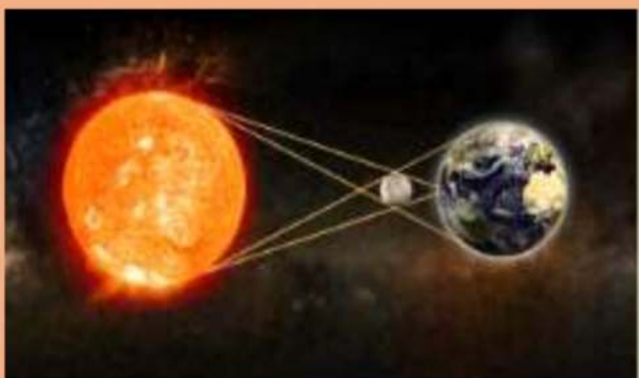
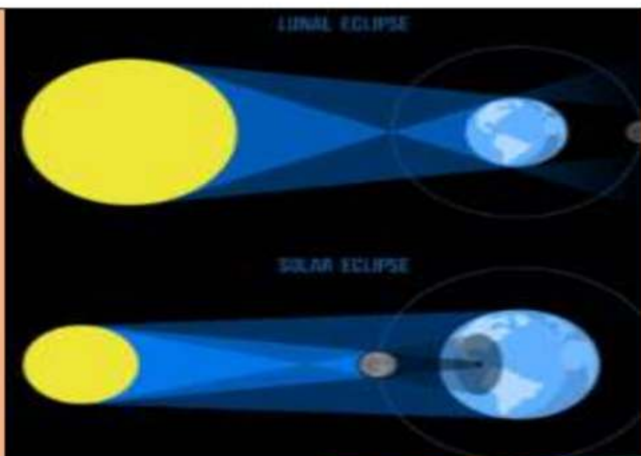
NEW LOWER SECONDARY CURRICULUM PHYSICS

LEARNERS' BOOK





S.1 AND S.2 COMPETENCE - BASED PHYSICS LEARNER'S BOOK

PROGRAMME PLANNER

SENIOR ONE	THEME	TOPIC	DURATION (NUMBER OF PERIODS)
Term 1	Introduction	Introduction to Physics	6
	Mechanics and properties of matter	Measurements in Physics	30
Term 2	Mechanics and properties of Matter	States of matter	10
	Mechanics and properties of Matter	Effects of forces	16
	Heat	Temperature measurements	10
Term 3	Heat	Heat transfer	12
	Heat	Expansion of solids, liquids, and gases	8
	Light	Nature of light; reflection of light at plane surfaces	16
SENIOR TWO	**THEME**	**TOPIC**	**DURATION (NUMBER OF PERIODS)**
Term 1	Mechanics and properties of Matter	Work, energy, and power	20
	Mechanics and properties of Matter	Turning effect of forces, centre of gravity, and stability	16
Term 2	Mechanics and properties of Matter	Pressure in solids and fluids	16
	Mechanics and properties of Matter	Mechanical properties of Materials and Hooke’s law	12
	Light	**Reflection of light at curved surfaces**	**8**
Term 3	Magnetism	Magnets and magnetic fields	10
	Electricity	Electrostatics	8
	Earth and space physics	The solar system	18
		Total	**108**

TABLE OF CONTENT

CHAPTER ONE

INTRODUCTION TO PHYSICS

LEARNING OUTCOMES

The learner should be able to;

a. Understand the meaning of physics, its branches and why it is important to study Physics.
b. Understand why it is important to follow the laboratory rules and regulations

Physics comes from a Greek word called "**physis**" which means nature.

Therefore, physics is a branch of natural science which deals with the study of matter and how it is related to energy.

Matter is anything that occupies space and has weight (mass).

Energy is the ability of the body to do work.

Branches of Physics

- Heat
- Light
- Magnetism
- Waves
- Sound
- Electricity
- Modern physics

1. **Mechanics and properties of matter:** It deals with the study of bodies in motion (dynamics) and those at rest (static).
2. **Light:** It is the form of energy that enables us to see. Materials that use light like microscopes, mirrors, