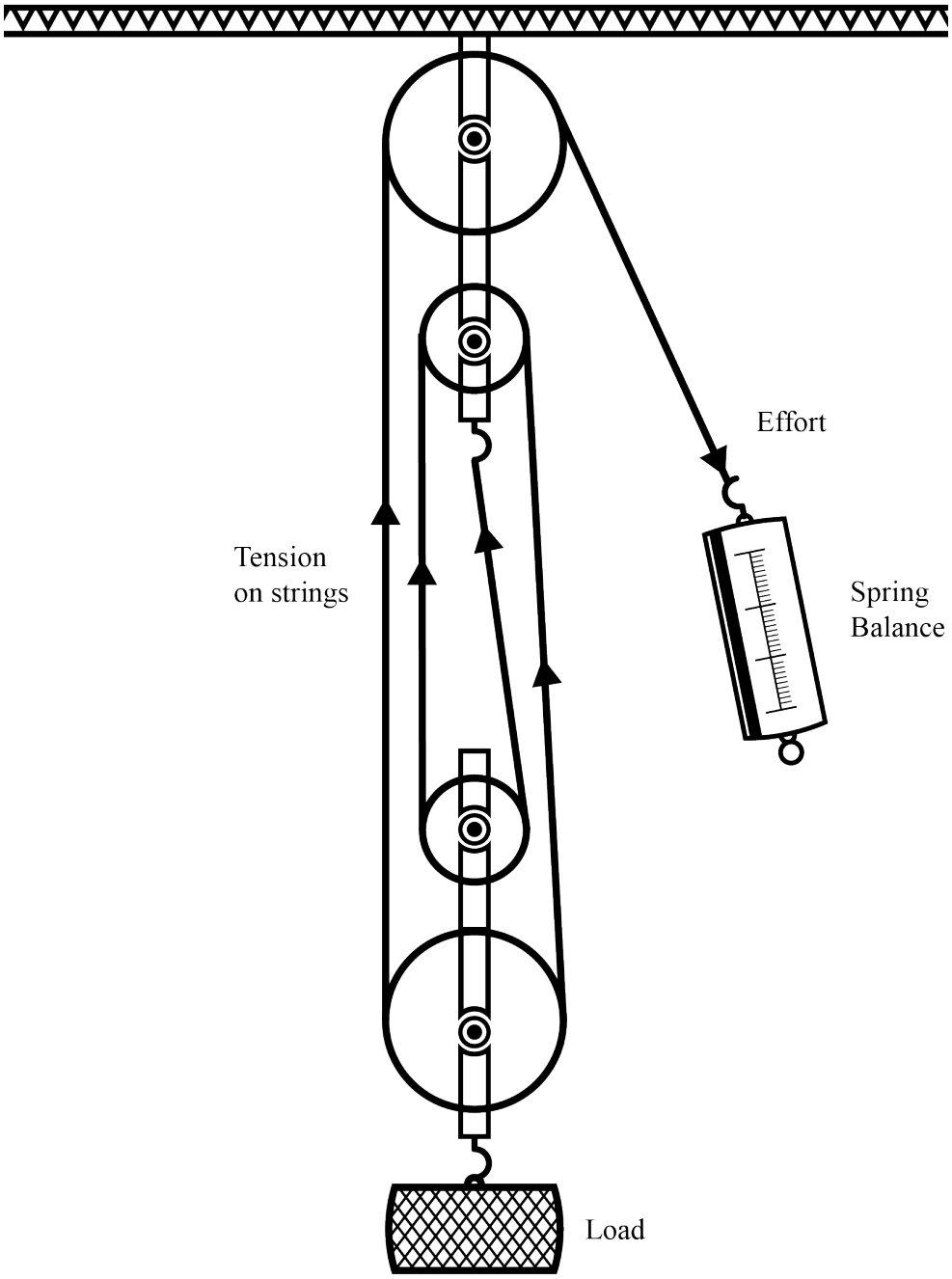
Is a simple machine consisting of two wheels of different diameters fixed together with a common centre. A length of rope is wound around the larger wheel and a weight such as a bucket of water attached to a small wheel by another rope.

The smaller wheel is called the **AXLE and the bigger WHEEL**.

First Class Levers

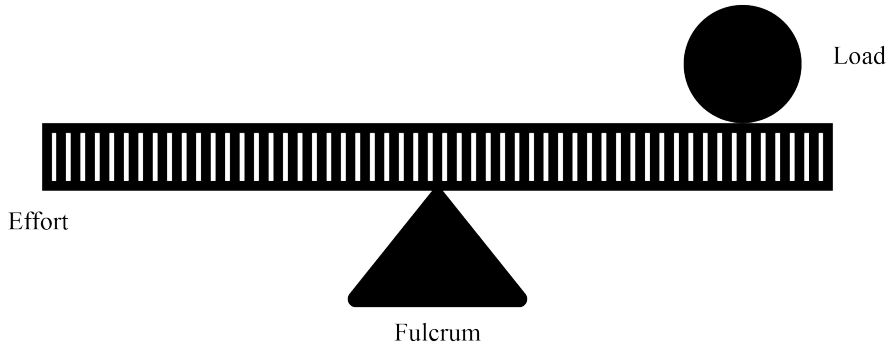


single fixed pulley

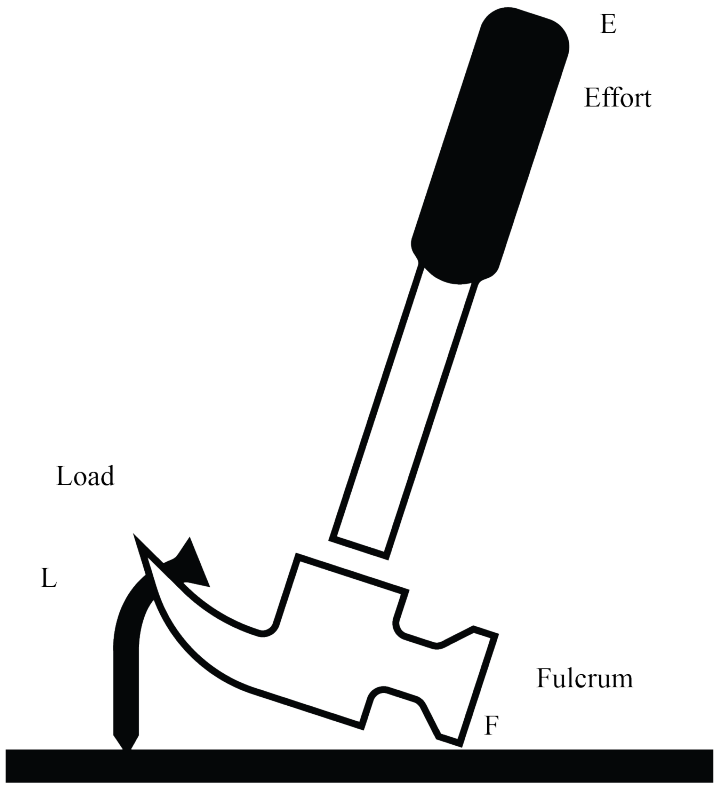


A system of pulley

Simple Lever

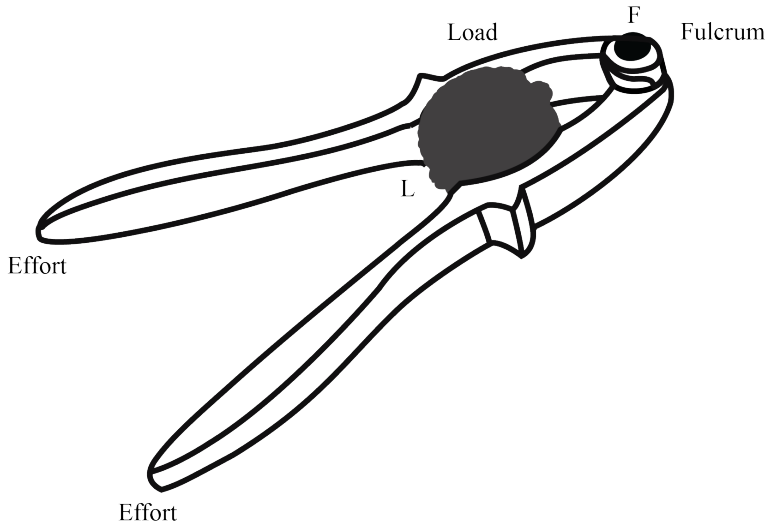


simple lever



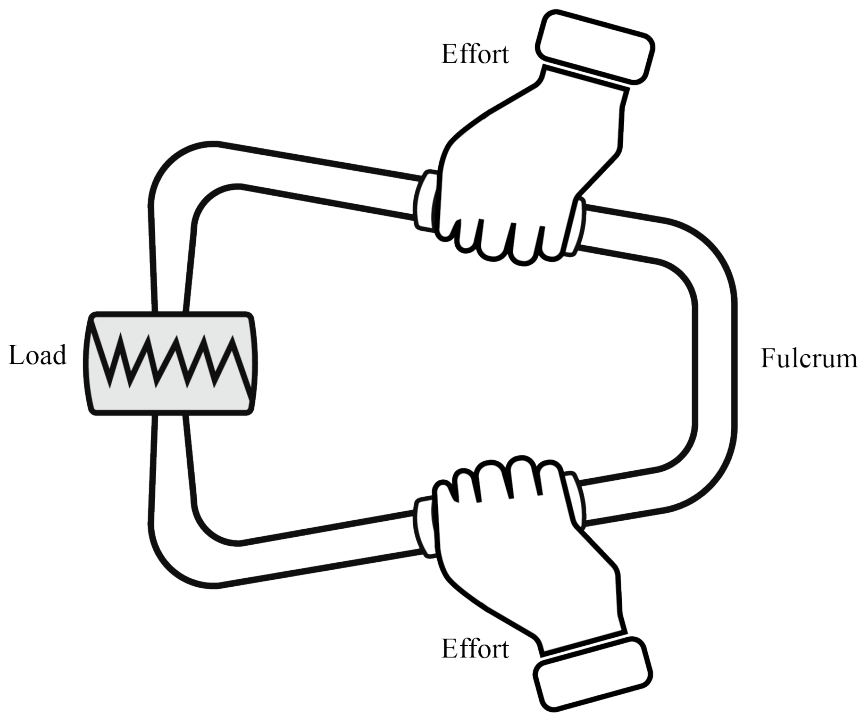
claw hammer

Second Class Levers

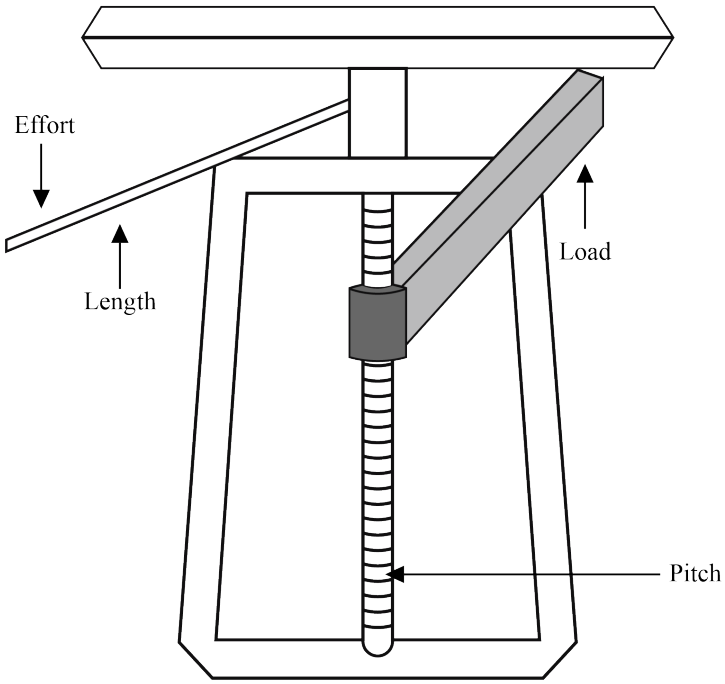


nut crackers

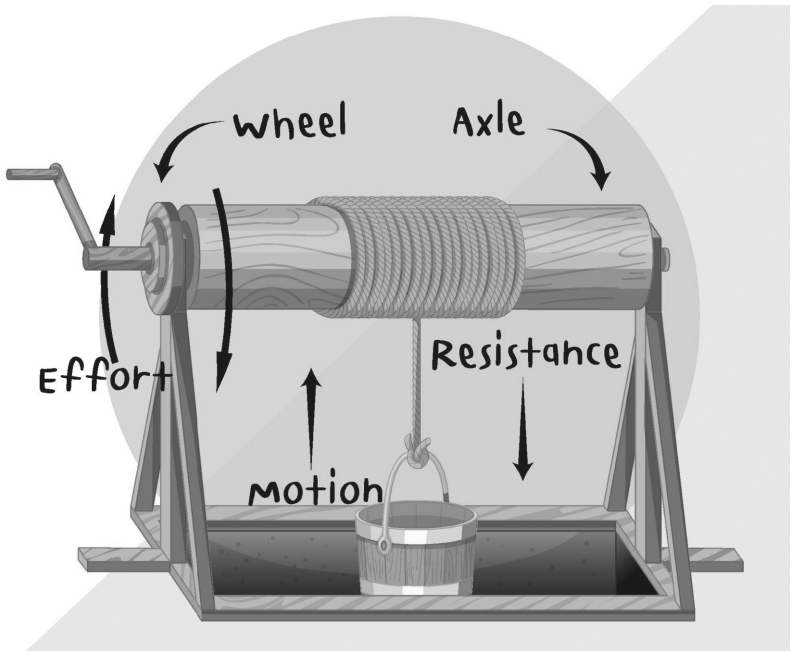
Third Class Levers



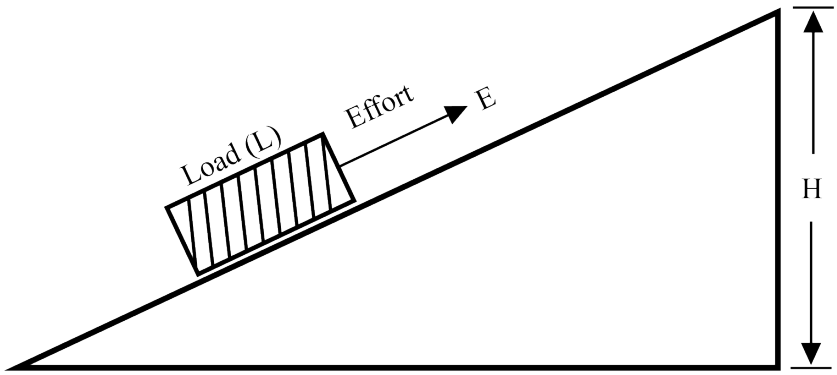
coal tongs



The car jack



wheel and axle



inclined plane

Examples
windlass used to draw water out of a well, bicycle etc

Mode of operation of a machine and its calculation
The work of a machine is determined by the following:

1. Mechanical advantage (M.A.)
2. Velocity Ratio (V.R.)
3. Efficiency of a machine

Mechanical Advantage (M.A.)
is the ratio of the load to the effort applied:

$$\text{M.A.} = \frac{\text{Load (L)}}{Effort\ (E)}$$

Effort = E

Mechanical Advantages has no unit

1. if the load is greater than the effort then the mechanical advantage is greater than 1 (MA>1)
2. if the effort is greater than the load the mechanical advantage is less than 1 (MA<1)
3. if the load equals the effort the mechanical advantage is 1 (MA = 1)

Worked Examples:

A man uses a wheelbarrow with an applied effort of 20N to move a load 80N. what is the mechanical advantage of the machine?

M. A = ? $\quad$ M.A = $\frac{Load}{Effort}$

Load = 80N $\quad$ = $\frac{80N}{20N}$

Effort E = $\quad$ 20N

Velocity Ratio (V.R.)

If a machine is the ratio of the distance moved by the effort to the distance moved by the load.

Velocity ratio has no unit

$$V.R = \frac{Distance\ moved\ by\ effort}{Distance\ moved\ by\ load}$$

$$V.R. = \frac{Length\ of\ plane}{Height\ of\ plane}$$

$$V.R. = \frac{Length\ of\ handle}{Radius\ of\ axle}$$

Worked Examples:

a) Calculate the velocity ratio of a machine when an effort moves at a distance of 6m moved a load to 10m.

Solution

V.R. = ? $\quad$ V.R. = $\frac{distance\ effort}{distance\ load\ moved}$

length of plane = 30m

Height of plane = 6m $\quad$ = $\frac{30m}{6m}$

V.R. = 5.0

b) Calculate the velocity rate of an inclined plane of length 30m used to roll a load into a truck of 6m from the ground.

Solution

V.R. = ? $\qquad$ V.R. = $\frac{Length\ of\ plane}{Height\ of\ plane}$

Length of plane = 30m

height of plane = 6m $\qquad$ = V.R. = $\frac{30m}{6m} = 5$

V.R. = 5.0

c) Find the velocity ratio of a crank whose hand is 44cm from the axis and has an axle of radius 11cm.

Solution

V.R = ?

$$V.R. = \frac{Length\ of\ plane=}{Radius\ of\ axle} = \frac{44cm}{11cm} = 4$$

$$= \frac{2\pi \times 4}{2\pi \times 4} = 4.0$$

EFFICIENCY

i. is the ratio of useful work done by the machine to the total work put into the machine expressed as a percentage.
ii. is the ratio of the work output to the work input expressed as a percentage?
iii. is the ratio of the mechanical advantage to the velocity ratio expressed as a percentage.

$$Efficiency = \frac{work\ output}{work\ input} \times \frac{100}{1}\ \%$$

$$Efficiency = \frac{M.A}{V.R} \times \frac{100}{1}\ \%$$

Note. *No machine is 100% efficient as the machine has to overcome friction between parts of the machine and gravitational forces.*

Worked Examples:

1. The work input of a machine is 100J. If the work output is 800J, calculate the efficiency of the machine.

work out put = 800J

work input = 1000J

Efficiency = ?

$$\text{Efficiency} = \frac{work\ output}{work\ input} \times 100\%$$

$$= \frac{800J}{1000J} \times \frac{100}{1} = 80$$

Efficiency = 80.0%

2. In machine an effort of 100N moved through a distance of 20m in order to lift a load of 250N through a distance of 5m. Calculate the:

- Mechanical advantage
- Velocity ratio
- Efficiency of the machine

$$\text{M.A} = \frac{\text{load}}{\text{Effort}} \qquad \text{b. V.R.} = \frac{\text{Effort distance}}{\text{Load distance}}$$

$$= \frac{250}{100} \qquad \frac{20}{5}$$

$$= 2.5 \qquad = 4.0$$

$$\text{Efficiency} = \frac{M.A}{V.R.} \times \frac{100}{1} = \frac{2.5}{4} \times \frac{100}{1}$$

$$= \frac{250}{4}$$

$$efficiency = 62.5\%$$

UNIT 5 HEAT AND SOURCE OF HEAT

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Explain the terms heat and energy.
2. Demonstrate the modes of heat transfer.

Heat can be generated

1. Mechanically, eg by friction.
2. Chemically, such as burning of fuel food.
3. By sun rays.
4. By electricity.
5. By biomass or biogas.
6. Nuclear change.

Effects of Heat on Substance

1. Heat can cause an increase or decrease in temperature.
2. It can cause a change of state e.g. melting, boiling, evaporation, sublimation, freezing etc.
3. Heat can cause burning.
4. Heat can cause expansion of a substance.
5. It assists chemical reaction.

Factors which affect the Heat change of a Body

1. The mass of the body.
2. The surrounding temperature.
3. The type or nature materials the body is made up of.
4. The specific heat capacity of the body.

Transfer of Heat

There are three main ways by which heat is transferred from one body to the other.

Conduction

Is the transfer of heat through solids without any visible movement of heated particles e.g., when one end of a metal is held in a strong flame the opposite end can become heated after a while.

If a metal spoon is dipped into a hot soup the heat from the soup travels through the spoon to the handle.

Convection

Is the transfer of heat through liquid or gas (fluids) with visible movement of the heated particles? E.g. heating a beaker of water with some crystal of potassium permanganate, thread like stream of colour will rise from the bottom of the solution to the top in a cyclic form. Heated water molecules rise. After losing their heat at the top of the liquid they fall back to the bottom of the water, get heated and repeat the cyclic or convectional process.

1. Land and sea breeze.
2. Ventilation of building.
3. Cooling system of an engine.
4. Formation of clouds.

Radiation

Is the process by which heat energy is transferred through vacuum which requires no material medium but travels in the form of waves from the sun e.g. heat energy from the sun reaches the earth surface by radiation. Radiation requires no material medium.

Good Conductors and Insulators

Conductor – Are materials in which heat can move through easily eg metals such as, iron, copper, aluminium, lead, zinc, tin etc

Insulators – Are substances in which heat cannot move through. They are referred to as poor or bad conductors. Examples are plastic, rubber, paper, wood, wool.

Assignment

1. a) State three effects of heat on a substance.
   b) Give two (2) factors which affect the heat change of a body.
2. a) Distinguish between conduction and convection.
   b) give two (2) examples of:
3. (i) Good conductor (ii) insulators

UNIT 6 MEASUREMENT OF HEAT

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Determine the quantity of heat in an object.
2. Define heat capacities and latent heat.

Heat capacity and specific heat capacity

Heat capacity of a substance or a body is the quantity of heat required to raise its temperature of the whole body of the substance through 1°C.
Specific heat capacity of a substance or body is the amount of heat required to raise the temperature of 1g or 1kg of a substance through 1°C

Latent Heat
Is the heat that is given off or absorbed during a change of state of a substance without a corresponding increase in temperature.

Latent Heat of Fusion
is the heat required to change a solid to liquid without a corresponding increase or change in temperature.

Latent Heat of Vaporization
Is the heat required to change a liquid to gas (vapour) without a corresponding change in temperature.

Specific Latent Heat
Is the heat absorbed or evolved when 1g or 1kg of substance undergo change of state without a corresponding increase or in temperature.

Specific Latent Heat of Fusion
Is the heat absorbed or evolved when 1g or 1kg of a substance change form solid to liquid without any corresponding increase or change in temperature.

Specific Latent Heat of Vaporization

Is the heat absorbed or evolved when 1g or 1kg of a substance change from liquid to gas (vapour) without any corresponding increase or change in temperature.

Temperature

1. Is the degree or amount of hotness of a body or substance.
2. Is the property of a substance that determines the direction in which heat must flow.

Formula for conversion from Celsius to Fahrenheit

N.B.

1. ***Upper fixed points of Celsius and Fahrenheit Scales are 100 and 212 degrees and the lower fixed points are 0 and -32 degrees respectively. The ratio of their fundamental intervals is (100-0): 212-32 which is 100:180, that is 5:9.***

2. ***Formula for conversion is as follows:***

To convert from Fahrenheit to Celsius a smaller figure must be obtained since you multiply the given figure in Fahrenheit with 5/9.

E. g. 1.Convert 212 degrees F to Celsius.

i. e. (212-32 F)x5/9= ^{o}C

180 x5/9 = 100C

To Convert 100C to Fahrenheit.

(100-0) 9/5 = F-32

100x 9/5 = F-32

180 +32 = F

212 = F.

To convert from Celsius to Fahrenheit use the formula:
$^{o}F-32= 9/5(^{o}C-0)$.
E.g. Convert !00^{o}C to Fahrenheit

$^{o}F-32 = 9/5(100-0)$
$= 9/5 x100$
$= 180$
$^{o} F = 180 + 32$
$F = 212^{o}$

ii. Convert 45^{o}C to ^{o}F
$(45-0) x 9/5) =F-32$
$= (9 x 9) + 32$
$= 81 + 32$
$= 113^{o}F$

iii. Convert 68^{o}F to ^{o}C

$^{o}C = 5/9(^{o}F - 32)$

$= 5/9(68 - 32)$

$= 5/9(34)$

$= 5 x 4$

$= 20\,^{o}C$

Difference between Heat and Temperature

Heat	**Temperature**
Heat is a form of energy.	Temperature is the degree of hotness or coldness of body substance
Heat is the transfer of energy due to temperature difference between two points.	Temperature is the property of a substance which determines the direction in which heat must flow.
Heat cannot be measured directly.	Temperature can be measured.
Heat is measured in Joules (J).	Temperature is measured in Kelvin (K).
The instrument used to measure heat is the calorimeter.	The instrument used to measure temperature is the thermometer.

Worked Example:

What quantity of heat is required to change the temperature of 4kg of water from 2°C to 100°C. (The specific heat capacity of water is 4.200 $JKg^{-1}K^{-1}$)

Q = mcTQ = mcT

$Q = mc (T_2 - T_2)$

4 x 4.200 x (100 – 2)

= 16.8 x 98

1646.4 J

UNIT 7 ELECTRICITY

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Describe static and current electricity.
2. Mention the various components of electric circuits and their functions.
3. Differentiate between primary cells and secondary cells.

Electricity is a form of energy generated when electric charges (electrons) move for one point to another in a conductor.

SOURCES OF ELECTRICITY

Electricity energy is generated by:

1. Chemical energy
2. Air/wind
3. Water (tidal waves)
4. Nuclear energy
5. Sun/solar energy
6. Geothermal

Electric circuit

An electric circuit is the path through which electric currents flows. it has four components:

A. Source-cell or battery.
B. Wires/ lead (cables) – path or lines through which electric current flows.
C. Switch (tapping key – Device which opens or closes the circuit.
D. Electrical appliance – An object which uses the electric current e.g. Electric iron.

- When all the four components are present we have a complete circuit.
- The circuit is incomplete when two or more of the components are not present.
- A closed circuit is one in which the switch is closed to allow current to flow.
- It is an open circuit when the switch is not closed so no current flows.

BATTERY AND CELL

A battery – A battery is a collection of several cells connected together. It is a device that changes chemical energy into electrical energy due to the chemical reaction which takes place inside the battery.

Batteries are the same as storage or secondary cells.

Batteries or secondary cells are rechargeable when they run down.

Examples:

1. Lead acid accumulator or car battery.
2. Alkaline accumulator or NiFe.
3. Nickel-Cadmium battery.

CELLS

- A cell is a simple unit device found in a battery.
- Is a device that stores energy in the form of chemical the energy being released when a current is conducted between the terminals of two cells.
- Is the chemical device that converts chemical energy into electrical energy.

There are two types of cell

1. Primary cell.
2. Secondary cell/ storage battery.

A Primary Cell

A primary cell converts chemical energy directly into electrical energy. They cannot be recharged when they run down.

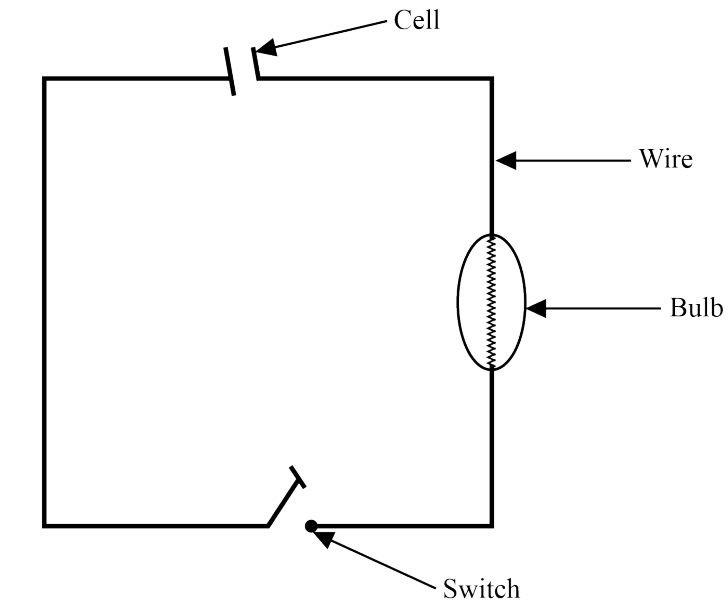
Examples of Primary cells are:

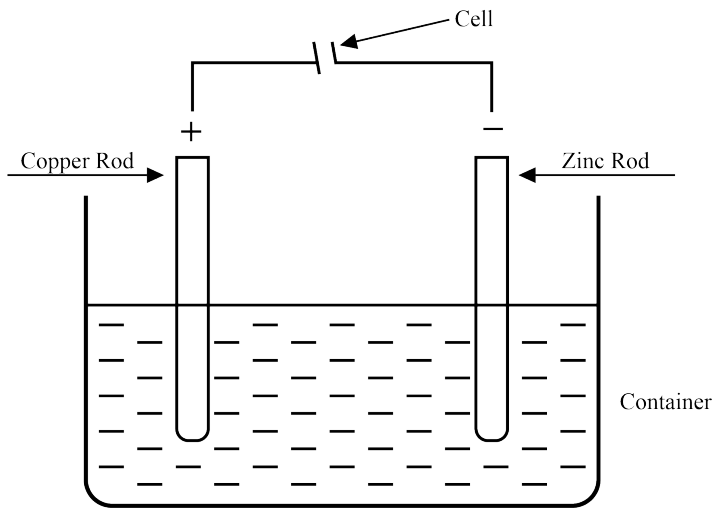
i. Daniel cell ii. Simple Voltaic cell iii. Wet Leclanché cell

iv. Dry Leclanché cell v. Danielle cell

Assignment

1. Give two (2) examples of cell battery.
2. a) What is an electric circuit?
   b) Draw a diagram of a complete electrical circuit with all the four component presents.
3. a) State three (3) sources of electricity.
   b) What is a circuit.



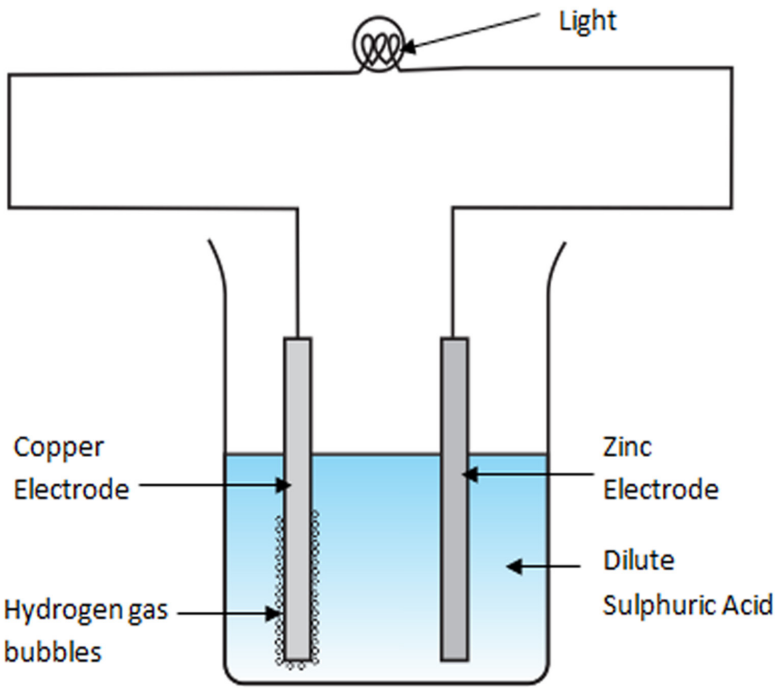


wheel and axle

SIMPLE PRIMARY CELL

Effects of simple primary cells are Local action: Its occurs when the electrolyte(acid) dissolves the zinc electrode.
Polarisation: Its occurs when the electrolyte dissociates and the hydrogen ions drift to cover the surface of the copper electrode as gas.

Local Action is caused by the impurities present in zinc rod. When the zinc rod is immersed in acid, the zinc atoms and the impurity atoms form a large number of local cells and the zinc rod gets consumed even when the cell is not in use. This defect can be avoided by using amalgamated zinc rods.



copper-zinc cell.

UNIT 8 MATTER

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Explain matter.
2. Describe the nature and state of matter.
3. Outline the characteristics of the states of matter.
4. Demonstrate how matter is changed from one state to another.

MATTER – Anything that has mass and can occupy space.

PROPERTIES OF MATTER

1. Has mass/weight
2. Has volume/size
3. Can occupy space

Matter exist in three states. They are solid (like stones, wood), liquid (like water, kerosene) and gas (oxygen, carbon dioxide).

States of Matter and their properties

Solid	Liquid	Gas
Has a definite volume.	Has a definite volume.	Has no definite volume.
Has a definite shape.	Has no definite shape Takes the shape of the container.	Has no definite shape.
Cannot be easily compressed.	Can be compressed.	Can be easily compressed.
Particles are closely packed.	Particles are a bit free to move about.	Particles are free to move about.
Has very high density.	Has high density.	Has low density.

Examples: stone, chalk, table, blackboard, stick etc.	Water, petrol, kerosene, oil, milk	Oxygen, nitrogen, carbon, dioxide, chlorine, helium

CHANGING THE STATE OF MATTER

Is the conversion of one state of matter to another by means of change in temperature or heat and pressure.

Melting - is the process by which a solid is changed into a liquid by heating.

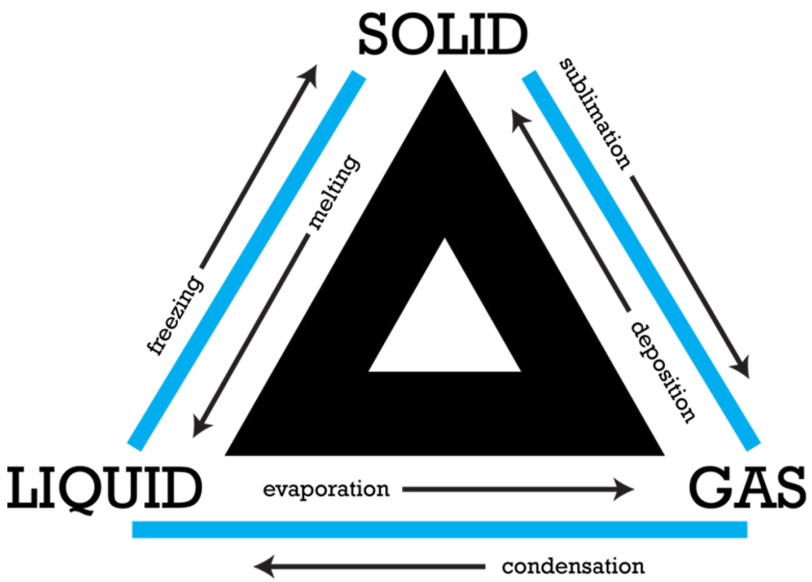
Boiling/evaporation - is the process by which a liquid changes into gas (vapour) by heating.

Condensation/cooling – is the process by which a gas changes to a liquid by cooling.

Freezing/solidification - is the process by which a liquid changes to a solid by cooling.

Sublimation - is the process by which a substance changes from the solid state directly to gaseous state when heated without forming the liquid state e.g. iodine, camphor balls, and ammonium chloride.

Deposition or Re-sublimation - is the process by which a substance changes from gas state directly to solid when cooled forming the solid state.



change of state of matter

PHYSICAL AND CHEMICAL CHANGES

PHYSICAL CHANGE – is a change in which no new substance s are formed and the change is reversible.

Examples:

- Dissolving common salt in water.
- Melting of ice.
- Freezing of water.
- Melting of candle.
- Magnetization of iron.

CHEMICAL CHANGE – is a change in which new substances are formed and the change is irreversible.

Examples:

- Burning of charcoal.
- Digestion of food.
- Fermentation.
- Rusting of iron.
- Burning of paper.

Differences between Physical and Chemical changes

Physical change	**Chemical change**
Non new substances are formed.	New substances are formed.
Easily reversible.	Not easily reversible.
Produce no change in mass.	Produces changes in mass.
Not accompanied by great heat change.	Usually accompanied by great change in mass.

ELEMENT, COMPOUND AND MIXTURE

Element is a substance which cannot be split up into two or more substances by any known chemical means.

Examples: Hydrogen – H, lithium – Li, Beryllium – Be, Magnesium – Mg, Copper – Cu, Iron – Fe, zinc – Zn, Aluminiium – Al, Boron – B Carbon – C, Phosphorus - P, Iodine, I, Fluorine – F, oxygen-O, Nitrogen-N, Helium-He, Neon-Ne, Argon-Ar etc.

Compound - is a substance which is made up of two or more substances that are chemically combined together.

Examples:

1. Water (hydrogen and oxygen) – H_20
2. Common salt (sodium and chlorine) - NaCl
3. Carbon dioxide (carbon and oxygen) - CO_2
4. Ammonia (nitrogen and hydrogen) – NH_3

Mixture is a substance which is made up of two or more substances (elements or compounds) that are not chemically combined together.

Examples:

Sand and water – Sand and rice
Salt and water _ Alcohol and water
Sand and cement – Iodine and common salt

Differences Between Compounds and mixtures

Compounds	Mixtures
1. The composition of elements present in a compound is fixed.	1. The composition of elements present in a mixture is not fixed.
2. The properties of a compound are different from those of its constituents.	2. The properties of a mixture are the same as that of its constituents.
3. The constituents can be separated only by chemical means.	3. The constituents can be separated by physical means.
4. Definite chemical formula for compounds.	4. No definite chemical formula for mixtures.

Assignment

1. a) Define
   i. Element ii. Compound iii. mixture
   b) Give two (2) examples of each in (a) above.
2. Write 10 elements with their symbols.
3. Give 2 differences between an element and a compound.

UNIT 9 SEPARATION OF MIXTURE

Learning Outcomes

At the end of the lesson, pupils should be able to:

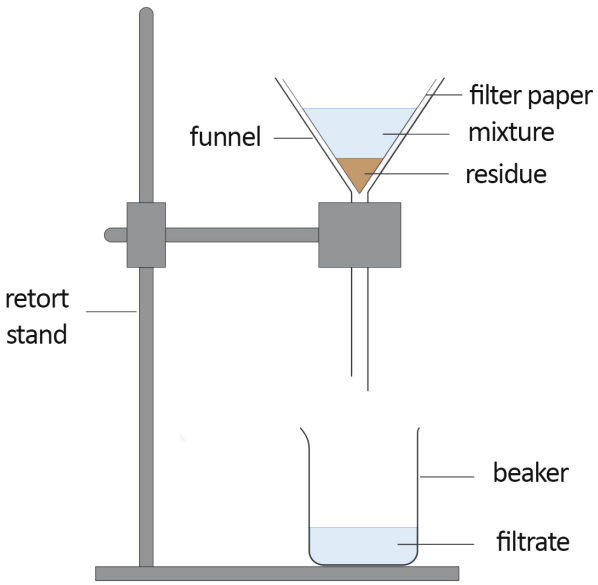
- Distinguish between elements, compounds and mixtures.
- List and explain some methods of separating mixtures.

Mixture can be separated by physical means. Separation by physical method depends on:

- the properties of the substance that is their state whether they are solid, liquid or gas.
- their solubilities.
- their melting and boiling point.

FILTRATION

Filtration is the method used in separating insoluble solids form liquid. Example: sand can be separated from water by filtration. The sand and water mixture is poured on a filter paper inserted in a funnel with a beaker underneath the set-up.
The liquid (water) that passes through space in the filter paper is the filtrate while the solid (sand) left behind on the filter paper is known as the residue.



SEDIMENTATION

This method can be used after the mixture is shaken vigorously and allowed to settle. The heaviest particles settle first at the bottom, followed by less heavy ones with the clear water at the top. Settlement of particles is aided by gravity.

DECANTATION

This method involves the pouring out of the clear liquid from the settled solid after sedimentation.

SOLIDS SOLUBLE IN LIQUID

Example: Salt in water
Add water to dissolve the salt (dissolution). This forms solutions of salts and water. The salt is the "solute" dissolving and the water is the solvent (dissolving medium).
A solution is a uniform mixture of two or more substances. Example, sand and water.
A suspension is a mixture of two or more substances in which the particles are seen clearly.
Example: starch in water, chalk powder and water.

EVAPORATION TO DRYNESS

With a mixture of salt and water the solution can be separated by evaporation ordryness method of separation. This method can be used to get back the salt from the salt and water solution.
The mixture is heated until the liquid vaporizes.
Indirect heating – this method is used when the liquid is volatile or flammable. To avoid the liquid from catching fire, a water bath is used.
Example: separating alcohol and water.

DISTILLATION

This method can also be used to separate salt from water. The water can be recovered by condensation of the liquid to form distillate.

LIQUID – LIQUID MIXTURE
Immiscible liquid Example, palm oil and water
The two liquids cannot mix. The denser liquid sinks at the bottom, while the less dense floats.

Example: palm oil floats on water.

This mixture can be separated using the separating funnel. All the water is drained down into the beaker leaving the palm oil in the separating funnel.

SIMPLE DISTILLATION

This method is used to separate two miscible liquids that can mix. The two miscible liquids will have different boiling points eg alcohol and water. The alcohol boils at 28°C and water boils at 100°C.This method is suitable for two miscible liquids with a big or difference in boiling points. Distillation involves vaporizing the liquid and condensing the vapour to liquid. The alcohol first vaporizes and is condensed using the condenser. The liquid which is collected in a beaker after distillation is called a distillate

FRACTIONAL DISTILLATION

Used to separate miscible liquids with several components in the mixture having different boiling points with small differences in temperature between them.
When heated the substance with the lowest boiling point starts to boil first and converts to vapour.
Crude oil is separated into various components - petrol, kerosene, diesel, lubrication oil and coal tar in that order.

In this method a FRACTIONAL COLUMN is used containing beads and a thermometer. The glass beads in the column offers a large surface area for vaporization at different temperatures. The thermometer shows the temperature range of the different components.

SOLID – SOLID MIXTURES

Chromatography colour separation

This method is used to separate various colour components in ink, dyes, leaf extracts etc.
Three types exist based on the mixture to be separated.

a. Paper chromatography.
b. Column chromatography.
c. Gas chromatography.

Paper Chromatography – a mark is made in the centre of the strip of a filter paper and allowed to dry. The strip is then placed in a suitable solvent with the mark just 2cm above the solvent. As the solvent rises, it carries with it dissolved substances, which are deposited substance as various bands showing the number of substances (colours) present in the mixtures.

Sublimation

A mixture of two solid in which one changes directly to vapour (gas) on heating and back to solid on cooling without going through the liquid state.

Solid	**Gas**
Iodine	Iodine vapour

Examples of substances that are sublime are, a mixture of ammonium chloride and common salt can be separated by this method. The ammonium chloride sublimes and cools down on the inverted funnel.

MAGNETIC SEPARATION OR MAGNETISATION

This method is used to separate magnetic substances from non-magnetic substances. For a mixture of fillings and Sulphur the magnet passed through the mixture will attract all magnetic substances (iron filling) and remove them from the mixture. The iron fillings cling to the magnet while the Sulphur is left out.

Another examples is razor blades mixed with sand. The magnet will attract the razor blades and leave the sand behind.

Assignment

1. Draw and label the apparatus for the following methods of separation:
   a. Filtration
   b. Evaporation
   c. Distillation
   d. Fractional distillation
   e. Separating funnel
   f. Sublimation
2. Draw any ten laboratory equipment and state their uses.

UNIT 10 AIR

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Explain the components of air and their relative percentages.
2. Demonstrate rusting and how to prevent rusting.
3. Explain the preparation/properties and uses of some of the gases in air.

AIR

Air is a mixture of gases. The blanket of air which completely covers the earth is called the atmosphere.

Composition of air by percentages

Component (constituent)	Percentage Volume
Nitrogen (N_2)	78.1%
Oxygen (O_2)	21%
Carbon dioxide (CO_2)	0.003%
Inert/Rare/Noble gases	about 1%
Water vapour	Varies
Dust particles	Varies

Differences between Inhaled and Exhaled Air

Inhaled Air	Exhaled Air
Dust particles present	Dust particles absent
Large amount of oxygen present (21%)	Small amount of oxygen present (16.17%)
Low percentage of carbon dioxide (0.03%)	High percentage of carbon dioxide present (3% to 4%)
Low water vapour present	High water vapour present

Rusting

Rusting occurs when iron is exposed to ordinary air and moisture (water). The iron becomes coated with a reddish brown substance known as rust.

Rust is a reddish brown substance that coats an iron after exposure to ordinary air and moisture.

Rust is a hydrated iron (III) oxide

i.e. Fe_2O_3 X H_2O (hydrous ferric oxide)

Rusting is an oxidation process like burning but it is very slow compared to burning. The conditions necessary for rusting are:

Air and moisture (water).

Prevention of Rusting

- Oiling or greasing
- Painting
- Electroplating
- Alloying
- Enamel
- Galvanizing
- Coating with tar

Uses of Oxygen

1. It is used in oxy-acetylene flame for welding and cutting steel.
2. It is used in respiration in plants and animals.
3. It is used as breathing aid by mountain climbers, sea divers, astronauts and patients in hospitals.
4. Liquid oxygen is used as rocket fuel.
5. Oxygen is used in the production of steel.

Uses of Carbon dioxide

1. It is used as dry ice (solid CO_2) in making ice cream.
2. It is used in fire extinguishers since it does not support combustion.
3. It is used in mineral drinks such as coca cola, sprite, soda water and medical salt such as Epsom salt.
4. It is used in preventing fruits from losing flavour and rotting faster.
5. It is used in baking powder which makes bread and cake rise.
6. Promotes growth of plants in greenhouses.

Assignment

1. a) State the constituents and composition of the three major gases in Air.
   b) Give three ways by which rusting can be prevented
2. State two uses of each:
   i. Oxygen ii. Carbon dioxide
3. State three differences between inhaled air and exhaled air.

OXYGEN GAS (0_2)

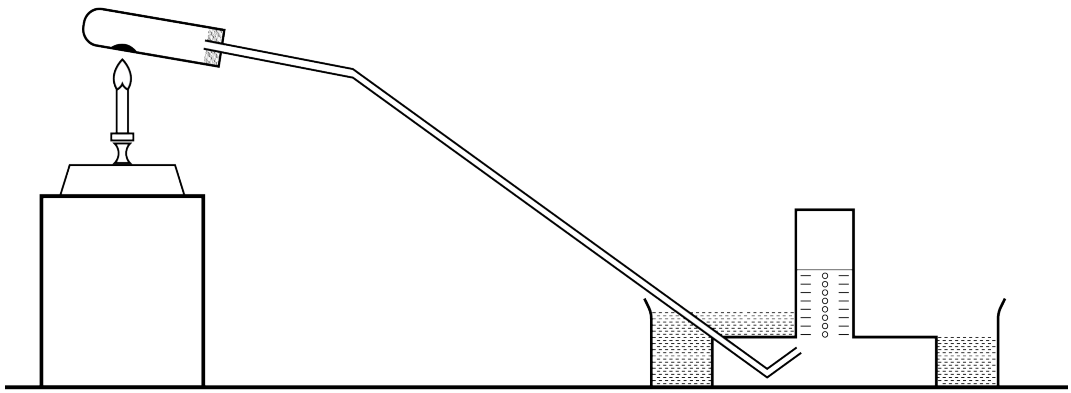
Laboratory preparation of oxygen

Oxygen is prepared in the laboratory by heating a mixture of potassium chlorate and manganese dioxide acting as a catalyst.

A catalyst is a substance which alters the rate of a chemical reaction but remains unchanged at the end of the reaction. The manganese dioxide acts as a speed agent to speed up the reaction but does not appear to take part in the reaction.

$$2KClO_3 \xrightarrow{MnO_2} 2KCl + 3O_2$$

The gas oxygen (02) is given off and collected over water by downward delivery.



PROPERTIES OF OXYGEN

- Oxygen is tasteless, odourless and colourless.
- It supports combustion (burning) and therefore relights/rekindles a glowing/lighted splint
- It is neutral to litmus paper
- Metals burn in oxygen to form basic oxides

Sodium + oxygen to give sodium oxide

$$4Na + 0_2 \longrightarrow 2Na_20$$

Calcium oxygen to give Calcium Oxide

$$2Ca + O_2 \longrightarrow 2CaO$$

Sulphur + Oxygen $\longrightarrow$ Sulphur dioxide

$S + O_2$ $\qquad$ SO_2

TEST FOR OXYGEN

Oxygen relights or rekindles a glowing splint when the glowing splint is lowered into a gas jar containing oxygen.

CARBON OXIDE (CO_2)

LABORATORY PREPARATION OF CARBON OXIDE

Carbon dioxide is prepared in the laboratory by the action of dilute hydrochloric acid on marble or limestone (calcium carbonate)

Effervescence bubbling occurs and gas is produced, passed through the delivery tube and collected over water, since it in insoluble in water

$$CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$$

The carbon dioxide can be collected by downward delivery or upward displacement, since carbon dioxide is dense than air.

PROPERTIES OF CARBOB DIOXIDE

- CO_2 is a colourless and odourless gas.
- CO_2 is denser than water.
- It is slightly soluble in water to give an acid solution.
- It turns damp blue litmus paper faint red.
- It do not support combustion (burning) and therefore can put a glowing splint.
- CO_2 turns lime water $Ca(0H)_2$ milky or cloudy.

TEST FOR CARBON DIOXIDE (CO_2)

When carbon dioxide (CO_2) gas is passed through lime water (calcium hydroxide $Ca(0H)_2$, the lime water turns milky due to the formation of calcium carbonate - ($CaC0_3$)

UNIT 11 WATER

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Mention the sources and uses of water.
2. Describe the properties of water.
3. Explain how water is treated for public consumption.
4. Differentiate between hard water and soft water.

Water is a stable compound with the chemical formula H_2O meaning two atoms of hydrogen and one atom of oxygen.

The ratio of hydrogen to oxygen in water is 2:1
Water is a basic necessity of life.
It occupies about 75% of the earth.
Water is a universal solvent that is it can dissolve most substances.
The molecules have the structure:

or H-O-H (H_2O)

Water is commonly referred to as a universal solvent, The only liquid at room temperature(from zero to 100 degrees centigrade) because of the tiny weak hydrogen bonds that hold the water molecules together for short intervals.

Sources of Natural Water

The main natural sources of water include:

- Rain water
- Streams
- Wells
- Ocean/Sea
- Spring
- Pond

The purest form of natural water is rain water and the impurest is sea water.

Purification of Water

Domestic means

a. Filtration
b. Boiling
c. Distillation
d. Addition of chemicals (alum, camphor, chlorine, naphthalene
e. Sedimentation/Decantation

Town Water Supply

The purification of water for a town or community involves several stages.
These are as follows:
Water from lakes/rivers à screening à filtration à sedimentation àExposure to sunlightàAddition of alumàChlorinationàAddition of limeàstorage tanksàhomes

Screening

Water from the river or lake is screened or strained to remove suspended materials such as rags, sticks, solid organic matter which may interfere with the purification step.

Filtration

Water is passed over sand filter beds since the water consists of gravels. Coarse sand is arranged at the bottom of the filter bed and fine sand at the top. Large particles such as leaves, soil, and dead animals can be removed from the water.

Sedimentation and decantation

Water is pumped into a sedimentation tank to allow suspended fine material that escaped the screening and filtration to sink to the bottom. The water is poured out into another tank.

Exposure to sunlight/Aeration

The filtered water is brought into contact with the atmospheric air which removes the bad taste and odour caused by organic matter. Exposing the water to sunlight kills anaerobic bacteria that may be present in the water. It also changes dissolved iron and manganese compounds into soluble hydrated oxide of the metal which may then be readily taken out.

Addition of Alum

The addition of alum causes smaller particles to coagulate, that is the smaller particles stick together and settle at the bottom.

The water is then filtered to remove the coagulated materials (sediments). This method does not remove dissolved chemicals and micro-organisms.

Chlorination

Chlorine is then added to the water that has been exposed to kill any bacteria that may still be in the water.

Addition of Lime

Calculated amount of calcium hydroxide ($Ca(OH)_2$) is added to the water to give the required $_pH$ that is acidity or alkalinity.

Storage Tank

The chemically treated water is then poured into tanks for storage which is later on transported to our homes, schools and industries through pipes.

Physical Properties of Water

Pure water is odourless, colourless and tasteless.

- Pure water freezes at 0°C at standard temperature and pressure.
- Pure water boils at 100°C at standard temperature and pressure.
- Pure water has high specific heat capacity.
- Pure water has a maximum density of $1g/cm^3$ or $1000kg/m^3$
- Pure water has high surface tension(elastic surface).
- Pure water expands on heating.
- Water exists in the three states of matter.
- It is a universal solvent.

Chemical Properties of Water

1. **Action of water on metals**

   Active-metals/sodium (Na), Potassium (K), Calcium (Ca)

   Water reacts violently with Na and Ca to form metal hydroxide and hydrogen gas.

   $2Na + 2H_2O \rightarrow 2NaOH + H_2$

   $2K + 2H_2O) \rightarrow 2KOH + H_2$

   $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$

2. **Semi-Active metals**
   Examples: Magnesium (Mg) Aluminium (Al), Zinc (Zn), Iron (Fe) Lead Pb) are semi-active metals.
   Semi-active metals are not very reactive with cold water however they react with hot water or steam to form the metal oxide and hydrogen gas.

$$Mg + H_2O \rightarrow MgO + H_2$$
$$4Fe + 3H_2O \rightarrow 2Fe_2O_3 + 3H_2$$
$$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$$

3. **In-Active Metals**
   Silver (Ag), Gold (Au).
   They do not react with water.

Action of water on non-metal oxides

Oxides of non-metals are acidic and dissolve in water to form acids.
Non-metal oxides are also referred to as Acid ANHYDRIDE

$$CO_2 + H_2O \rightarrow H_2CO_3$$
(Carbonic acid)

$$SO_3 + H_2O \rightarrow H_2SO_4$$
(sulphuric acid)

Action of Water on Metal Oxides (Test for water)

$$K_2O + H_2O \rightarrow KOH + H_2$$

- Water reacts with anhydrous copper sulphate to give blue hydrated copper sulphate crystal.
- Water reacts with blue cobalt (II) chloride to give pink hydrated cobalt chloride.

Types of water

1. Hard water – Water that does not easily lather with soap (because of the presence of Calcium Ca^{2+} and magnesium ($Mg2^{+}$ ions.).
2. Soft water – Water that easily lathers with soap (because of the absence of salt).

The causes of Hardness of water

Hardness of water is caused by the presence of dissolved mineral salts such as calcium or magnesium salts in the water. Such salts as Calcium (Ca^{2+}).

Calcium salts causing hardness in water include:

1. Calcium sulphate (CaSO4).
2. Calcium chloride (CaCl).
3. Calcium hydrogen carbonate($Ca(HCO_3)_2$

Magnesium salts causing hardness in water include:

1. Magnesium sulphate ($MgSO_4$).
2. Magnesium chloride ($MgCl_2$).
3. Magnesium hydrogen carbonate ($Mg(HCO_3)_2$.

- The ions of magnesium or calcium salts destroy the action of soap by forming a scum on the surface.
- Water from the river, lake, pond, well and stream are hard because they contain dissolved magnesium or calcium ions from rocks.

Types of Hard water

Hard water could be temporary or permanent.

1. The temporary hardness in water

- Temporal hardness is caused by the presence of soluble calcium hydrogen trioxocarbonate (IV) ($Ca(HCO_3)_2$ i.e. calcium ions (Ca^{2+}) and hydrogentrioxocarbonate (IV) ions (HCO_3^-) present.
- Temporary hardness also occurs when rain water dissolves atmospheric carbon (IV) oxide and passes through rocks or soil containing limestone ($CaCO_3$).

Removal of temporary hardness to make water soft

- By boiling

  Equation: $Ca(HCO_3)_2 = CaCO_3(s) + CO_2(g) + H_2O(l)$

  Fur/scale
- By the addition of calculated amount of calcium hydroxide (slaked lime) to cause $CaCO_3$ to precipitate. This can then be filtered from the water. This method is used to treat temporary hard water on a large scale.

2. Permanent Hardness in water

Permanent hardness is caused by the presence of sulphate or chloride or calcium magnesium and iron.

a. Calcium sulphate – $CaSO_4$
b. Magnesium chloride – $MgCl_2$
c. Magnesium sulphate – $MgSO_4$
d. Calcium chloride – $CaCl_2$

Permanent hardness cannot be removed by boiling.

Removal of permanent hardness of Water to make it soft:

1. Distillation
2. Treatment with water softeners
3. Ion exchange or de-ionisation

1. Distillation

Water is vaporized by heating leaving behind calcium and magnesium ions (Ca^{2+} ,$Mg2^{+}$) in the container. The vapour is condensed or cooled back to pure water. Distillation can remove both temporary and permanent hardness.
This method is very expensive on a large scale.

2. Treatment with water softeners

Water softener simply ensures ion exchange by which ions that cause the hardness are exchanged for sodium or potassium ions. This reduces the concentration of hardness material and makes the water soft.

Addition of Sodium Carbonate or Washing Soda

Adding water softener such as sodium carbonate (washing soda) to hard water can remove the hardness. This addition removes calcium ions.
The calcium ion form a precipitate which is filtered off.
Equation: $Ca^{2+}(aq) + Na_2CO_3(aq) = CaCO_3(s) + 2Na^{+}(aq)$
Softener Precipitate
Other softeners are borax and zeolite.

3. Ion Exchange (De-ionisation)

The ions (Ca^{2+} and Mg^{2+}) causing hardness in water are exchanged for sodium Na^{+}, which does not cause hardness.
This method is used for removing both temporary and permanent hardness. It can also be used on large and small scale basis.

Advantages of Hard water

1. Hard water is essential for building strong bones and teeth because it contains calcium ion.

2. Hard water does not dissolve lead and therefore it can be supplied throug lead pipes to prevent lead poisoning.
3. Hard water prevents heart diseases.
4. Hard water has a pleasant taste hence extensively used in brewery industries for the preparation of alcoholic drinks.
5. The calcium in hard water helps in blood clothing.

Disadvantages of Hard water

1. Hard water wastes a lot of soap when used in washing.
2. Hard water produces scales in kettles, boilers, hot water pipes and radiators.
3. Hard water interferes with dyeing and tanning and it is therefore not suitable for industrial purposes.
4. Hard water tends to make white clothes turn grey when used in laundry.

Differences between Hard and Soft Water

Hard water	**Soft water**
Presence of salt.	No salt present.
Does not easily lather with soap.	Lathers easily with soap.
Has a pleasant taste, thus used in the production of alcoholic drinks.	Has no taste, thus is not used in alcoholic products.
Not used in dyeing and tanning industries.	Used in dyeing and tanning industries.
Reduces the chance of heart disease in humans.	Increases the chance of heart disease in humans.
Produces scales in kettles and boilers.	Dose not produce scales in kettles and boilers.
Does not dissolve lead.	Dissolves lead which is poisonous

Uses of Water includes for

1. domestic purposes.
2. drinking, cooking, bathing and washing
3. Industrial purposes.
4. Generation of electricity (hydroelectric power)
5. Irrigation of crops.
6. Cooling of engines and nuclear reaction.

UNIT 12 THE PERIODIC TABLE

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Explain the periodic classification.
2. Arrange common elements into groups and periods.
3. Distinguish between the families of elements on the periodic table.

THE PERIODIC TABLE

A list of elements arranged in increasing order of atomic number displayed in groups and periods.

GROUPS

The periodic table of the first 20 elements has 8 groups.

GROUPS – are vertical rows showing elements with similar physical and chemical properties having the same number of electrons in their outermost shells.

PERIODS

The period table has 4 periods. A period is the horizontal row of the elements on the table. There are the same number of shells in elements of the same period.

GROUP	ELEMENTS	PERIOD	ELEMENTS
1	H, Li, Na, K	1	H, He
2	Be, Mg Ca		
3	B, Al	2	L, Be, BC, NO, Fe Ne
4	C, bi		
5	N P	3	Na, Mg, Al, bi, P, S, cl, Ar
6	O, S		
7	F, cl	4	K, Ca
8	He Ne Ar		

PERIODIC TABLE

GROUPS	GROUP I	GROUP II	GROUP III	GROUP IV	GROUP V	GROUP VI	GROUP VII	GROUP VIII
PERIOD 1	H I							H 2
2	Li 3	Be 4	B 5	C 6	N 7	O 8	F 9	Ne 10
3	Na 11	Mg 12	Al 13	Bi 14	P 15	S 16	Cl 17	Ar 18
4	K 19	Ca 20						

GROUP I – Elements – H, Li, Na, K - ALKALI METALS

Properties

1. They have one electron in their outermost shells.
2. They are called Alkali metals.
3. They dissolve in water to form Alkali solution.
4. They are soft metals and can easily be cut with a knife.
5. They are very reactive.
6. They react with oxygen to form oxides easily tarnished by air.
7. They form Hydrogen gas when dissolved in water.

GROUP II – Elements – Beryllium(Be), Magnesium(Mg), Calcium(Ca) – ALKALINE EARTH METALS.

Properties

1. They are called Alkali earth metals.
2. They form basic Alkali solution with water.
3. They have two electrons in their outermost shells.
4. They are harder than group one (1) metals.
5. They form oxides when react with oxygen.
6. They form Alkali solution when dissolved in water.
7. They give off Hydrogen gas when react with water.

GROUP III – Elements – Boron (B), Aluminium (Al)

Properties

1. They have three electrons in their outermost shells.
2. Their hardness increases with atomic number.

GROUP VII Elements- Fluorine (F), Chlorine (Cl) are called halogens.

Properties

1. They are non-metals.
2. Highly electronegative.
3. Highly reactive.
4. They are toxic.
5. Form acids when it combines with hydrogen.
6. The outermost shell has seven electrons.

Group VIII Elements- Helium (He), Neon (Ne), Argon (Ar) are called inert or rare or noble gases.

Properties

1. They have eight electrons to complete their outermost shells and be stable.
2. They are called inert, stable or noble gasses.
3. They are used to fill balloons in air ships and electric light bulbs.

UNIT 13 ATOMIC STRUCTURE

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Distinguish between atomic number and mass number.
2. Describe how the particles are arranged in the atom.

ELECTRONIC CONFIGURATION

ELEMENT	SYMBOL	ATOMIC NUMBER	ELECTRONIC STRUCTURE				
			SHELL				
			K	L	M	N	
Hydrogen	H	1	1				
Helium	He	2	2				
Lithium	Li	3	2	1			
Beryllium	Be	4	2	2			
Boron	B	5	2	3			
Carbon	C	6	2	4			
Nitrogen	N	7	2	5			
Oxygen	O	8	2	6			
Fluorine	F	9	2	7			
Neon	Ne	10	2	8			
Sodium	Na	11	2	8	1		
Magnesium	Mg	12	2	8	2		
Aluminium	Ac	13	2	8	3		
Silicon	Sl	14	2	8	4		
Phosphorous	P	15	2	8	5		
Sulphur	B	16	2	8	6		
Chlorine	Cl	17	2	8	7		
Argon	Ar	18	2	8	8		
Potassium	K	19	2	8	8	1	
Calcium	Ca	20	2	8	8	2	

THE ARRANGEMENT OF ELECTRONS

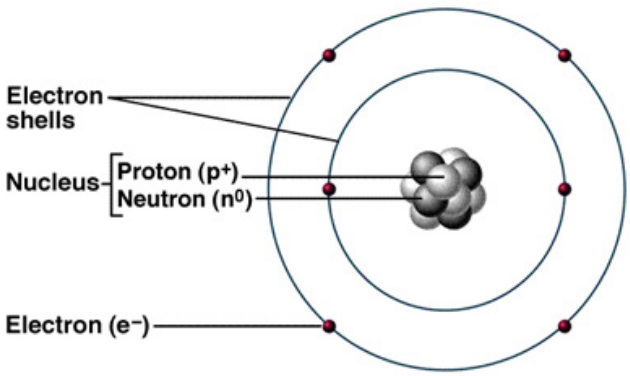
	SHELL	Total Number Of Electrons
1	K–Shell	2
2	L–Shell	8
3	M–Shell	8
4	N–Shell	8

CONFIGURATION

This refers to the arrangement of electrons on the shells around the nucleus of an atom.

ATOMIC STRUCTURE

- An atom is **spherical** in shape.
- It is composed of **central part called nucleus** around which negatively charged particles called **electrons move in orbit or shells**.
- The nucleus consist of **two sub-atomic particles called protons and neutrons**.



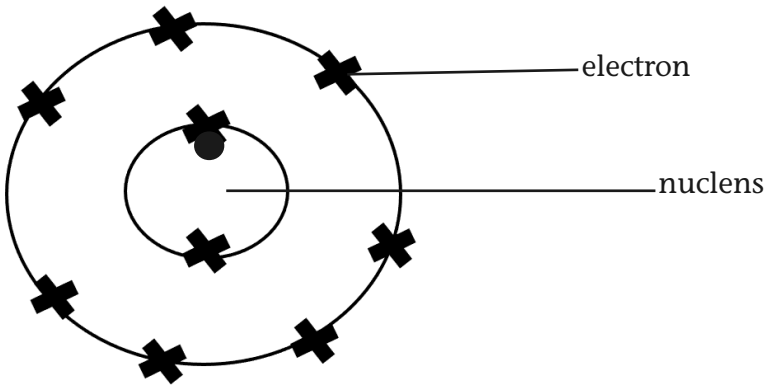
Electrons are negatively charged particles.
Protons are positively charged particles.
Neutrons are neutrally charged particles.
Proton number = Atomic number = Electron number (when the atom is electrically neutral).
Neutron number = mass number – Proton Number

Example

Configuration of Neon (Ne) =

1. Atomic number = 10
2. Number of electrons = 10
3. Atomic mass = 20
4. K shell = 2 electron
5. L shell = 8 electron
6. Neutron = atomic mass – Atomic Number

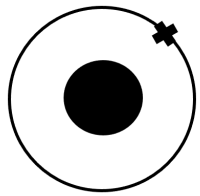
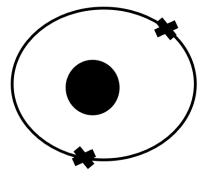
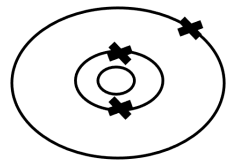
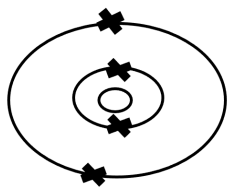
Structure

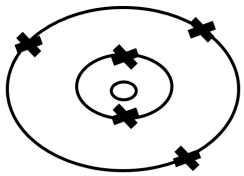
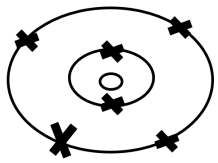
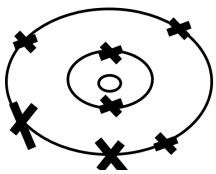


Element	Proton	Election	Atomic Mass	Neutron Calculation, number of neutrons	
H	1	1	1	1 – 1	0
He	2	2	4	4 – 2	2
Li	3	3	7	7 – 3	4
Be	4	4	9	9 – 4	5
B	5	5	11	11 – 5	6
C	6	6	12	12 - 6	6
N	7	7	14	14 – 7	7
O	8	8	16	16 – 8	8
F	9	9	19	19 – 9	10
Ne	10	10	20	20 – 10	10
Na	11	11	23	23 – 11	12
Mg	12	12	24	24 – 12	12

Al	13	13	27	27 – 13	14
Sl	14	14	28	28 – 14	14
P	15	15	29	29 – 15	14
S	16	16	32	32 – 16	16
Cl	17	17	35.5	35.5 – 17	17.5
Ar	18	18	40	40 -18	22
K	19	19	39	39 – 19	21
Ca	20	20	40	40 – 20	20

Electronic structures from the table

1.	Hydrogen (H) Protons = 1 Electron = 1 Mass = 1 Neutron = 1 - 1 = 0	${}_{1}^{1}H$	
2.	Helium (He) Protons = 2 Electron = 2 Mass = 4 Neutron = 4 - 2 = 2	${}_{2}^{4}He$	
3.	Lithium (Li) Protons = 3 Electron = 3 Mass = 7 Neutron = 3 - 7 = 4	${}_{3}^{7}Li$	
4.	Beryllium (Be) Protons = 4 Electron = 4 Mass = 9 Neutron = 9 -4 = 5	${}_{4}^{9}Be$	

5.	Boron (B) Protons = 5 Electron = 5 Mass = 11 Neutron = 11 - 5 = 6	$^{11}_{5}B$	
6.	Carbon (C) Protons = 7 Electron = 7 Mass Number = 14 Neutron = 12 - 6 = 6	$^{12}_{6}C$	
7.	Nitrogen (N) Protons = 7 Electron = 7 Mass Number = 14 Neutron = 14 - 7 = 7		

UNIT 14 CHEMICAL FORMULA

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Write chemical formulae and chemical equations.
2. State the symbols of the first 20 elements and other common elements.

Chemical Formula

Is a sign representing molecules of elements, radicals or compounds comprising a combination of symbols and valencies.

Valency

a. This refers to the combining power of atoms.
b. The valency of an element or radical is the number of Hydrogen atoms which will combine or displace one atom of the element or one group of the radical.

Radical

An atom, molecule or ion that has an unpaired valence electron making them highly chemically reactive.

Examples

Radical	Valency
HCO_3^-	1
OH^-	1
NO_2^-	1
ClO_3^-	1
NH_4^+	1
NO_3^-	1
MnO_4^-	1
SO_4^{2-}	2
CO_3^{2-}	2
PO_4^{3-}	3
SO_3^{2-}	2

VALENCIES OF THE FIRST 20 ELEMENTS

	ELEMENT	VALENCY
A	Argon	0
	Helium	0
	Neon	0
B	Hydrogen	1
	Lithium	1
	Fluorine	1
	Sodium	1
	Chlorine	1
	Potassium	1
C	Beryllium	2
	Oxygen	2
	Sulphur	2
	Calcium	2
	Magnesium	2
D	Boron	3
	Iron	3
	Nitrogen	3
	Phosphorous	3
	Aluminium	3
E	Carbon	4
	Silicon	4
F	Nitrogen	3
	Phosphorous	
G	Sulphur	2

Other valencies of elements outside the first 20 elements

Element	Symbol	Valencies
Zinc	Zn	2
Cupper	Cu	1, 2
Iron	Fe	2, 3
Tin	Sn	2, 4
Lead	Pb	2, 4

CHEMICAL FORMULAE AND NAME OF COMPOUND	
CaO	Calcium oxide
Na_2O	Sodium oxide
H_2O	Water
$MgCl_2$	Magnesium Chloride
NaCl	Sodium Chloride
MgO	Magnesium Oxide
KCl	Potassium Chloride
$Al_2 (SO_4)_3$	Aluminium sulphate
$Ca (OH)_2$	Calcium Hydroxide
$Fe_2 (SO_4)_3$	Iron (III) Sulphate
$Mg (OH)_2$	Magnesium Hydroxide
$Ca CO_3$	Calcium Carbonate
FeS	Iron Sulphide
CO_2	Carbonate (IV) Oxide
$Fe_2 O_3$	Iron (III) Oxide
$CaCl_2$	Calcium Chloride
FeO	Iron (II) Oxide
PbO	Lead Oxide
CuO	Cupper Oxide
$H_2 So_4$	Sulphuric acid
ZnO	Zinc Oxide
$ZnCl_2$	Zinc Chloride
$H_3 PO_4$	Phosphoric acid

HNO_3 – Nitric acid
$H_2 CO_3$ – carbonic acid
NH_4 – Ammonium
NH_3 – Ammonia
ClO_3 – chlorate
PO_4 – phosphate
NO_3 – Nitrate
$NH_3 (OH)_2$ – Ammonium hydroxide
KOH – Potassium hydroxide
K_2O – Potassium oxide

Al_2O_3	–	Aluminium oxide
NaO	–	Sodium oxide
$Al_2 (OH)_3$	–	Aluminium hydroxide
$Mg (OH)_2$	–	Magnesium hydroxide
$NH_4 NO_3$	–	Ammonium nitrate
KCO_3	–	Potassium carbonate
NaCl	–	Sodium chloride
Zn NO_3	–	Zinc nitrate
$CuSO_4$	–	Copper sulphate
$Na_2 CO_3$	–	Sodium carbonate
$H_2 SO_4$	–	Sulphuric acid
$ZnCl_2$	–	Zinc chloride
$CuCO_3$	–	Calcium carbonate

WRITING CHEMICAL FORMULAE

Steps

1. Represent the elements and radicals in symbols.
2. Write the valencies underneath the symbols.
3. If the valencies are the same divide both with one of the valencies.
4. Inter change the valencies of each symbol by a cross sign.
5. Match down the symbols with the-inter changed valencies.
6. Write out the formula derived.

Example

1	**Magnesium Oxide (MgO)**	6	**Calcium oxide (CaO)**
	1st. Mg + 0 2nd. 2 2 ***3rd.*** $\frac{2}{2}$ $\frac{2}{2}$ 4th. 1 1 ***5th.*** Mg_1 O_1		1st. Ca + O 2nd. 2 2 3rd. 1 1 4th. Ca_1 O_1 5th. CaO
MgO: One atom of magnesium combines with one atom of oxygen		One atom of Calcium reacts with one atom of oxygen.	

2	**Sodium chlorine (NaCl)**	7	**Calcium Chloride ($CaCl_2$)**
	1st. Na Cl 2nd. 1 1 3rd. 4th. Na Cl		1st. Ca + Cl 2nd. 2 1 3rd. 4th. Ca_1 Cl_2 5th. $CaCl_2$
NaCl: one atom of sodium reacts with one atom of chlorine.			
3	**Sodium Oxide (Na_2O)**	**8**	**Magnesium Hydroxide $Mg(OH)_2$**
	1st. Na O 2nd. 1 2 3rd. Na_2 O_1		1st. Mg OH 2nd. 2 1 3rd. 4th. Mg_1 OH_2 5th. $Mg(OH)_2$
Na_2O: Two atom of sodium reacts with one atom of oxygen.			
4	**Water (H_2O)**	**9**	**Iron (III) Sulphate $Fe_2(SO4)_3$**
	1st. H O 2nd. 1 2 3rd. 4th. H_2 O_1 5th. H_2O		1st. Fe + So_4 2nd. 3 2 3rd. 4th. Fe_2 $(SO_4)_3$ 5th. $Fe_2(SO_4)_3$
Two atoms of Hydrogen react with one atom of oxygen.			
5	**Aluminium sulphate $Al_2(So_4)$**		
	1st. Al_2 + 2 2nd. 3 2 3rd. 4th. Al_2 $(So_4)_3$ 5th. $Al_2(So_4)_3$		
Two atoms of Aluminium react with 3 atoms of sulphate.			

Chemical compound	Combination by ratio of atoms of different elements
CaO	One atom of calcium reacts with atom of oxygen
NaCl	One atom of sodium reacts with one atom of chlorine
$H_2 SO_4$	Two atoms of Hydrogen reacts with one atom of sulphur and four atoms of oxygen radical
$Al_2 (SO_4)_3$	Two atoms of Aluminium reacts with three atoms of sulphur and twelve (12) atoms of oxygen radical
$Fe_2 (SO_4)_3$	Two atoms of iron reacts with thee atoms of sulphur and 12 atoms of oxygen radical
$CaCl_2$	One atom of calcium reacts with two atoms of chlorine
H_2O	Two atoms of Hydrogen reacts with one atom of oxygen

Number of Atoms of Radicals

1. $(SO_4)_3$
   3 × Sulphur = 3 Sulphur atoms
   3 × Oxygen = 12 oxygen atoms

2. $(OH)_2$
   2 × 1 oxygen = 2 oxygen atoms
   2 × 1 Hydrogen = 2 Hydrogen atoms

CHEMICAL EQUATION

It is a shortened form of word expression of chemical reaction.
A chemical reaction equation is divided into reactants and products.

Example

$H_2 + O_2$ → H_2O

Reactants Products

$Na + Cl_2$ → NaCl

Reactants Products

STEPS

1. Write out the chemical Equation
   Example magnesium oxide MgO
   $Mg + O_2 \rightarrow MgO$

2. Check to find out if the equation is balanced or not by counting the number of atoms on either side of the reactants and products one after the other.
3. Always write small whole number in front of symbols when balancing making sure that they are equal on either sides.

In balancing chemical equations the total number of atoms of the reactants must be equal to the total number of atoms of the product. It teaches that during chemical reactions, atoms are neither created nor destroyed (Rule of conservation of mass).

Example

1	$H_{2+}O_2 \longrightarrow H_2O$ (Not balanced) $2H_2 + O_2 \longrightarrow 2H_2O$ (Balanced)
2	$Fe + Cu\,SO_4 \longrightarrow Fe\,So_4 + Cu$ (Balanced)
3	$CaC + H_2O \longrightarrow Ca\,(OH)_2$ Balance
4	$Fe + S \longrightarrow FeS$ Balance
5	$P + O_2 \longrightarrow P_2O_3$ (Not balanced) $4P + 5O_2 \longrightarrow 2P_2O_5$ (Balanced)
6	$Mg + O_2 \longrightarrow MgO$ (Not balanced) $2Mg + O_2 \longrightarrow 2MgO$ (Balanced)
7	$Zn + O_2 = \longrightarrow ZnO$ (Not balance) $2Zn + O_2 \longrightarrow 2ZnO$ (Balanced)
8	$SO_2 + H_2O \longrightarrow H_2SO_4$ (Not balanced) $SO_2 + H_2O \longrightarrow H_2SO_3$ (Balanced)

UNIT 15 ACIDS, BASES AND SALTS

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Explain the terms acids, bases and salts.
2. Distinguish between an acid and a base.
3. Classify substances as acids, bases and salts.

ACID

1. (By definition)A chemical substance that donates protons/ hydrogen ions in solution.
2. A compound that turns litmus paper red.

Types of Acid

1. Organic Acid
2. Inorganic Acid

ORGANIC ACID

They are acids which occur naturally. They are found in plants and animals. Organic acids are weak and less harmful to man.

	ORGANIC ACID	SOURCE
1	Formic acid	Bees
2	Lactic	Milk
3	Citric acid	Unripe lemon and grape Fruit
4	Palmitic acid	Palm oil
5	Amino acid	Protein
6	Acetic acid	Vinegar
7	Methanoic acid	Red ants/sweat
8	Salicylic acid	Aspirin/some leaves
9	Tartaric acid	Grapes
10	Ascorbic acid	Citrus fruit
11	Butyric acid	Rancid/rotten butter

PROPERTIES OF ACIDS

A. Physical Properties

1. Dilute solutions of acids are sour in taste.
2. Dilute solutions of acids turn blue litmus paper red.
3. Concentrated acids are corrosive.

B. Chemical properties

1. Strong acids conduct electricity in aqueous solution.
2. They react with bases to form salt and water.

Example

1. Dilute acids react with metallic salts (Carbonates) to form salts water and carbon oxide.

Examples .

$H_2SO_4 + CuCO_3 \rightarrow CuSO_4 + H_2O + CO_2$
$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

They react with metals to produce Hydrogen gas.

Examples

i. $Zn + 2HCl \rightarrow ZnCl_2 + H_2$
ii. $Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$

INORGANIC ACIDS

These are acids that are chemically produced in the laboratory.

Examples

H_2SO_4 – Sulphuric acid
H_2CO_3 – Carbonic acid
HCl – hydrochloric acid

USES OF ACIDS

1. To manufacture fertilisers, detergents (Cleaning agents) and paints.
2. To manufacture dyes drugs and plastics.
3. Used as electrolytes in lead acid batteries.
4. Used as dehydrating agent.
5. Used in petrol refinery.
6. To manufacture explosives.
7. For soap making.
8. Used as fuel in rockets.
9. For food preservation or flavouring.
10. To remove rust.

BASES

These are compounds that turn red litmus paper to blue.

Types of Bases

1. Organic bases
2. In Organic bases

Organic Bases

These bases occur naturally in plants and animals.

Example

1. Saltpetre
2. Wood ash
3. Cocoa peels
4. Wasps stings

Note that the above organic bases produce KOH – Potassium Hydroxide The composition organic matter produces NH_3 – ammonia

INORGANIC BASES

They are bases prepared in the Laboratory.

Examples

1. KOH –Potassium hydroxide
2. NH_4OH – Ammonium hydroxide
3. $Ca(OH)_2$ – Calcium hydroxide

CLASSES OF BASES

1. Metallic bases
2. Soluble bases
3. Insoluble bases

Metal Bases

These are metals which react with oxygen to form bases.

1. CaO – Calcium oxide
2. K_2O – potassium oxide
3. NaO – Sodium Oxide
4. Al_2O_3 – Aluminium Oxide

Soluble Bases

Hydroxides dissolve in water to form Alkaline solution.

1. NaOH –Sodium hydroxide
2. KOH – Potassium hydroxide
3. NH_4OH – Ammonium hydroxide
4. $Ca(OH)_2$ – Calcium hydroxide

Insoluble bases

They do not dissolve in water to form solution.

1. $Mg(OH)_2$ – magnesium hydroxide
2. $Al(OH)_3$ – Aluminium hydroxide

Physical properties of Bases

Taste	Bitter
Feel	Slippery
Odour	Odourless
Litmus paper	Turns Red to blue

Chemical Properties of Bases

1. Bases react with acids in neutralisation reaction to form salt and water.

Examples

$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + H_2O$

$2HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2H_2O$

Bases conduct electricity when dissolved in water.

Bases and Alkalis react with ammonium salt on heating to produce ammonia gas.

Example,

1. $NaOH + (NH_4)_2SO_4 \rightarrow Na_2SO_4 + 2NH_3$
2. $Ca(OH)_2 + 2NH_4Cl \rightarrow CaCl_2 + 2NH_3 + 2H_2O$

SALTS

Substances (Compounds) which contain the negative ions of acids and positive ions of bases.

A salt is a compound formed when an acid reacts with a base.

Example of Salts

1. $CuSO_4$ – Copper Sulphate
2. $ZnNO_3$ – Zinc nitrate
3. NaCl – Sodium chloride
4. K_2CO_3 – Potassium carbonate
5. $Fe_2(SO_4)_3$ – iron (III) sulphate
6. NH_4NO_3 – Ammonium nitrate

Types of Salts

1. Normal salt
2. Acid salt
3. Basic salt
4. Double salt
5. Complex salt

Properties of salts

1. Salt on Water: soluble salts dissolve in water to form solutions.
2. Salt on Acids: strong acids react with salt to form salt, water and carbon dioxide. $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$
3. Salt on Alkalis: Alkalis react with salt to form salt, water and ammonia. $NH_4Cl + NaOH \rightarrow NaCl + H_2O + NH_3$
4. Action on Heat: Salt decompose on heating to form oxygen gas. $2NaNO_3 \xrightarrow{Heat} 2NaNO_2 + O_2$
5. Salts have no effect on litmus paper.

NEUTRALISATION

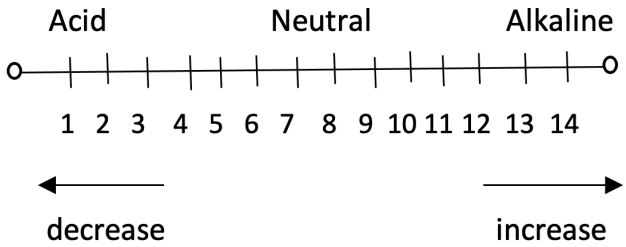
Reaction: this is the reaction between acids and bases to form salt and water only.

1. $HCl + NaOH \rightarrow NaCl + H_2O$
2. $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + H_2O$
3. $2HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2H_2O$

pH SCALE

This refers to the power of hydrogen ion.
It is a measure of hydrogen concentration in a solution.

pH SCALE



pH SCALE

pH less than 7 = acidic
pH greater 7 = Alkaline
pH around 7 = Neutral or Zero

As pH decreases the solution increase in acidity + decrease in alkalinity.
As pH increase, the solution decrease in Alkalinity.
The scale tests the acidity alkalinity and neutrality.

pH Meter
The instrument used to measure the pH solution.

Universal Indicator
This is used to estimate the pH of a solution showing the seven colours of the rainbow.

UNIT 16 METALS AND NON-METALS

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Classify elements into metals and non-metals.
2. State the properties of metals and non-metals.
3. Describe the composition of alloys and their uses.

About of the elements known are metals found in free states. They are present in earth as ores.

Ores – solid materials containing a metal or its compound mixed with other impurities.

Most elements in group I, II, III are pure metals except for Hydrogen that is a non-metal and carbon that is a metalloid.

METALS	NON-METALS	METALLOIDS
Lithium	Hydrogen	Silicon
Beryllium	Helium	Carbon
Sodium	Nitrogen	Boron
Magnesium	Oxygen	
Aluminium	Fluorine	
Potassium	Neon	
Calcium	Phosphorous	
	Sulphur	
	Argon	

Zinc – Zn Lead – Pb Iron – Fe Mercury – Hg Silver – Ag Tin – Sn Copper – Cu Manganese – Mn Nickel- Ni Gold – Au		Metalloids are elements that display both properties of metals and non-metals.

DIFFERENCES BETWEEN METALS AND NON-METALS

	METALS	**NON-METALS**
1	Good conductors of heat and electricity except copper.	Poor conductors of heat and electricity except carbon and graphite.
2	Strong and tough	They are not strong and tough.
3	Shiny or bright and can be polished.	Not shiny and bright and cannot be polished.
4	They can be hammered (malleable) into thin sheets.	Cannot be hammered (Not malleable) into this sheets.
5	Have high melting point except mercury with low melting point.	Have low melting point except carbon with high melting point.
6	Have high boiling point.	Have low boiling point.
7	Have high density except sodium and potassium with low densities.	Have low density.
8	Ring when hot (sonorus).	Do not ring when hit (Not sonorous).

ALLOYS

An alloy is a mixture of two or more metals or a composition of a non-metal and a metal to form a single uniform(fused) solid object that undergoes a change in physical properties.

	ALLOY	COMPOSITION	USE
1	Solder	Lead and Tin	Joining pieces of metals like electrical wires.
2	Bronze	Copper and Tin	Making copper coins
3	Typed metal	Lead, Antimony, Tin	Printing books.
4	Stainless steal	Chromium, Nickel and iron	Making cutting tools – knives, saws, scissors.
5	Magnet	Nickel, iron, Cobalt	Attracting metabolic substances.
6	Galvanized Iron	Iron, Zinc	For making buckets, tanks, tubes, wire fence, barbed wire, roofing materials, metals nails, nuts.
7	Brass	Copper, Zinc	Making tubes, rods, screws, nuts, bolts, ornaments.
8	Duralumin	Aluminium, magnesium, copper	Making bodies of planes, buses, Lories, Railways, Trains, Tankers.

UNIT 17 CONTINUITY AND CHANGE

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Differentiate living things from non-living things.
2. Classify living things.

Biology is the study of living things that is, plants and animals. The study of plants is known as BOTANY and the scientist who studies plants is a Botanist. The study of animal is ZOOLOGY, and the scientist is a Zoologist.

Characteristics or life processes of Living Things

1. **Movement** – Is the change of position of parts or the whole of the living organism. Animals move from place to place (locomotion). Plants do not move from place to place but move parts of their body e.g. plants can bend towards light.
2. **Respiration** – Is the breakdown of food within the cells of living organism with or without oxygen to release energy.
3. **Nutrition/Feeding** – Is the process by which living organism obtain or take in food. Green plants manufacture or make their own food by the process of Photosynthesis. Plant take in simple food, animals feed on ready-made food that is complex food.
4. **Irritability/Sensitivity** – Is the process by which living things respond to stimulus or external change in their environment. Animals respond faster to stimulus while plants respond slowly to stimulus.
5. **Growth** – Increase in size and height resulting in change in their body shape and functions. Plants differ from animals in terms of growth.

As young animals mature, all parts of the body grow until they reach a genetically determined size. Growth is diffused.
Plant growth covers the life span of the plant and is restricted to certain meristematic tissue in the shoot and root tips. Apical meristem is responsible for future root growth. Growth in plants is apical, intercalary or lateral. Intercalary growth is lengthwise growth in plants as a result of cell division in the formative tissue (meristem) located in the internodes of the stalk of grasses and at the base of the leaves.

6. **Excretion** – Is the process by which living things remove metabolic waste from their body. Metabolic waste includes sweat, urine, carbon dioxide etc.
7. **Reproduction** – Is the process by which living organisms give rise to young ones called offsprings. The acronym – **MR. NIGER** put together from the first letter of each process gives the seven characteristics of living things. **M**OVEMENT, **R**ESPIRATION, **N**UTRITION, **I**RRITABILITY, **G**ROWTH, **E**XCRETION AND **R**EPRODUCTION

DIFFERENCES BETWEEN PLANTS AND ANIMALS

Plants	**Animals**
Don't move from place to place(no locomotion).	Move from place to place(locomotion).
Respond slowly to external stimulus	Respond faster to external stimulus.
Growth in plants take place at definite regions called apical growth in root and leaves.	Growth in animals occur in all part of body and active regions (Growth is diffused).
Growth is continuous or indefinitely during their lifetime.	Growth stops maturity.

Assignment - 1

1. State any two other differences between plants and animals.
2. State 5 difference between living things and non-living things.
3. Give any 5 similarities between plants and animals.

UNIT 18 LIVING CELLS

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Explain what a living cell is.
2. Describe the structure and functions of plant and animal cells.

A living cell is the basic structural and functional unit of a living organism. Organisms with one cell are called unicellular organisms e.g. amoeba, paramecium, euglena etc

Organisms with two or more cells are called multicellular eg man, mango tree, rat, spirogyra etc

Parts of a Plant Cell and their functions

1. Cell membrane
   i. selectively permeable serves as a barrier allowing certain substances and not others.
   ii. It protects the cell.

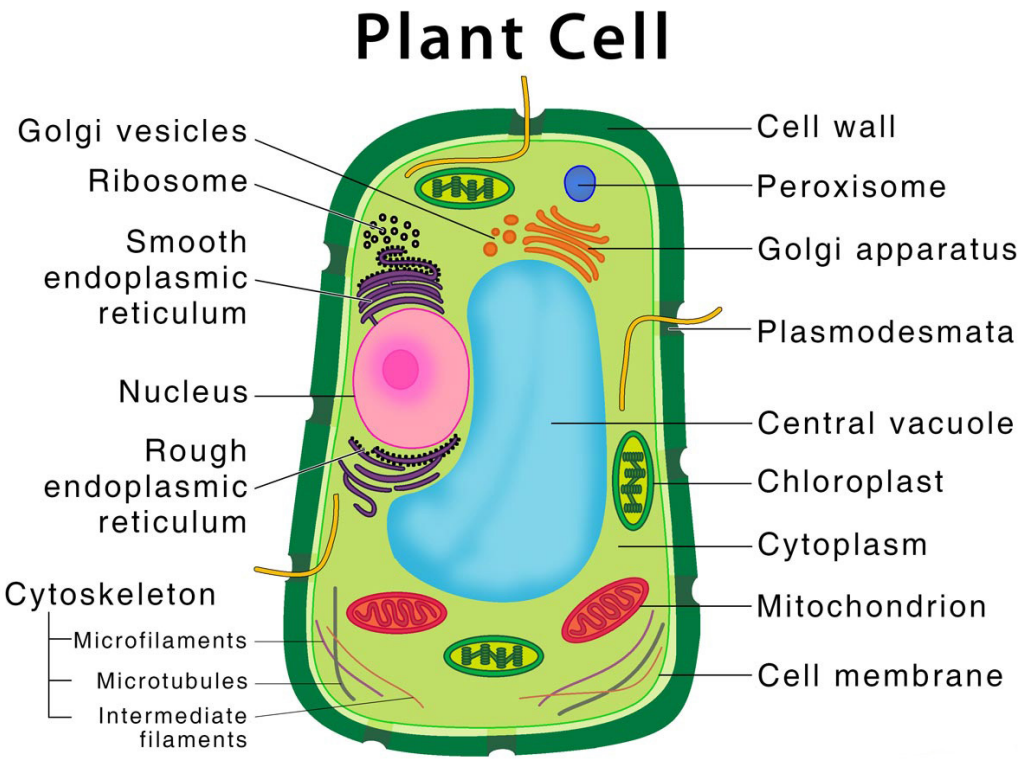
2. Cell wall – In plant cells only.
   i. give strength and support to other cell.
   ii. give shape to the cell.

3. Nucleus – controls lie activities of other cell.
   i. responsible for cell division (reproduction).
   ii. determines the shapes and functions of the cell.

4. Cytoplasm – contains cell organelles – minute cell structures

   organelles – minute cell structures that carries out specific functions.

Cell Organelles include: mitochondrion, ribosome, lysosome, Golgi bodies, cell membrane, chloroplasts etc



FUNCTIONS

Cytoplasm - Facilitates the movement of substances in and out of the cell. It is also the site for most chemical reactions in the cell.

Mitochondrion - Is the site for the oxidation of food substance concerned with the release of energy. It is referred to as the "power" House" of the cell

Ribosome - Is the site for protein synthesis.

Lysosome - Found in animal cells but not in plant cells.
It aids in the disintegration of dead cells and also to help in the digestion of food on the cells.

Vacuoles – Plant vacuoles are large and single in size but animal vacuoles are small in size and are more in number. In plants the vacuole maintains turgor pressure. Animal vacuoles store fluid called cell sap. This sap contains mineral salts, sugar and pigment dissolved in water.

Functions

i. Acts as storage organ
ii. It controls the amount of water which moves into and out. (osmo-regulation)

Golgi bodies are coiled and thread like. It helps process and the packagging of proteins and lipid molecules.

Cell Membrane – Encloses the cell and serves as a barrier and a link between the cell and its surroundings. The cell membrane is partially permeable, allowing substances depending on the size and nature to pass through it.

Functions

i. Contain the cell content.
ii. Controls the transfer of food and waste substance into and out of the cell.
iii. Cellulose cell wall – Found only in plant cells. It is a thick rigid wall lying just outside the cell membrane. The cell is non-living and is made up of cellulose.

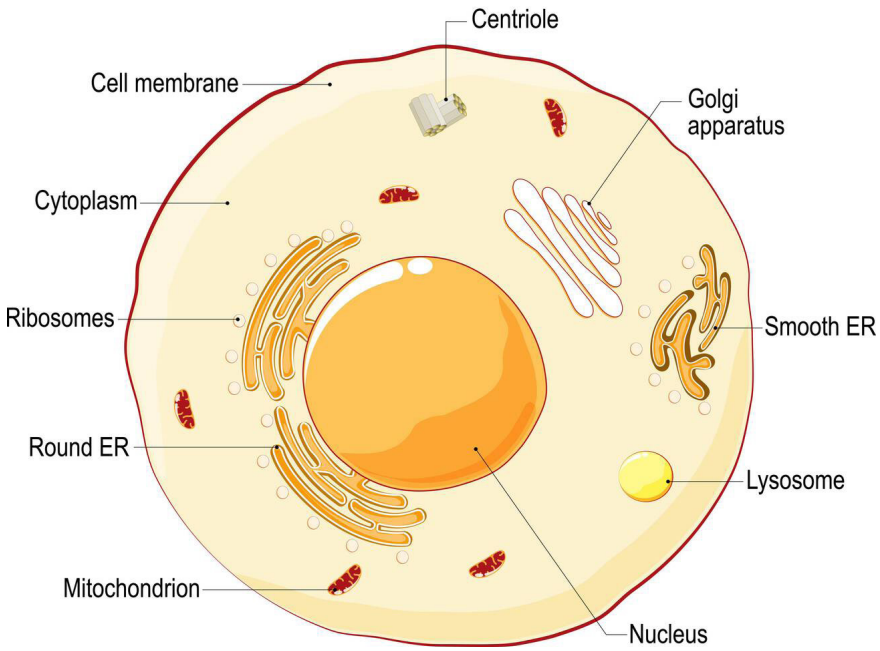
Functions of cell wall

i. Gives shape and rigidity to the cell.
ii. Is permeable to gases, water and other substances.
iii. Prevents bacteria from entering the cell.

Chloroplast – Found in plant cells only, they contain the green pigment called chlorophyll used to manufacture food by the process known as photosynthesis. The main function of chlorophyll is to capture energy from the sun for photosynthesis.

Endoplasm Reticulum – Produces and transports protein to the cytoplasm. It also transports materials from the cytoplasm to the nucleus. Example of cells include root cell, nerve cells, red blood cells, white blood cells, epithelial cells, sperm cells, egg cells, spongy cells, epidermal cells.

Animal cell anatomy



UNIT 19 AMOEBA PROTEUS

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Describe the structure of amoeba.
2. State the function of the various parts of amoeba.
3. Explain the living processes in amoeba.

Amoeba proteus is a unicellular, microscopic aquatic organism. It lives in ponds, ditches and stagnant pools. It belongs to the group called Protozoa.

Structure of Amoeba

Amoeba is irregular in shape i.e. it has no definite shape. It keeps changing its shape all the time.
Amoeba is bounded by an outer membrane known as the cell membrane. The cell membrane protects the cell contents and acts as a boundary.

Below the cell membrane is a clear outer layer – the ectoplasm and in the inner darker is layer the endoplasm. The ectoplasm and the endoplasm forms the Cytoplasm. The endoplasm contains the nucleus at the centre, the contractile vacuole and the food vacuole. The pseudopodia (false feet) bulges outside the cell membrane.

Mode of Life of Amoeba

Movement – Amoeba moves by means of the false feet known as pseudopodia.

Feeding – Amoeba feeds on microscopic organisms such as diatoms, desmids etc. Amoeba encircles the food by means of the pseudopodia, engulfs the food and forms the food vacuole. Digestive enzymes chemicals are secreted to speed

up the digestion. This process of feeding is phagocytosis. Some amoeba also feed by pinocytosis. They take in dissolved nutrients through vesicles formed within the cell membrane.

Respiration - Amoeba being aquatic obtains oxygen from the water through the cell membrane and also releases carbon dioxide into the water. This exchange of gases occur by simple diffusion through the cell membrane.

Excretion - The removal of metabolic wastes and excess water from the cytoplasm is done by the contractile vacuole, the process known as Osmo-regulation.

Reproduction - Amoeba reproduces by asexual means involving only one organism.
Amoeba divides into two, a process known as Binary Fission. The nucleus divides into two parts; the cytoplasm also divides to make two individual daughter cells. The original amoeba forms two new amoeba which will grow to maturity.

Encystment– Under unfavourable conditions, amoeba forms a protective coat known as **Cyst**. The amoeba will carry out life processes and reproduces several times. When conditions become favourable in the pond, the Cyst is blown off to release many new cells. This process is known as encystment.

Key Words

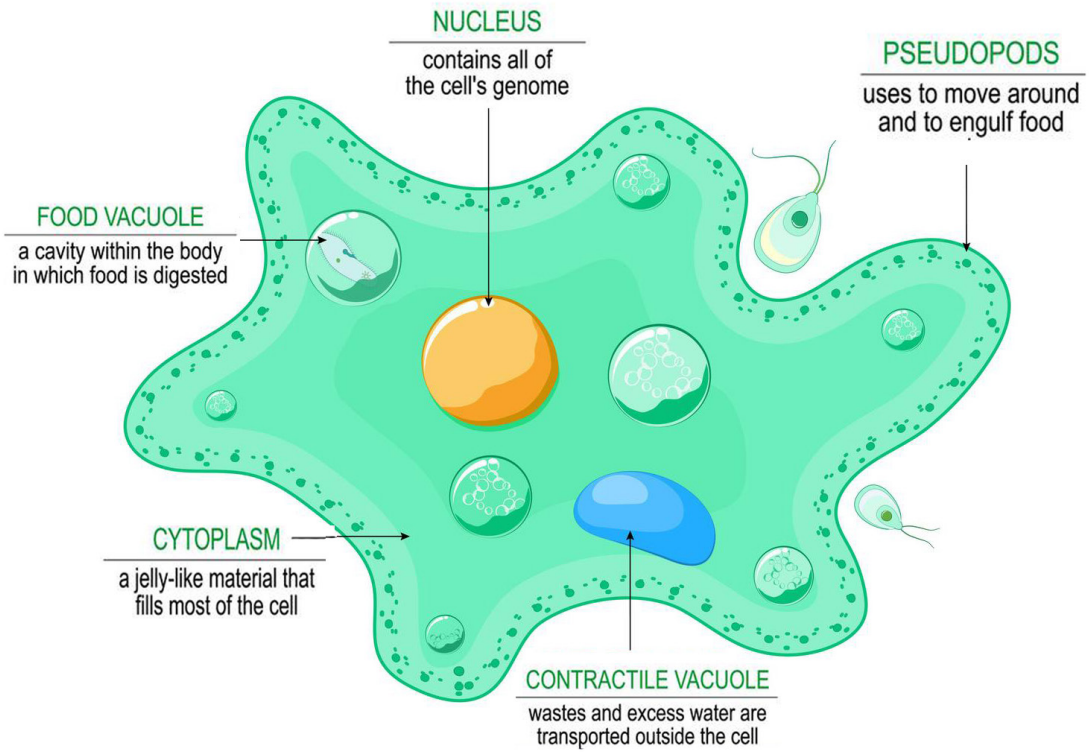
Amoeba	Cell membrane
Microscopic	Ectoplasm
Unicellular	Endoplasm
Aquatic	Cytoplasm
Ponds	Nucleus
Ditches	Food vacuole
Diatoms	Contractile vacuole
Desmids	Pseudopodia
Engulf	Osmo-regulation
Stagnant pools	Diffusion
Binary fission	Cyst

Encystment Asexual

Assignment

1. Name the parts associated with the following life processes in Amoeba:
   a. Movement
   b. Respiration
   c. Feeding
   a. Reproduction
2. Draw reproduction in Amoeba.
3. What is……..?
   a. Binary fission
   b. diffusion
   c. Aquatic
   d. Microscopic
   e. Encystment

Amoeba



Food vacuole

UNIT 20 FLOWERING PLANTS

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Describe the structure of a flowering plant.
2. State the functions of the parts of the plant.

Flowering plant

A typical flowering plant consists of two main systems i.e. the shoot and the root systems.

The root system is found below the ground surface consisting of the root, root cap and root hairs.

There are two main types of roots:

1. Tap root system
2. Fibrous system

The main function of the root are:

1. To absorb water and mineral salt form the soil.
2. To fix the plant firmly in the soil.
3. To transport water and mineral salts to the stem.

Shoot System

Consists of the stem, leaves and flowers. It is the aerial part of the plant.

The Stem

The stem is an aerial part of vascular plants which bears the leaves, buds, nodes and reproductive structure. For example, flowers and fruits.

The main Functions of the Stem are:

1. Holds leaf in a position in order to receive sunlight.
2. Transports manufactured food down to the roots.
3. Transports water and mineral salts to the leaves.

The Leaf

The leaf consists of three (3) main parts – They are:

- leaf blade or lamina
- Leafstalk or petiole
- Leaf base

The parts of the leaf are apex, leaf blade, midrib, leaf, margin, leaf vein, leaf stalk and leaf base.

Leaves of Dicotyledons have network venation e.g. orange, mango etc. while those of monocotyledons are parallel venation e.g. maize, grass.

The main functions of the leaf are:

a. Site for photosynthesis – manufacture of food
b. The leaf carry out respiration – exchange of gases
c. used as support for plants e.g. climbing plants

Assignment

1. State two other functions of:
   i. roots, ii. Stem, iii. Leaf
2. Give three differences between monocot plants and dicot plants.
3. Draw and label the external structure of a monocot plant.

Internal Structure of the stem

The stem is made up of:

Epidermis – Is the outer most layer of the stem. It withstands the pressure of all the turgid cells and acts as a protective layer. It has no stomata and no guard cells.

Cortex – Just behind the epidermis moving towards the stem centre, It is used to store food (starch).

Vascular Bundle

Xylem Tissues – Main function is the conduction of water and mineral salts up the plant to the leaf.

Phloem – Responsible for the transport of manufactured food from the leaves to the roots and the various parts of the plant for storage.

Cambium – Responsible for the growth, thickens and strengthens the stem and toughens it.

Pith – is a wide opening which occupies the whole centre of the stem and can be used for storage of food

Internal structure of the leaf

The leaf consists of three (3) main parts

Epidermis – It is covered by a cuticle which renders on the lower side of the leaf are minute openings called stomata (stoma).

The stomata regulates the exchange of gases(oxygen, carbon dioxide and water vapour) into and out of the leaf.

The bean-shaped cells which regulates the opening and closing of the stoma is known as the guard cell.

Mesophyll – Are mainly concerned with photosynthesis. The mesophyll consists of:

i. the palisade layer
ii. the spongy layer of tissue.
iii. The cells consist of chloroplasts and have a space between them.

The palisade cells are cylindrical while the spongy cells have regular shape.

Vascular bundle – The vascular bundle consists of the Xylem and Phloem tissues. The extensive network of vein supplies water to the mesophyll and carries the products of photosynthesis from them.

Assignment

1. State three differences between the internal structure of a monocot stem and that of dicot stem
2. Where in the internal structure of the leaf does photosynthesis take place?

UNIT 21 FLOWERS

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Identify the floral parts and variation in flower structure..
2. Describe how flowers are pollinated and fertilized.
3. Identify the agents of dispersal of fruits and seeds.

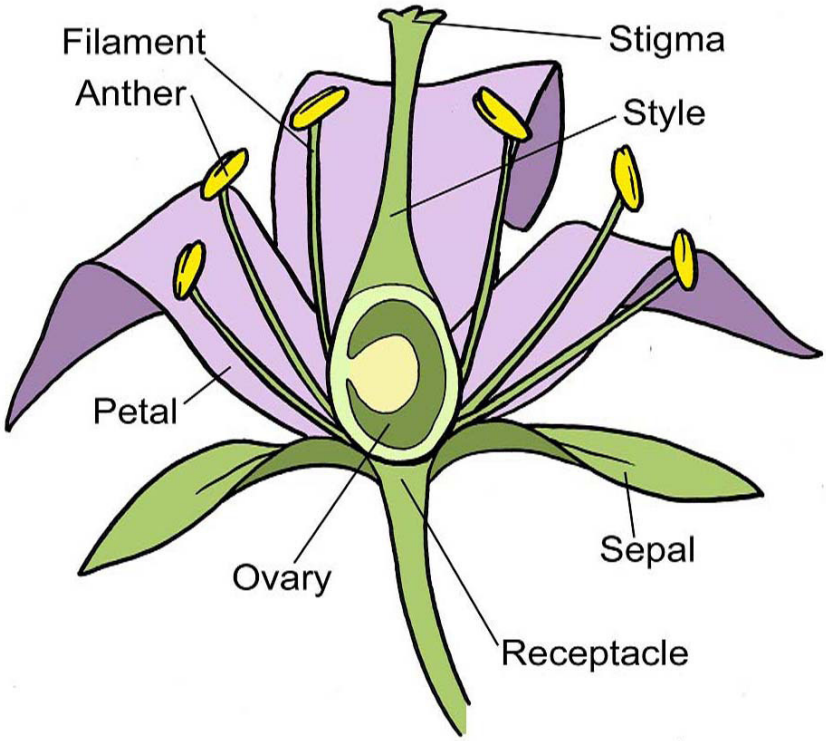
STRUCTURE OF A FLOWER

A FLOWER: Is the reproductive organ of a flowering plant. Is produces seeds and fruits. It consists of flower stalk or pedicel, the end of which is swollen to form the receptacle.

There are four kinds of floral leaves arranged in circles or whorls around the receptacle: Calyx, corolla, androecium and gynaecium.

1. **CALYX** - is the outer most whole made up of sepals. Usually green and protects the flower in bud. When coloured, they are petiole.
2. **COROLLA** - it is made up of petals, brightly coloured to attract insect for pollination.
3. **ANDROECIUM (STAMENS)** - it is the male part of the flower and consists of stamens. A stamen is made up of a filament and a head called anther. The anther contains the pollen grains, which contains male gametes.
4. **GYNAECIUM OR PISTIL** - these consist of the female part of the flower, and consist of one or more carpels. A carpel is usually made up of three parts which are **STIGMA** which receives the pollen grains, **STYLE** which connect the to the ovary and ovary which contain the ovules, and ovules contain the ovum or the female sex cell.

4. **THE NECTARY –** secretes nectar, a food for insects. This plays an important role in pollination.



Filament + Anther = Stamen
Stigma + Style + Ovary = Carpel

FUNCTIONS OF THE FLOWER

1. **FORMATION OF SEX CELL:** It is also called gametes. These are both male and female gametes. Thus the flower undergoes, sexual reproduction.
2. **POLLINATION:** Is the process were pollen grains are transferred to the stigma of the same flower or a flower of the same plant.
3. **FERTILISATION:** Is the union of the male and female gametes to form a zygote. Since the male and female gametes are haploid when the two unite the zygote is diploid.

4. **FRUIT DEVELOPMENT:** the ovary becomes the fruit. The wall of the ovary becomes the wall of the fruit called the pericarp. The fruit protects the developing seeds and plays an important role in seed dispersal.
5. **DEVELOPMENT OF THE EMBRYO SAC:** The embryo sac is the female gametophyte. The embryo sac is developed within the ovule surrounded by the nucellus, which is also surrounded by the integuments. One cell of the nucellus undergoes meiosis to produce four megaspores.
6. **GERMINATION**: The embryos will germinate from the seed if the proper germination eruditions are present. When this occurs the plant resumes its growth.

POLLINATION AND FERTILISATION

1. **POLLINATION:** Is the transfer of pollen grains from the anther to the stigma of the same flower or flower of another plant of the same kind. The pollen grains are transferred by insects or by wind. There are two types of pollination, and this includes:
2. **SELF POLLINATION:** This involves transfer of pollen grains from the anther of a flower to the stigma of the same flower or to a flower on the same plant.
3. **CROSS POLLINATION:** This involves transfer of pollen grains from the anther of a flower of one plant to the stigma of another plant of the same kind (species).
4. **FERTILISATION:** This is the union of male and female gametes or sex cell to form a zygote. This process follows pollination in plants. In animals fertilisation is either internal, takes place inside the female organism, or external (outside) the body of the female organism.

UNIT 22 NUTRITION

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Classify food items based on their nutrients.
2. State the importance of food nutrients.
3. Test for starch and proteins.

Nutrition is the process whereby living things obtain and use food to maintain health and growth.

FOOD AND CLASSES OF FOOD

FOOD: is any substance taken in by living things to nourish their bodies. The different food we eat daily form our ***DIET.***

CLASSES OF FOOD

Food items are classified according to the main function of the food in the body. The main classes are energy-giving foods, body-building foods and protective (maintenance) foods.

a. **ENERGY-GIVING FOODS** – Energy-giving foods are the food items that provide the body with the energy. These foods are carbohydrates and lipids (fats and oil).

b. **BODY-BUILDING FOODS** – Body-building foods provide the body with the substances it requires to grow and to repair and replace worn-out tissues or parts. They are mainly proteins.

c. **PROTECTIVE FOODS**-Protective foods are foods that regulate metabolism and keep our bodies healthy. Examples are vitamin rich food like vegetables, fruits and dairy products.

WHY DO WE NEED FOOD?

i. As fuel (source of energy)
ii. As body building materials (building and repair of body tissues).
iii. To maintain a healthy body (protection against diseases)

In our diets, we need seven essential components of food. These are called **NUTRIENTS.**

A nutrient is a substance that provides nourishment. The seven food nutrients are; **carbohydrates, fats and oils, vitamins and water, fibre (roughage), minerals and proteins.**
Roughage is an important component of our diet but it is not a nutrient.

CARBOHYDRATES

Are the major sources of energy needed in the body to perform any activity? The main elements present in carbohydrates are carbon (C), Hydrogen (H) and Oxygen (O) in the ratio of 2:1. Carbohydrates are obtained from starchy food such as cereals, and roots and tubers. Cereals include cassava, potato, sweet potato and yams. End product of carbohydrate digestion is GLUCOSE.

FUNCTION OF CARBOHYDRATES

1. They provide energy.
2. Carbohydrates help in the maintenance of the structure of the cell walls.
3. They are food storage components.
4. Provide fibre that makes food move smooth through the gut.
5. Serve as origin of other organic molecules like amino acids.

Effects and dangers of excess or lack of carbohydrates are:
Excess carbohydrates can cause obesity (over weight).
Overweight or obesity can lead to heart disorder. Too much sugar can cause tooth decay.

Test for carbohydrates

Test for starch

i. put a little food substance into a test tube.
ii. add a few drops of iodine solution to it.

Solution

Formation: A blue-black indicates the presence of starch in food substance

Test for reducing Sugar

Put a little food substance into a test tube add a little benedict's solution or Fehling's solution A and B to the food substance in the test tube.

Formation of orange or brick-red precipitate shows the presence of reducing sugars in the food substance.

Proteins

Proteins are the food substances that contain carbon, hydrogen, oxygen and nitrogen. Some proteins contain sulphur and phosphorus as well.

Major sources of proteins include meat, milk, eggs, fish and legumes

Functions of proteins in the diet

i. Proteins make up hormones, enzymes and co-enzymes.
ii. They help us grow.
iii. They are responsible for repair of damaged or worn-out tissues.
iv. Proteins give energy but not as much as carbohydrates.
v. Controls the rate of metabolism.
vi. The end product of protein digestion is Amino Acids.

Test for Proteins

Two tests in the laboratory

Million's Test

i. Place some quantities of mashed food substance in a test tube and add some water and shake well.
ii. Add few drops of Million's reagents and heat for about 1 minute.
iii. A ***white curdy*** precipitate formed which turns deep red on heating is an indication of proteins in the food substance.

Biuret Test

i. Put a sample of the food in to a test tube
ii. Add water
iii. Add few drops of Biuret solution(sodium hydroxide and copper sulphate solution) drop-wise and shake well.
The formation of a violet coloration indicates the presence of proteins in the food substance.
Lack of proteins lead to diseases like kwashiorkor and Rickets.

Assignment

1. Why do we need food?
2. What is a balanced diet?
3. Give 3 (three) functions of:
   a) protein b) carbohydrates
4. State one test for:
   a) starch b) protein c) lipids
5. What type of food is tested by using
   a) Fehling's solutions A and B?
   b) Sudan IV?

UNIT 23 NUTRITION

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Classify substances based on their nutrients.
2. State the importance of food nutrients.
3. Test for fats and oils.
4. Describe a balanced diet and state its importance.

LIPIDS (FATS AND OILS)

Fats and oils are generally called lipids. Lipids are esters of long chain-fatty acids and glycerol. They contain carbon, hydrogen and oxygen. Phosphorus and nitrogen occur in some type of lipids.

Fats and oils are obtained from;

a. Three animals. For example, mutton fat, beef fat and chicken.
b. Four plants, for example, ground nut oil, palm kernel, palm oil, sheabutter tree.

DIFFERENCES BETWEEN FATS AND OILS

FATS	OILS
Are solids at room temperature.	Are liquids at room temperature.
Are obtained from animals.	Are obtained from plants.
Contain more saturated fatty acids.	Contain more unsaturated fatty acids.

FUNCTIONS OF LIPIDS

i. Lipids produce twice more energy to the body than carbohydrates.
ii. They insulate the body. That is, they prevent or reduce heat losses.
iii. They act as energy store.
iv. They serve as structural material. For example, they form part of the components of cell membrane.
v. Fats dissolve fat-soluble vitamins.
vi. They protect internal organs such as intestines, kidney and heart.
vii. They form fatty sheath around nerve impulses.

viii. Fats make aquatic animals buoyant.
ix. Lipids makes some body parts water-proof. Examples are waxes on plant leaves and exoskeleton of arthropods.
x. They are used to make hormones.

TEST FOR LIPIDS

Lipids can be identified by using **Sudan(IV) test**, spot test and emulsion test.

USING SUNDAN 1V SOLUTION

1. Half-fill a test tube with any cooking oil, eg, peanut oil or coconut oil.
2. Add 3 to 5 drop of Sudan 1V solution.
3. Shake the mixture well.

Observation: the reagent stains the oils red.

Spot test

Release a drop of oil on any plain paper (e.g, filter paper). Leave the paper to dry in the sun hold the paper to light and look at the light via the spot where the oil was dropped. The spot becomes translucent.

Emulsion test

a. Put about 2ml of ethanol into a test tube
b. Add 1 ml of any oil.
c. Shake the mixture thoroughly
d. Transfer the mixture into another test tube containing about 2 ml of water.

Observation: the mixture forms a milky emulsion.

ASSIGNMENT

1. Why do we need food?
2. Give two uses of each of the following nutrients in the body:
a. Carbohydrate
b. Protein
c. Fats and oils
3. A) List any four reagents used to test for food.
B) For each of the reagents named above, give the food it tests for and the final colour change.

UNIT 24 DIGESTION OF HUMANS

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Describe the structure of the digestive system of humans.
2. Name the function of the parts of the digestive system of humans.

Digestion is the process by which the body breaks down complex food substances into simple soluble forms by means of enzymes so that they can be absorbed into the body to release energy.

The food that is digested or broken down is transported by the blood lymph into the cells of the body. This process is called absorption.

Absorption is the passage of digested food into the cell of the body. The cell then makes use of the absorbed food and this process is called Assimilation.
Assimilation is the use of absorbed food by the cells of the body.
When digested food is assimilated into the cells of the body, energy is produced.
Egestion is the removal of undigested food materials from the body.

The Digestive System in Humans
The digestive system consists of the mouth, oesophagus, stomach, small intestine, large intestine, anus and other organs such as liver, stomach pancreas etc.
The oesophagus, stomach, small intestine, large intestine and anus are all part of the alimentary canal

Functions of the parts of the Digestive System in Human

Buccal cavity (mouth) – Contains teeth and tongue. Teeth break down solid food into smaller pieces. Tongue rolls the chewed food into a bolus (a form of ball) before it is swallowed. Carbohydrate digestion begins in the mouth

Salivary gland – It produces salivary amylase. The salivary amylase converts starch to maltose. Saliva moistens and binds chewed food – enabling it to be formed into a bolus and also lubricates the bolus for easy swallowing. Saliva creates an optimum pH (slightly alkaline) for salivary amylase.

Gullet or oesophagus – It is a muscular tube through which food (bolus) passes before it gets to the stomach. The lining of the oesophagus secretes mucus to lubricate the ball of food.

Stomach – It is a sac-like structure that receives chewed food from the buccal cavity. The walls of the stomach contain gastric gland. The gastric gland secretes gastric juice. The gastric juice contains hydrochloric acid and protein-digesting enzymes called proteases. These are pepsin and rennin which digest and milk protein into peptides and casein respectively. Protein digestion begins in the stomach.

Small Intestine – It consists of the duodenum and the ileum. In the duodenum pancreatic juice, consisting of three enzymes, enter. Pancreatic amylase converts starch to maltose. Trypsin converts proteins to peptides. Lipase converts fats to fatty acid and glycerol.
It is in the ileum that final digestion to give final products occur. After that absorption of the end products of the digested food occurs. Succus entericus, comprising of four enzymes act here. Maltase converts maltose to glucose. Lactase converts lactose to glucose and galactose. Sucrase converts sucrose to glucose. Erepsin converts peptides to amino acids.

Pancreas – It produces a juice called pancreatic juice. Pancreatic juice contains three digestive enzymes namely pancreatic amylase, trypsin and lipase pancreas also secretes a hormone known as insulin that helps in the conversion of excess sugar to glycogen for storage in the liver.

Liver – It produces bile. Bile is not an enzyme but helps to break up fats into smaller droplets in the duodenum for easy digestion by enzymes.

Gall bladder – It stores the bile that is produced by the liver.

Large Intestine – It consists of the colon and rectum. It is here that undigested food substances are stored. It also absorbs water from the undigested food.

Anus – It serves as an opening allowing undigested material to be removed from the body.

Food type	**End product of digestion**
Carbohydrates	Glucose
Protein	Amino Acids
Lipids	Fatty acids and glycerol

Assignment

1. What is:
   i. Digestion ii. Egestion
2. State four structures associated with the human alimentary canal.
3. Give one main function for each:
   i. mouth ii. gullet iii. stomach iv. large intestine
4. What are the end products of digestion? To each state the source of type of food.

UNIT 25 THE CIRCULATORY SYSTEM

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Describe the structure of the circulatory system.
2. State the functions of the parts of the circulatory system.
3. Give the functions of blood and the heart.
4. Explain how the circulatory system works.
5. List the types of circulatory systems.
6. Draw and describe the human heart.
7. Name the functions of the various parts of the human heart.

THE CIRCULATORY SYSTEM

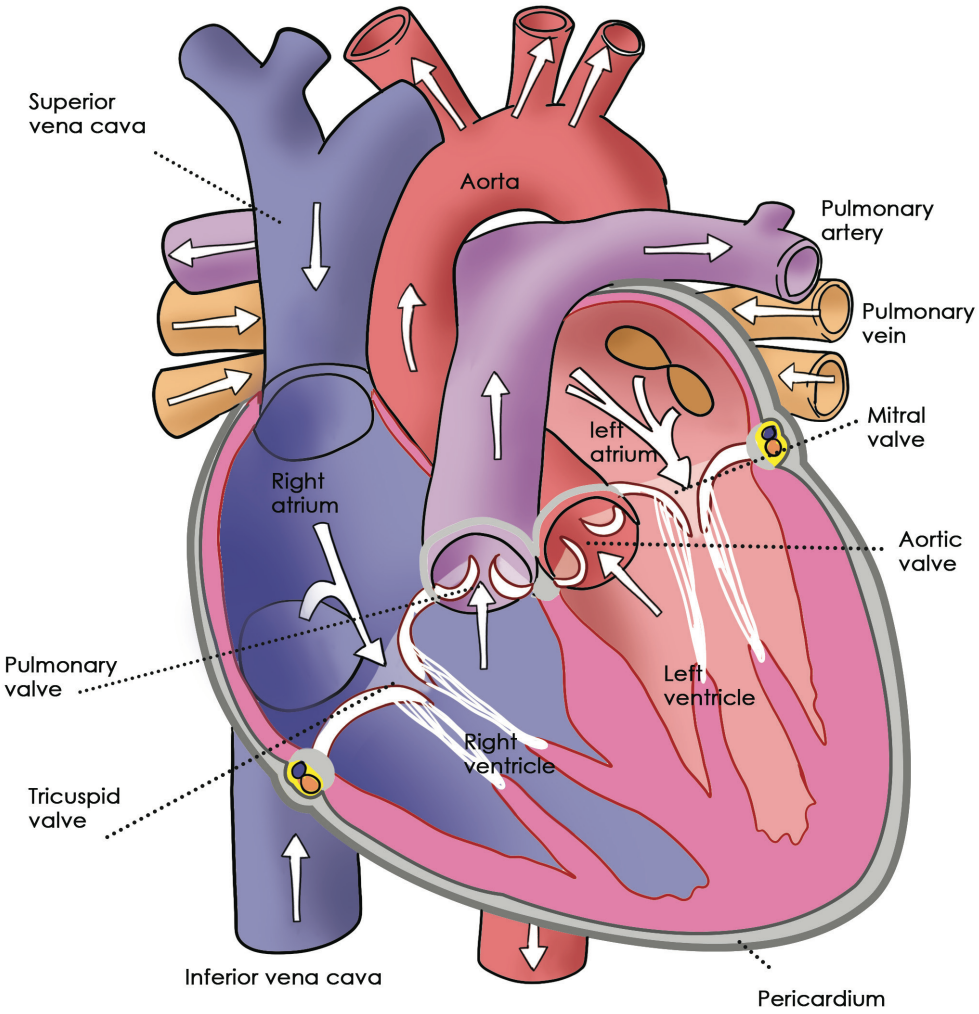
The circulatory system is made up of blood vessels that carry blood away from and towards the heart. The arteries carry blood away from the heart and the veins carry blood back to the heart. The circulatory system carries oxygen, nutrient, and hormones to the cells, and removes waste products like carbon dioxide. The two sub divisions of the circulatory system are: pulmonary circulation and systematic circulation.

HEART – It is a large muscular organ found in the chest cavity. It controls the circulation of blood, by pumping the blood to other parts of the body.

FUNCTIONS OF THE HEART

1. It controls the circulation of blood by pumping the blood to other parts of the body.
2. It pumps oxygenated blood to the body to the other parts of the body.
3. It pumps hormones and other vital substances to different parts of the body.

4. It receives deoxygenated blood and carries metabolic waste products from the body and pumps it to the lungs for oxygenation.
5. It maintains pressure.



THE HEART

BLOOD – Is a body fluid that transports oxygen and nutrients to the cell and carries away carbon dioxide and other waste products.

FUNCTIONS OF THE BLOOD

1. The blood transports dissolved food substances, blood cells and blood platelets.
2. The blood is fluid connective tissues (because of the cells in the plasma).
3. The blood provides the body's cell with oxygen and removes carbon dioxide.
4. The blood regulates body temperature.
5. The blood platelets clot blood at sites of injury.
6. The blood brings waste products to the kidney and liver.
7. The red blood cells are the most numerous living cells in blood.
8. The white blood cells protect the body from pathogens.

TYPES OF BLOOD CELLS

PLASMA – The liquid component of the blood in which the following blood cells are suspended.

RED BLOOD CELLS – These carry oxygen from the lungs to rest of the body.

WHITE BLOOD CELLS – These help fight infections and aid the immune process. The types of white blood cells include:

- Lymphocytes
- Monocytes
- Eosinophils
- Basophils
- Neutrophils

PLATELETS – These help in blood clotting.

TYPES OF CIRCULATION

The two sub-division of the circulation are:

PULMONARY CIRCULATION – is the contraction of the right ventricle which forces blood past the semi-lunar valves into the pulmonary artery, which in turn carries it to the lungs.

SYSTEMIC CIRCULATION – is the contraction of the left atrium that forces blood past the bicuspid valve into the left ventricles.

Parts of the heart and their functions

TWO MAIN TRANSPORT SYSTEMS IN HUMANS

There are two main transport systems in humans.
These are the:

- blood circulatory system
- lymphatic system

The organ which controls the blood circulation in mammals is the heart

The Heart – Structure

This is the organ that controls the circulation of blood in mammals. It is a large muscular organ, which lies in the thorax between the lungs but slightly in the left.
The longitudinal section of the heart reveals four chambers namely:

- right auricle/atrium
- right ventricle
- left auricle/atrium
- left ventricle

Separating the left auricle and the left ventricle is the bicuspid valve. The tricuspid valve separates the right auricle and right ventricle.

Parts of the circulatory system of mammals and their functions

Aorta: The aorta carries oxygenated blood from the heart to all parts of the body.

Vena cava : Vena cava brings into the heart deoxygenated blood from all parts of the body to the (right atrium) of the heart.

Pulmonary vein: Pulmonary vein transports oxygenated blood from the lungs to the heart.

Pulmonary artery: Pulmonary artery transports deoxygenated blood from the heart to the lungs.

Right atrium/auricle: Right atrium/auricle relaxes and expands to receive blood from the vena cava. Contracts to pump blood under pressure into the right ventricle.

Right ventricle: Right ventricle relaxes and expands to receive blood from the left auricle which contracts to pump blood under pressure into the lungs through pulmonary artery.

Left auricle/atrium: Left auricle/atrium relaxes and expands to receive oxygenated blood from the lungs through the pulmonary vein.

Left ventricle: Left ventricle relaxes and expands to receive blood from the left auricle which contracts to pump oxygenated blood under pressure to all parts of the body through the aorta.

Tricuspid valve: Tricuspid valve ensures blood flow in the forward direction and prevents the flow of blood back from the right ventricle into the right auricle.

Bicuspid valve: Bicuspid valve allows blood to flow from the left ventricle to the aorta and prevents the back flow of blood form the left ventricle into the left auricle.

MAMMALIAN BLOOD CIRCULATION – FLOW OF BLOOD THROUGH THE HEART

For every circuit that the blood takes, it passes through the heart twice. In mammals there is double circulation which means that blood flows through the heart twice in the circulatory path. The process is described as follows:

Deoxygenated blood enters the right auricle of the heart via the two vena cavae. From the right atrium it enters the right ventricle through the tricuspid valve. From the right ventricle, it is pumped into the pulmonary artery and through to the lungs where it is oxygenated. Oxygenated blood returns to the heart through the left auricle via pulmonary veins. It then passes through the bicuspid valve into the left ventricle where it is forced into the aorta and around the body where it is used for tissue respiration. The blood vessels which carry blood away from the heart are called arteries and those that carry blood into the heart are called veins.

Sequences of blood flow through the heart from the tissue

Below is the sequence through which the blood enters the heart and various organs it passes through before finally leaving he heart.

Red blood cells from the tissues → anterior and superior vena cava → right auricle → tricuspid valve→ right ventricle→ pulmonary artery → lungs → pulmonary vein→ left auricle → bicuspid valve → left auricle → aorta → to all parts of body.

Key Words

auricle	atrium
ventricle	bicuspid
tricuspid	pulmonary
vena cava	oxygenated
valve	arteries

Assignment

1. Draw and label the mammalian heart.
2. Give the functions of the:
   a) pulmonary artery
   b) pulmonary vein
   c) right ventricle
   d) left ventricle

UNIT 26 ECOLOGY

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Explain the basic ecological term.
2. Define the term ecosystem.
3. List the main components of an ecosystem.

ECOLOGY - Is the scientific study of the inter-relationship between organisms and their environment. Plants and animals depend on their environment to derive their food. Living organisms need such things as water, air, food or sunlight and therefore rely on their environment.

Basic Concepts in Ecology

Environment - Refers to the surrounding or all the conditions in which the organism lives, e.g. the surrounding soil, water, air, climate, physical features for the landscape, other organisms.

Habitat - Is any locality within an environment in which an organism can successfully survive i.e. the place where the organism lives.

Terrestrial habitat - The natural home of organisms living on the land and underground.

Arboreal habitat - The natural home of organisms living on trees and in the air (aerial).

Aquatic habitat - The natural home of organisms living in water.

Species - Are group of individuals which form an ecological and structural unit that are capable of interbreeding to produce fertile offspring.

Organism - Is the fundamental functional unit of ecology. It includes both plants and animals.

Population - Is a group of individual or species or genetically similar individuals living in the same habitat at the same time or at a particular time e.g. the mango tree in a school compound, grasshopper in a field. Population may tend to change over a period of time, such changes are called "fluctuation."

Community - Are group of population of organism of different species that are occupying the same area but not necessarily sharing the same resource material.

Ecosystem - Refer to an area (habitat) composed of plants and animals (biotic) interacting with each other and with the non-living (abiotic or physical) factors of the environment e.g. a pond.

The components of the Ecosystem

An ecosystem comprises of the living components (biotic) and the non-living or physical component (abiotic).
Biotic Component – Are all the living organisms associated with an environment. This consists of producers, consumers and decomposers.

Producers – Mainly green plants which manufacture their food from simple inorganic raw materials with the aid of sunlight and chlorophyll.

Consumers – Refers to all animals that take in food directly or indirectly from plants. Three kinds exist.

Primary Consumers – herbivores that feed directly on plants e.g. grasshoppers, cows.

Secondary Consumers – Carnivores that feed on herbivores e.g. toads, lizards.

Tertiary Consumers – Those that eat the secondary consumers e.g. man, lion, snake.

Decomposer – Are mainly non-green plants, bacteria and fungi that break down plant and animal remains to obtain energy. They help in nutrient recycling photosynthesis.

UNIT 27 ECOSYSTEM

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Describe how the components interact to make the ecosystem.
2. List ways in which animals depend on plants and plants depend on animals.

Interactions between individuals in a community

Apart from the relationship between producers, consumers and decomposers, there are other interactions between the individuals in the community. This includes:

Predation - the killing of another animal for food. The predator is usually larger than its prey (organism it kills for food). E.g. the fox kills the rabbit. The fox is the predator and the rabbit is the prey.

Parasitism - A feeding relationship between two organisms in which only one partner (the parasite) benefits at the expense of the other. A parasite is an organism which only lives on or in the body of other organism (the host) from whose tissues it derives its nourishment to harm the host. E.g. bed bugs, mites, ticks, lice etc (ectoparasites) and tapeworm, ascaris, plasmodium, trypanosome, (endoparasites).

Saprophytes - Are organisms (plants) that derived their nutrients from dead organic matter e.g. bacteria and fungi. They lack chlorophyll and cannot therefore photosynthesise. They obtain their nutrients by extra cellular digestion.

Symbiosis (mutualism) is an association between two different organisms in which both organisms benefit e.g. bacteria in the intestine of termites, bacteria in root nodules of legumes, bacteria in the rumen of ruminants.

Commensalism - An association between two different species of living organism in which only one (the commensal) benefit and the other neither benefit nor is harmed. E.g. cattle and cattle egret, shark and sucker fish, sea anemone and hermit crab.

Food Chain and Food Web

One of the ways in which the organism of a community interacts is by feeding or providing food for each other.

Food chain – Refers to a line of organisms in a feeding relationship in which the lower one is used as a food source. It is also the linear feeding relationship in which one organism uses the other as source of food. By this, food or energy is passed from producers to consumers and to a decomposer. All food chains begin with green-plants (producers). Example grass→grasshopper→lizard→snakes→hawks. The grass is the producer, the grasshopper is the primary consumer, the lizard is the secondary consumer and the hawk is the tertiary consumer (top predator). Another example of a food chain is spirogyra→mosquito→small fish→water snakes.

Food Web – Is the complex feeding relationship in which an organism has more than one source of food. It is a complex feeding relationship in which one organism feeds on and is itself being fed on by many other organisms. It is a combination of two or more food chains.

Differences Between a Food Chain and a Food Web

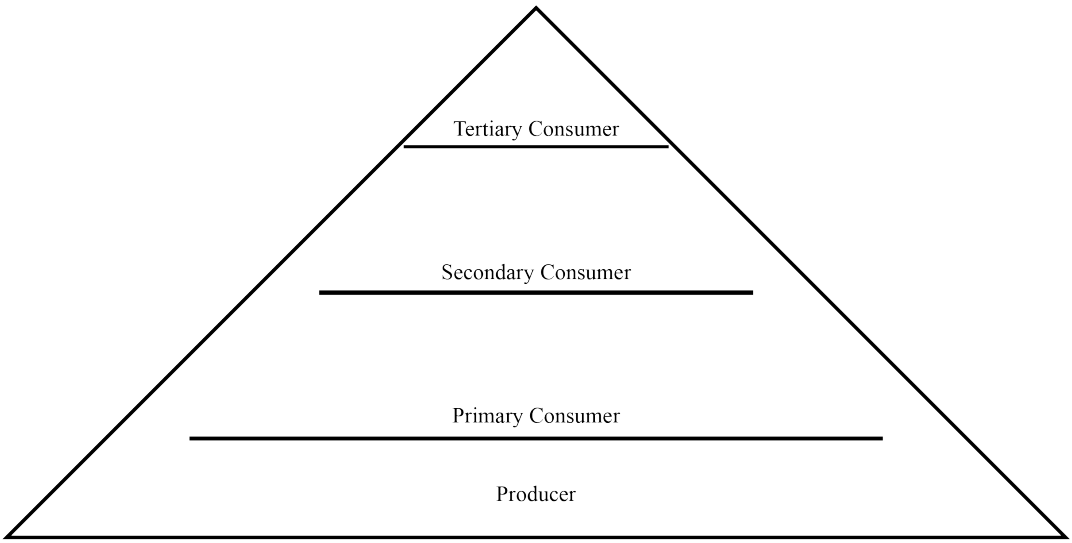
Food chain	**Food web**
Is a simple linear feeding relationship.	Is a complex feeding relationship.
Contains consumers feeding on one kind of food.	Comprises consumers that feed on different kinds of foods.
Involves fewer organism in the community.	Involves many organisms in the community.

Pyramid of Numbers

The number of individual organisms present at each stage of a food chain generally decreases. A pyramid or number is a way of representing the relationship between the numbers of individuals at each stage of the food chain.

The population of each organism in a food chain can be shown in a type of bar chat called pyramid of numbers. The size of the bar indicates the size of the population of a particular organism in the food chain.

Pyramid of numbers can also be shown using a triangle. Usually in this case, the size of the organisms reduce with loss of energy along the chain.



Assignment

1. Give three examples of a food chain
2. What is,,,?

   a) Parasite b) Host c) Predator d) Prey e) Commensals
3. Give two examples each of
   a. Endoparasites
   b. Ectoparasites
4. Draw food chain involving
   a. two organisms.
   b. three organisms.
   c. four organisms.

UNIT 28 POPULATION CHANGES

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Define the term population, migration, immigration and emigration.
2. List the factors that will increase or decrease population in the school
3. Give the problems of population growth.
4. Describe the movement of people.

The number of people in a place or country does not always remain the same. It changes every day, month or year. The size of the population can be smaller or larger as a result of these changes. i.e. increase or decrease in population. The factors that will increase population in the school community are:

i. Increase in birth rate
ii. Decrease in death rate
iii. Immigration
iv. New admission

Factors that can decrease or reduce population in the school community are:

i. High death rate
ii. Low death rate (mortality)
iii. Emigration
iv. Wars
v. Expulsion
vi. Graduation
vii. Transfer

Basically changes in population of people within the country depend on three factors:

i. Birth rate-number of babies born in a year.
ii. Death rate- number of people who died in a year.
iii. Migration rate- number of people coming in or leaving.

MIGRATION - Is the number of people moving into or out of a country. Two main types of migration exists:

IMMIGRATION - Is the movement of people into a country. The people who come are called immigrants and they add to the total population.

EMIGRATION - Is the movement (going) of people out of a country. The people who move out of a country are called **EMIGRANTS** and they reduce the total population. Other forms of migration include:

RURAL - URBAN MIGRATION - Movement of people within the same country from the rural area (village or towns) to the urban areas (cities and large towns) this reduces the population in the rural areas.

URBAN - URBAN MIGRATION - This is an internal movement of people from one urban area to another urban area e.g. BO to Freetown.

REASONS FOR MIGRATION

i. In search of food.
ii. Jobs or employment opportunity.
iii. Educational opportunities.
iv. Health facilities.
v. Security facilities (war).
vi. Agricultural facilities.

PROBLEMS OF POPULATION GROWTH

Major problems are over-crowding and sanitation which lead to:

1. Many infectious diseases such as cholera, diarrhoea, T.B, can spread easily.
2. More waste and poor sanitation causing pollution. No proper disposal of refuse.
3. Increase in crime rate. E.g. Stealing, fighting, prostitution, etc.
4. Poor housing and social facilities.
5. Odd jobs (employment).

MAN AND HIS ENVIRONMENT

There are different types of environment**:**

Physical environment: Including the soil, land, forest, ocean, sea, air. This environment can be changed by man. Two other types of environment are known.

Natural environment: Has not undergone any changes e.g. sea, ocean, sky, rivers. The earth is man physical environment.

Artificial environment: Environment made by man. It is not in its original state swimming pools, dams, houses, lakes.

NATURAL RESOURCES IN THE ENVIRONMENT

Natural resources are anything that exist without any actions of man which man can make use of in the environment.
These includes plants, animals, land, water, minerals, rocks, wild life, livestock, fishes, fossils, forest trees. These materials provide man with the basic necessities of life, such as food, clothing, shelter and energy.

1. **RENEWABLE RESOURCES**: The resources that the environment can replace or recycle at the same time.
   We use them. e.g. water, tree, wild life, crops, fish.

2. **NON-RENEWABLE RESOURCES:** The resources that are not replaced at the same time we use them. They need several years to even replace themselves. E.g. minerals, metals, fossils, fuels, (crude oil), coal, biofuel (biogas).

ACTIVITIES OF MAN AND THE CHANGES IN THE ENVIRONMENT

Activities of man have greatly influenced and brought changes in the environment.
These includes:

1. **AGRICULTURE**: Over cultivation, over grazing, land cleaning, burning, tilling, killing, etc, leads to the destruction of trees, exposure of the soil to erosion and killing of large animals and soil

micro-organisms. Indiscriminate use of chemicals (pesticides and fertilizers) can kill other animals and cause soil toxicity.

2. **DEFORESTATION:** Cutting down of forest trees for timber, fuel, wood or farming without replacing them. This can cause soil erosion and lost forever of some forest trees, vegetation and animals (wild life). The exposure of the soil can cause leaching of the soil nutrients. Carbon dioxide is unabsorbedleading to global warming.
3. **MINING**: Involves the removal of minerals such as diamonds, rutile, iron Ore, buried down in the earth crust. It destroys drinking water systems treatment and fertile agricultural land.
4. **FISHING**: Can destroy would-be bigger fishes, pollutes the water and sometimes the chemicals used can kill many fishes and other organisms.
5. **HUNTING**: This may lead to the extinction or complete disappearance of many important animals.
6. **POLLUTION**: The accumulation or addition of harmful wastes into the environment. The harmful substances are called POLLUTANTS. E.g. a) Carbon dioxide (burning) b) Smoke (factories and burning) c) Carbon monoxide (factories and garages)
7. **INDUSTRIALISATION AND URBANISATION :** Construction of roads, building dams, recreation centres, have led to deforestation and pollution of fertile agricultural lands.

POLLUTION

POLLUTION: Is the release, addition or accumulation of harmful wastages into the environment. Pollution can be air pollution, water pollution or land pollution depending on the part of the environment affected.

TYPES OF POLLUTION

1. **Air pollution:** Mainly caused by the discharge of gases or particles from domestic fires, motor vehicles, generating stations, factories,

city roads, building sites, discos, etc. Air pollution include dust carbon dioxide, carbon monoxide, Sulphur dioxide, noise, etc. Air pollution can cause asthma, acid rain to corrode metal, bricks and mortar, eye irritation, suffocation, global warming (greenhouse effect) and death.

Air pollution may be prevented or controlled by:

a) Siting factories away from residential areas.
b) Building tall chimneys so that waste gases are discharged high up in the air.
c) Passing waste gases from factories through filters to remove the polluted air before they are discharged.
e) Entertainment halls and churches to be sited away from residential areas.

2. **WATER POLLUTION**: Caused by the discharge of untreated sewage, industrial waste pathogens, oil spillage and agricultural waste materials that make water unsafe for the use of man and disrupt aquatic ecosystems. It can also lead to blockade of river and other water bodies leading to flooding. Water pollution contaminates drinking water, fish or other animals. This can result in the death of humans who eat contaminated food as well as the death of sea birds.

Water pollution can be controlled by:

a) Treating sewages before being discharged.
b) Industrial materials should be recycled or treated in controlled amount.
c) Farmers should avoid using excessive amount of chemical and fertilisers.

3. **LAND POLLUTION**: Polluted by discarded objects like old cars and lorries, tins, cans, bottles, plastics, industrial wastes and uncontrolled mining.

Land pollution can be controlled by:

a) Recycling of metal and other materials from old motor vehicles.
b) Proper disposal of refuse.
c) Controlled mining.

UNIT 29 EARTH SCIENCE

TOPIC 1: THE UNIVERSE

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Describe the components of the universe.
2. State the importance of the sun and the star.
3. Explain the star patterns in Sierra Leone.

The universe means the whole world. The universe includes the sun, moon the planets, comets, galaxies and other heavenly bodies.

The Solar System

- The solar system is a small part of the universe called the milky way galaxy (where other planetary systems, like ours, exist in the universe with planets orbiting a host star).
- The solar system is made up of the sun, the eight planets, the moons, comets, asteroids (planetoids) meteors and stars.

The Sun

- The sun is a ball like substance that is made up of hot gases.
- The sun is the centre of the solar system.
- The sun is a star with a great amount of energy.
- The sun is 150 million (One hundred and fifty million) kilometres or 93 million (ninety three million) miles away from the Earth and that is why we feel or receive very little of the energy it radiates.

Importance of the sun

The sun makes it possible for life to exist on Earth.

- Green plants absorb light from the sun which they use to manufacture food for themselves and for animals.
- The energy (heat) from the sun is used to operate solar equipment (e.g. watches, calculators).
- It is a source of vitamin D which is needed in our bodies.
- The rotation of the earth helps to provide an even distribution of the

radiant energy from the sun because the rotation of the earth exposes different parts of the earth to the sun at different times.

The Stars

- The stars we see on a clear night are very big spheres of gases, which release a lot of radiant energy. Many of them are bigger than our sun.
- The temperature of the stars is usually very high, but fortunately they are at a very great distance away from us so we are protected from the violent energy they radiate.
- Stars form part of the milky way galaxy and they are always moving as the earth moves.
- Stars are of different shapes and sizes and they are also far away from each other.
- The only star that is nearer to the earth (besides the sun) is called Proxima Centauri.
- Some stars are brighter than others.
- The brightness of a star depends on its size and its distance from the earth (a large star is brighter than a smaller star)
- Stars exist in groups called galaxy.

The Importance of stars

- Stars give us light and heat on earth.
- Stars are used to determine time and direction or to navigate the earth.
- People use stars to predict the weather.
- Astrologers use stars to predict the future of people by using this life circle of stars.

Star Constellations

Star constellations are a group of stars that form different patterns or picture in the sky.

Some of the star constellations around the earth are:

Pisces	Sagittarius
Leo	Libra
Aquarius	Gemini
Cancer	Taurus
Capricorn	Aries
Scorpio	Virgo

Star Constellations that can be seen in Sierra Leone

Four star constellations that can be clearly seen in Sierra Leone are:

1. **Orion** - It is seen in the months of January, February, March and April.
   - It resembles a hunter.
   - It is named after a famous Greek hunter called Orion.
2. **Plough** - It is seen in the months of January, February, March, April, May and June.
   It resembles a great bear.
3. **Pegasus** - It is seen in the months of September, October, November and December.
   - It resembles a winged horse.
4. **Scorpius(scorpio)** - It is seen in the months of May, June, July and August.
   - It resembles a scorpion.

Some stars exist in pairs that revolve around each other.
These are called Double stars.
A band of twelve constellations around the earth is called Zodiac

Assignment

1. Define the following:
   i. Universe, ii. Solar system, iii. Sun iv. galaxy
2. State the distance of the sun from the earth in kilometres.
3. List five (5) star constellations around the earth.
4. Name the four star constellation that can be seen in Sierra Leone.

TOPIC 2: THE MOON

Learning Outcomes

By the end of the lesson, Pupils should be able to;

1. Identify and draw the phases of the moon.
2. List the importance of the moon.
3. Define and give the types of satellites.
4. State the importance of a satellite.

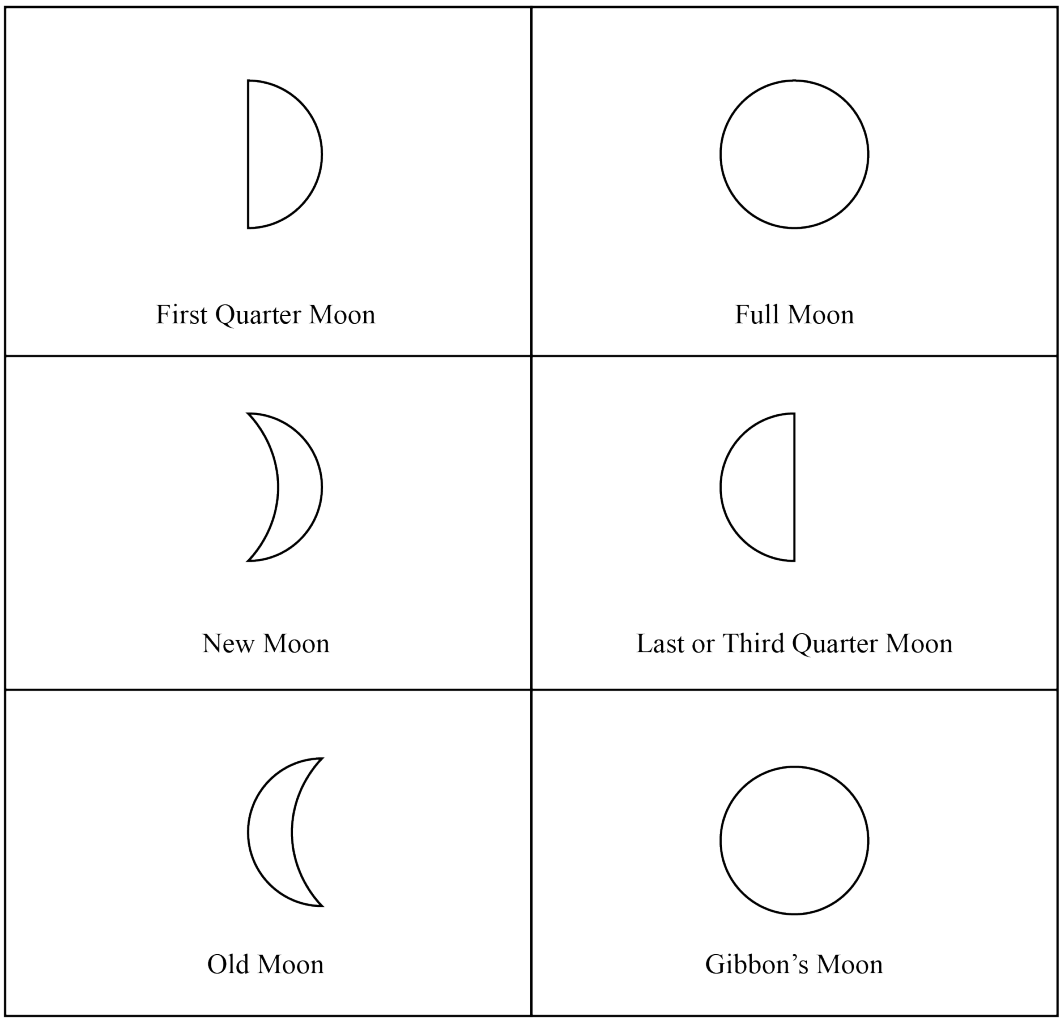
THE MOON

- The moon is the closest heavenly body to the earth in the sky.
- It is so close that we can see it. The moon was the first heavenly body that scientists landed a rocket and Astronauts on
- The first astronauts to land on the moon were two Americans called **Neil Armstrong** and **Edwin Aldrin** on the 20th July 1969.
- The space craft they used was code named **Apollo.**
- The moon is much smaller than the earth
- It has a diameter of **12,800 km** and it is four hundred thousand kilometres (**400,000 km**) away from the earth.
- The moon does not produce its own light. The light of the moon is caused by the sunlight that is reflected from the surface of the moon.
- There is no life on the moon (i.e. no grass, no soil, no wind, no sound and very little air).
- The moon takes twenty nine (29) days to complete a revolution around the earth. (This is known as a lunar month)
- As the moon revolves round the earth, it undergoes some changes at different times in the month.

THE PHASES OF THE MOON.

As the moon revolves round the Earth, it undergoes some changes at different times of the month. This is called the phases of the moon.

PHASES OF THE MOON



SATELLITES

A Satellite is a body that orbits or revolves round another heavenly body.
Two types of Satellites exit:
These are:

1. Natural Satellites
2. Artificial Satellites

1. **Natural Satellites:** Are heavenly bodies that are not made by man and is not sent up or placed into space by any man e.g. moon.
2. **Artificial Satellites:** Are Satellites that are made by man and sent up or placed into space so that they can orbit round the Earth. E.g. communication satellites, Earth Satellites, Rocket etc.

IMPORTANCE OF SATELLITES

1. Weather forecast: Satellites assist meteorologists in fore casting the weather.
2. Communication: Satellites pick up and relay radio, telephone or television messages.
3. For Science Research: Supply information about radiation, magnetism etc.
4. For warfare: They are used to locate enenies and attack them.
5. For spying: They are used to collect information.

The Importance of the Moon

1. The moon gives light at night.
2. It causes ocean currents and tides.
3. It can help to determine the time, month and date.

Assignment

1. Name the first astronauts to land on the moon.
2. What is the distance of the moon form the earth (in kilometres).
3. What are the four phases of the moon?
4. State two more importance of Satellites apart from those stated above.

TOPIC 3: ECLIPSE

Learning Outcomes

By the end of the lesson, pupils should be able to:

1. Define and give the types of eclipses.
2. Describe solar eclipse and lunar eclipse.
3. Illustrate the formation of the rainbow.
4. Show the colours of a rainbow.
5. Define and give examples of some heavenly bodies.

ECLIPSE

The sun is a large luminous body that sends light onto earth and the moon. Due to the movement of the earth and the moon, it is possible for one of them to cover or block the other from the sun.

TYPES OF ECLIPSES

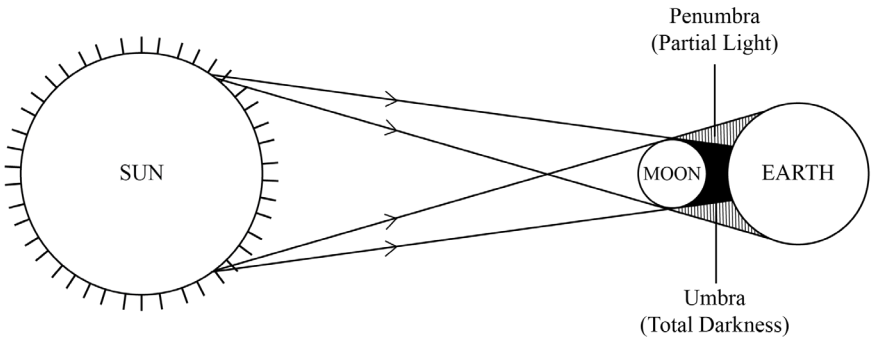
There are two types of Eclipses:

1. SOLAR ECLIPSE
2. LUNAR ECLIPSE

1. **SOLAR ECLIPSE:** Solar eclipse or the eclipse of the sun occurs when the moon passes directly between the sun and the earth. The shadow of the moon will fall on some parts of the earth because the earth is much bigger than the moon.

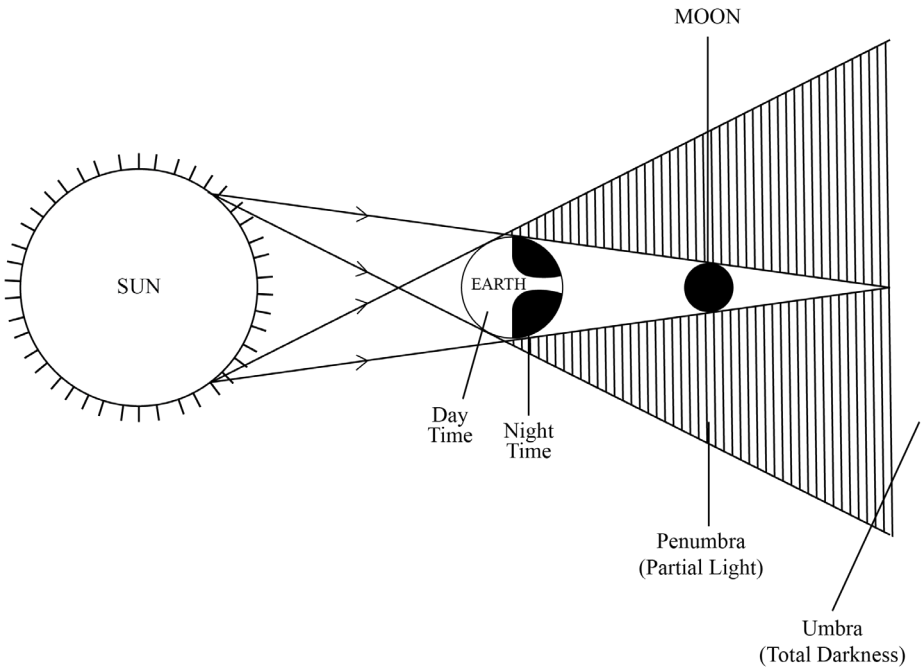
Regions of total shadow (***umbra)*** and partial shadow (***penumbra***) will fall on the earth. This will cut off the sunlight on some parts of the earth's surface. This total or partial darkness has a short duration.

The area on earth where the umbra of moons shadow falls experiences total eclipse of the sun whilst the area covered by the penumbra of the moon's shadow experiences partial eclipse of the sun. At times the moon is too far away from the earth such that no part of the moon's shadow will fall on the earth. This is called annular solar eclipse.



Solar eclipse

2. **LUNAR ECLIPSE:** (or eclipse of the moon): Lunar eclipse occurs when the earth comes between the sun and the moon. The shadow of the earth thrown on the moon causes the lunar eclipse. Areas on Earth where the umbra of the moon's shadow falls, experiences the total lunar eclipse of the moon. The area that comes under the influence of the penumbra has partial eclipse of the moon.



Lunar eclipse

RAINBOW

A meteorological phenomenon caused by refraction and dispersion of white light in water droplets which gives a spectrum of seven different colours (ROYGBIV).

Red	blue	green
Orange	indigo	
Yellow	violet	

A rainbow is a special kind of spectrum (colour) formed in the sky after rain. There are millions of small water drops in the atmosphere. When the sunlight strikes these water droplets, each droplet acts like a glass prism. As the sunlight enters the droplets, it splits into seven colours known as a rainbow.

RED	ORANGE	YELLOW	GREEN	BLUE	INDIGO	VIOLET
R	O	Y	G	B	I	V

Sir Isaac Newton was the first scientist to split light using a prism. He held a glass prism in the path of a beam light. He found that light splits into bands of colour known as a ***spectrum.***

SOME OTHER HEAVENLY BODIES

1. **ASTEROIDS**: Generally, asteroids are large mass of rocks that are found between the planet Mars and Jupiter. Like all planets, asteroids move around the sun. They are otherwise known as ***planetoids***.
2. **COMETS:** They consist of a head and a tail and orbit the sun. They are masses of frozen gas and other crusts orbiting the sun. They are long-tailed objects gleaming in the sky. Examples of some comets are:
   i. Halley's comets
   ii. Biela's comets
   iii. Enke's comets

METEORS: They are small lumps of stones or metal that sometimes shoot through the atmosphere from outer space. Their speed is so great that friction with the upper atmosphere makes them heat and glow. They are commonly called ***Shooting stars*** or ***falling stars.***

METEOROIDS

They are pieces of rocks or metals that orbit round the sun.

ASSIGNMENT

1. Explain the formation of a rainbow:
   a. using glass prism.
   b. using water droplets in the atmosphere.
2. Give two differences between solar eclipse and lunar eclipse.
3. Define the following terms:
   a. meteors
   b. meteoroids
   c. asteroids
   d. comets
   e. umbra
   f. penumbra

TOPIC 4: PLANETS

Learning Outcomes.

By the end of the lesson, pupils should be able to:

1. Define a planet.
2. List the eight (8) planets.
3. Give the characteristics of the planets.
4. Show the distances from the sun, time to complete a revolution and the number of moon (s) each planet has.

THE PLANETS

A planet is a non-luminous heavenly body that revolves round the sun in an elliptical path known as the orbit.
There are eight common planets in the solar system. These are listed in the order of their distance from the sun.

1.	Mercury	5	Jupiter
2.	Venus	6.	Saturn
3.	Earth	7.	Uranus
4.	Mars	8.	Neptune

POINTS TO REMEMBER

1. The orbit of the planets is always in one place.
2. The planets revolve in the same direction (the nearer a planet is to the sun, the faster its speed).
3. The four planets nearest to the sun are made up of rocky materials. Whilst the two most distant (Uranus and Neptune), consist mainly of gases (hydrogen and helium).
4. Pluto is no longer a planet but a dwarf planet because its orbit is not clear.

ACRONYM- My Very Educated Mother Just Served Us Nuts. The first letters stand for the planets and the whole sentence is for the eight (8) planets: (MVEMJ SUN).

NOTE*: Pluto is no longer a planet because its orbits is not clear and is obscured. Pluto has been reduced to a* **DWARF PLANET.**

All the planets can be grouped into two. The first four plants-***Mercury, Venue, Earth*** and ***Mars*** are known as the Inner Planets and are close to the sun. They are made mainly of rock and iron.

The last four Planets ***Jupiter, Saturn, Uranus*** and ***Neptune*** are known as the Outer Planets and are far from the sun. they are mainly made up of gas (***Hydrogen*** and ***Helium***) with relatively small core of rock.

INNER PLANETS

1. Mercury
2. Venus
3. Earth
4. Mars

OUTER PLANTS

1. Jupiter
2. Saturn
3. Uranus
4. Neptune

THE CHARACTERISTICS OF PLANETS

1. Planets travel in an elliptical path known as ORBIT round the sun.
2. Planets are non-luminous. i.e. they do not produce light of their own. They get light from the sun which they reflect.
3. All planets are spherical or round in shape.
4. Most planets have their own moon or natural satellites which travel around them.

DIFFERENCES BETWEEN THE PLANETS AND THE SUN

PLANET	SUN
1. Does not produce light and heat.	1. Produces light and heat.
2. Does not twinkle.	2. Usually twinkles.
3. Moves in an orbit around the sun (star).	3. Does not move in an orbit.
4. It is solid in nature.	4. It is made up of burning gases.
5. It is smaller in size than the sun.	5. It is bigger in size than the planet

Below is table of planets; their distance from the sun (in km), time spent to complete a revolution and the number of moons each has.

PLANETS	DISTANCE FROM THE SUN	TIME TO COMPLETE A REVOLUTION	NUMBER OF MOON
Mercury	58 million km	88 days	0
Venus	108 million km	225 days	0
Earth	105 million km	365 days	1
Mars	228 million km	687 days	2
Jupiter	778 million km	2, 380 days	12
Saturn	1, 921 million km	10, 445 days	10
Uranus	2, 890 million km	30, 260 days	5
Neptune	4, 497 million km	388, 426 days	2

ASSIGNMENT

1. (a) What are planets?
   (b) Name the four planets that are gases in nature.
2. (a) What is an orbit with respect to the solar system?
   (b) Give the shape of the orbit of the planets

3. Name the:
   a. The largest planet
   b. Smaller planets
   c. Hottest planet
   d. Coldest planet
   e. Planet where life is possible
4. Why is Pluto no longer considered a planet?

UNIT 30 SOIL AND ROCKS

Learning Outcomes

At the end of the lesson, pupils should be able to:

1. Name the external and internal structure of the earth.
2. Describe the various layer of the earth's structure.
3. Define the term rock.
4. Describe how the major types of rocks are formed and give their characteristics.
5. Mention some uses or importance of rocks.

SOIL

Soil is a collection of weathered material covering the surface of the Earth and supports plant growth.
Soil is a medium for plant growth or the outer most layer of the earth's crust.

SOIL SUPPORT LIFE: There are various living and non-living substances in the soil. Examples of some living things in the soil include: Earthworm, lizard, millipedes, snail, aunts, rats, frogs, plants termites, micro-organisms (bacteria, amoeba).

The non-living substances include: rocks, diamonds, coal, iron ore, gold, rutiles, sands. They are found in or on the soil.

SOIL TYPES

On the basis of the particles which make up the soil, soil may be divided into the following types:
Sandy Soil
Clay Soil
And Loamy Soil

1. **SANDY SOIL:** It contains mostly sand, some silt, stone and gravel. Sandy soil is gritty to touch and feel. Water passes through quickly, and they dry out easily. Sandy soil contains low amount of humus.

CHARACTERISTICS OF SANDY SOIL

i. Sandy soil is coarse and gritty.
ii. Sandy soil is not sticky when wet.
iii. Sandy soil has high percolation while capillarity is very low.
iv. Sandy soil is well aerated and cannot hold water.
v. Sandy soil has large pore spaces.

2. **CLAY (CLAYEY) SOIL:** It contains mostly clay, some silt and sand. Clay soil contains very small particles which stick together. They are sticky to touch. Water does not easily pass through clay soil.

CHARACTERISTICS OF CLAY SOIL

i. Clay soil is lightly packed with little pore spaces.
ii. It is poorly aerated and can hold water.
iii. It is fine grained and smooth.
iv. It is sticky when wet and hard when dry.
v. Percolation is low but capillary is high.

3. **LOAMY SOIL:** It contains silt, a small amount of clay a good amount of humus, some gravel and sand. Loamy soil is crumbly to touch, fertile and supply air, water and nutrient for healthy plant growth. Loamy soil is the best soil for agriculture because all of the constituents of the good soil are present.

CHARACTERISTIC OF LOAMY SOIL

i. It contains a lot of organic matter and is in between being gritty and being sticky.
ii. It is loose and moist in nature.
iii. It is well aerated and can hold water.
iv. It does not support erosion and water logging.

SILT: This consists of very small quartz particles. They are micro sand grains but have more surface area than sand.

LATERITE: This is leached soil and it is not very suitable for agricultural purpose.

DIFFERENCE/COMPARISON OF SANDY AND CLAY SOIL

SANDY SOIL		CLAY SOIL	
1	Low water hold capacity	1	High water capacity
2	Have large air space	2	Have small air space
3	Have large particle size	3	Have small particle size
4	Drainage is rapid	4	Drainage is slow
5	Feel gritty	5	Sticky to feel
6	Cannot be moulded into shape on wetting	6	Can be moved into shape

SOIL CONSERVATION

Soil erosion has rendered millions of acres of land highly unproductive. If the world is to meet up with adequate provision of food for the daily increase in the population, and to avert famine and diseases, then measures must be taken to check the ravages of excessive erosion.

TYPES OF SOIL CONSERVATION

a. By terracing hill sides to prevent soil erosion: This method is commonly practised in parts of Monsoon Asia, Java, Japan.
b. Through contour ploughing whereby the furrows in which the crops are planted create narrow and banked up terraces round hill sides.
c. By strip-cropping: This is when grasses are planted in strips, soil-binding leguminous crops and yearly cereals, all at right angles to the prevailing winds.
d. By creating hill slopes.
e. Conversion of crop land into pasture.
f. Replacing furrow with suitable crop rotation.
g. By dividing up large fields into smaller ones surrounded by hedges and walls that act as wind breakers.
h. Limiting the amount of animals on a farm to the actual holding capacity of the pasture.

IMPORTANCE OF SOIL

1. Soil provides the only medium through which agriculture is practised to provide food for man.
2. Soil serves as the source of all minerals used by man.
3. Soil provides the habitat for most organisms especially bacteria.
4. Soil provides plants with all the needed nutrients for their continuous existence.
5. Soil acts as reservoir for air and water needed by soil-living organisation to survive.
6. All vegetation types form their basis from the soil. Without soil, plants cannot get support and nutrient for growth.
7. All forms of construction works are carried out on soil.

COMPONENTS OF THE SOIL

There six (6) major constituents of a fertile soil and these include: rock particles, water minerals salts, air, humus (organic matter) and macro and micro-organisms.

ROCK PARTICLES: these include stones and gravels of different sizes. There are three (3) main types of rocks. Igneous rocks, Sedimentary rocks, and Metamorphic rocks.

ROCKS

A rock is any solid substance that forms part of the earth's crust. This solid substance may be hard, like granite or may even be soft like mud.

ROCK	MINERALS
Limestone	Quartz, feldspar, micas
Sandstone	Quartz, calcite, feldspar
Granite	Feldspar, agate
Basalt	Calcite, dolomite
Shale	Quartz, micas, feldspar

The external structure of the earth

The earth is divided into three external structures:

1. Lithosphere
2. Hydrosphere
3. Atmosphere

1. The Lithosphere

It is the solid part of the earth (land) that makes up the continents, rocks, soil and minerals. All land plants and animals are found on this layer, 25% of the entire earth is dry land, and forms the lithosphere.

2. Hydrosphere

This is the body that consists of water and includes oceans, seas, rivers, lakes, springs, streams. The aquatic (water) plants and animals are found in the water. About 75% of the earth surface is made of water.

3. Atmosphere

It is made up of gases such as oxygen, nitrogen, carbon dioxide, pure gases. The oxygen in the atmosphere is used by plants and animals for respiration.

The crust

This is the outer most layer of the earth found below the oceans and continents. It is 82 kilometres thick and consists of chemical elements such as silicon, iron, sodium, potassium.

The Mantle

i. It is found beneath the crust and it is about 2,900 km.
ii. It is made up of mainly solid rocks and forms about 67% of the mass of the earth.
iii. It is believed that the mantle is very hot with a temperature of 3,000°C.

The Core

i. It forms the centre of the earth.
ii. The centre of the core is very hot with a temperature as high as 41000°C
iii. The core is divided into two parts

The Inner Core

i. It is made up of iron and nickel

The Outer Core

i. It is made of liquid

Rocks and their Composition

A rock is a naturally occurring solid aggregate that consists of one or more mineral materials. Examples of rocks are granite, diorite, slate, conglomerate, coal and sandstone.

Many rocks comprise several minerals such as feldspar, quartz and mica. Some rocks contain only one mineral. For example, limestone contains only calcium carbonate ($CaCO_3$). Other rocks lack minerals. For example, coal and peat are formed from remains of plants and animals.

Types of rocks and their characteristics

Based on their mode of formation, rocks are classified into the following types:

Igneous Rocks

Igneous rocks are massive, shiny rocks formed from magma (molten rock) which cools and solidifies either below or above the soil level. They consist mainly of primary minerals such as quartz and feldspar. Examples of igneous rocks are gabbro, diorite, scoria, pumice, basalt, felsite, rhyolite and andesite.

Characteristics of Igneous Rocks

i. Igneous rocks are crystalline in structure.
ii. They are heavy, shiny and hard.
iii. They are fossil-free.
iv. Igneous rocks are non-stratified.
v. They are resistant to erosion and other weathering conditions.

Sedimentary Rocks

Sedimentary rocks (stratified rocks) are rocks formed when organic materials and weathered products of other pre-existing rocks accumulate and harden together into strata. The weathered products and the organic materials are called sediments.

Sedimentary rocks are composed of secondary minerals such as dolomite, gypsum, calcite and clay minerals. These rocks contain fossil or organic matter, examples of sedimentary rocks are sandstone, conglomerate, breccia, chalk, dolomite, limestone, peat and coal. Peat and coal are formed from only plant and animal remains. Thus, they are free of minerals.

Characteristics of Sedimentary rocks

i. Sedimentary rocks lie in layers (strata).
ii. They contain secondary minerals.
iii. They have lines of weakness in between the strata.
iv. They contain fossils (harden remains of prehistoric plants and animals).
v. They are susceptible to erosion and other agents of weathering.
vi. They are non-crystalline coarse or fine-grained.

Metamorphic Rocks

Metamorphic rocks are rocks formed when pre-existing rocks are transformed by intense heat and pressure. Examples are slate, schist, gneiss, marble and quartzite.

Characteristics of metamorphic rocks

i. Metamorphic rocks are dull and rough in appearance.
ii. They are non-crystalline.
iii. They are either soft or hard. For example, gneiss is hard but graphite is soft.
iv. They may contain fossil.
v. They may be foliated. That is they may occur in separable layers.

Importance or Uses of Rocks

i. Rocks weather to produce parent material which forms soil. They produce the mineral matter in soils. For example, sandstone weathers to produce sandy soils.
ii. Rocks contain plant nutrients which are released into the soil as they weather. Some rocks are used directly as fertilizers. For example, limestone is applied to add calcium or magnesium to the soil.
iii. Rocks contain useful minerals such as gold, aluminium and diamond. The minerals are mined and extracted from the rocks.
iv. They decorate the surroundings or are used to decorate the environment. For example, rocks are placed in flower beds in most roundabouts in urban centres.

v. They are quarried and used to construct roads to build houses and to cover the ground as ballast.
vi. Sedimentary rocks such as coal are used as fuel to generate electricity and to produce heat for cooking.
vii. Permeable rocks are aquifers from which groundwater is extracted as borehole and well water.
viii. Porous rocks serve as deposits of crude oil.

EXPERIMENTS TO STUDY SOIL SAMPLE

A. EXPERIMENT TO SHOW THAT AIR IS PRESENT IN GARDEN SOIL

METHOD: Fill a container with soil and pour water onto the soil.

OBSERVATION: Bubbles of air are given out from the soil particles. The bubbles are as a result of air present.

CONCLUSION: Air is present in garden soil.

B. EXPERIMENT TO SHOW THAT MICRO-ORGANISMS ARE PRESENT IN GARDEN SOIL

METHOD:

1. Fill two containers with soil, one with fresh garden soil and the other with heated garden soil.
2. Label them A and B and enclose under a bell jar with a beaker of lime water.
3. Observe after 2-3 days. Smear the edge of the bell jar with vaseline to make it air tight.

OBSERVATION: Lime water enclosed with fresh garden soil turns milky, while lime water enclosed with heated garden soil remains unchanged.

Micro organisms contained in the fresh garden soil give out carbon dioxide which turns the lime water milky.

CONCLUSION: Microorganisms are present in garden soil. Microorganism are living organism that cannot be seen with the naked eye, unless by use of an instrument called MICROSCOPE.

THE ROLE OF LIVING ORGANISMS IN THE SOIL

The role of living organisms in the soil includes:

1. They help us to clear dead bodies from the earth surfaces.
2. They help to make soil loose by burrowing holes and mixing the top soil with the sub-soil.
3. They help to enrich the soil. Examples, earthworm, bacteria
4. Termites damage crops and wooden parts of buildings.

EXPERIMENT TO COMPARE THE PROPORTIONS OF SAND AND CLAY IN SOIL (SEDIMENTATION)

METHOD: Mix up a handful of soil with water in a 500ml measuring jar and leave it to settle.

OBSERVATION: The heavy, coarse gravel and sand settle first then the silt and finally the clay. The proportion of each type of particles in the soil can be estimated by measuring the depth of earth layer and relating it to the total depth of the layers.

CONCLUSION: The proportion of sand and clay can be determined by measuring the depth of each layer, after settling.

C. EXPERIMENT TO COMPARE THE WATER AND DRY SANDY AND CLAY SOIL AND POROSITY OF CLAY AND SANDY SOIL

Place two filter funnels in the necks of two 100ml measuring cylinders. Place some dry sand soil in the filter funnel, and an equal weight of dry clay soil in the second funnel. Pour 50ml of water on to each and leave to drain through. When the water has stopped dripping through each funnel, read the level of water in the measuring cylinders.

Volume of water added to soil	= 50ml
Volume of water in jar	= X ml
Volume of water retained in soil	= 50 – Xml

Much more water will be retained by the clay than by the sandy soil, this is due that fact the clay has a higher water holding capacity than sand, because of its small air spaces.

To compare the rate of drainage (porosity) of sandy and clay soil, the apparatus mentioned above is used. Pour equal amount of water on the two sets of soil at the same time. Note the time taken for the water to drain through each.

D. EXPERIMENT TO DEMONSTRATE THE RISE OF WATER IN SOIL BY CAPILLARITY

1. Take three long, wide glass tubes and plug them at one end with glass wool. Fill each tube with soil (A) Sandy (B) Loamy and (C) Clay
2. Place them upright in a trough of water.
3. Leave the setup for some time and observe the rise of water in the three soil samples.

Observation

Water rises in all three soil samples but the one with the highest rise is clayey soil followed by loamy soil. The lowest rise is the sandy soil.

Conclusion

The highest rise in clay soil shows that it has the highest capillarity. This is because its particles have very small pore spaces.

Loamy soil has moderate capillarity because particles have moderate pore spaces.

Sandy soil has the lowest rise in water. It has the lowest capillarity because its particles are large with a lot of air spaces.

Assignment

1. List the internal structure of the earth in their correct order or layer.
2. Name the external layers of the earth.
3. a) What are rocks?
   b) Give three ways in which rocks are important to crop farmers.
4. Give the main difference between the following pairs of rocks:
   a) Igneous rocks and sedimentary rocks.
   b) Sedimentary rocks and metamorphic rocks.

APPENDIX

SAMPLE QUESTIONS AND ANSWERS

1. a) State two functions of blood.
   i. Transports oxygen from the lungs to the body tissues.
   ii. It carries digested food form the small intestines to the body tissues.
   iii. It carries carbon dioxide form the body tissues to the lungs.
   iv. It distributes heat in the body to regulate body temperature.
   v. It carries excretory produce form the body tissues to the excretory organs.
   vi. It carries hormones form the glands to target organs or tissues.
   vii. It contains white blood cells which help the body fight against disease.
   viii. It helps make the penis erect so that sexual intercourse can take place.
   ix. Platelets in blood help in blood clotting.

   b) Name two types of simple machines
   i. Lever
   ii. Pulley
   iii. Inclined plane
   iv. Gears
   v. Wedge
   vi. Wheel and axle
   vii. Screw
   viii. Screw jack

2. a) **What is Pollution**
   Is the contamination of our environment with substances that are harmful or toxic to life.
   or
   Is the release of harmful substances into the environment which can affect living things.

3. **List four examples of pollutants**
   i. Carbon dioxide
   ii. Methane
   iii. Hydrogen sulphide
   iv. Noise
   v. Dust particles
   vi. Smoke
   vii. Nitrogen dioxide
   viii. Sulphur dioxide

ix. Chlorofluorocarbon
x. Smog
xi. Excess carbon dioxide

4. A coconut of mass 800 g hangs 15m above the ground
   i. Name the type of energy possessed by the coconut

Potential energy

   ii. Calculate the value of the energy named in (i).

5. **Give one example of plants that undergo each of the following types of germination**

Rice, maize, corn, cereals, all monocots.

   i. Epigeal germination
   ii. Hypogeal germination

6. State two functions of each of the following plant structures

Root

   i. Absorbs water and dissolves mineral salts from the soil.
   ii. Holds the plant firmly into the soil.
   iii. Some serve as food storage organs.
   iv. Some roots help plants to climb.
   v. Transport/conduct water and dissolved minerals salt to the stem.

Stem

   i. Conducts water and dissolved minerals up the plant.
   ii. Conducts manufactured food from the leaves to the other parts of the plant.
   iii. Transports/conducts manufactured food from the leaves to the other parts of the plant.
   iv. Holds the leaves in an upright position to facilitate photosynthesis and transpiration.
   v. Holds the flowers in a correct position for pollination.
   vi. Some stems store food/act as food storage organs.
   vii. Green stems undergo photosynthesis.
   viii. Hold the fruits up so that dispersal occur easily occur.

Define the following terms

7. **Valency**
   i. The combining power of an element/radical.
   ii. The number of hydrogen atoms which will combine with or displace one atom of the element/radical.
   iii. The number of electrons an element will donate, accept or share.

8. **Radical**
   A group of atoms/charged particles that can exist in several compounds.

9. **State four differences between eclipse of the moon and eclipse of the sun**

Eclipse of the Sun	Eclipse of the Moon
Occurs when the moon is between the sun and the earth	Occurs when the earth is between the sun and the moon
Occurs during daytime	Occurs at night
Less frequent	More frequent
Emit dangerous rays	Does not emit dangerous rays

10. State the SI Unit of each of the following quantities

Current	-	ampere/amp
Energy	-	joule
Force	-	newton
Heat	-	joule
Mass	-	kilogram
Power	-	watt
Resistance	-	Ohms
Temperature	-	degree Fahrenheit, centigrade, Kelvin
Volume	-	cable
Weight	-	newton

SAMPLE BECE THEORY QUESTIONS AND ANSWERS

1. **Define each of the following terms**

i. Penumbra

A partial shadow/darkness that occurs during an eclipse or when an opaque substance falls in the way of an extended source of light.

ii. Satellite

A small body that revolves/moves around another body in space.
Or
A heavenly body that revolves around/orbits a larger body in space.
A celestial body orbiting the earth or another planet.

iii. Sublimation

The change of state of a substance from solid to gas without going through the intermediate liquid state.

2. **State four positive effects of Science to man**

i. It improves health.
ii. Improves transportation.
iii. Improves communication.
iv. Improves agriculture.
v. Improves sanitation.
vi. Improves educational performance.

3. **State four ways by which man's activities have caused damage to the environment**

i. Deforestation
ii. Mining
iii. Indiscriminate hunting
iv. Agricultural activities/farming
v. Bush burning
vi. Industrialization
vii. Construction of roads/buildings, etc.
viii. Pollution
ix. Overgrazing

4. **State three differences between a mixture and compound**

i. In a mixture the components can be separated by physical means, whereas in a compound components cannot be separated by physical means but by chemical means.
ii. The components of a mixture can be present in varying amounts, whereas the components of a compound are present in a fixed amount by weight.

iii. The properties of a mixture are an average of its components, whereas the properties of a compound are quite different from those of its constituent elements.
iv. No heat or light is given out or absorbed when a mixture is formed, whereas heat or light is given out or absorbed when a compound is formed
v. The substances in a mixture are physically combined whereas the constituents of a compound are chemically combined

5. **Define a balance diet**
vi. Is a food that contains all the essential food nutrients in their correct proportions.
vii. Name one element that is liquid at room temperature mercury
viii. Put the following food items below into the different classes: Butter, beans, rice, cheese, egg, ;palm kernel, cassava, milk, yam millet

6. **Name six organs of the digestive system of man**
i. Anus
ii. Oesophagus/gullet
iii. Stomach
iv. Duodenum
v. Small intestine/ileus
vi. Large intestine/colon
vii. Rectum
viii. Pancreas

7. **Name one disease caused by the deficiency of**
a) i. Iodine goitre
.ii. Protein kwashiorkor Marasmus

b). Write down the chemical formula for each of the following compounds
i. Calcium carbonate - $CaCO_3$
ii. Magnesium hydroxide - $Mg(OH)_2$
iii. Potassium sulphate - K_2SO_4

c). Balance each of the following chemical equation
i. $2Mg + O_2 \longrightarrow 2MgO$
ii. $CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$
iii. $N_2 + 3H_2 \longrightarrow 2NH_3$
iv. $2KClO_3 \longrightarrow 2KCl + 3O_2$

8. A simple machine is used to lift a load of 50 N through a distance 0.4m. The effort used is 25 N and it moves through a distance of 16m. Calculate the Mechanical advantage.

9. **State three importance of artificial satellites**
   - For communication
   - Weather forecasting
   - Studying stars and galaxies/heavenly bodies
   - Transmission of radio and television signals
   - Scientific experimentation
   - Mapping natural resources such as forests, diamonds
   - Surveying/navigation
   - For military purposes/espionage/defence
   - Space exploration
   - Agricultural purposes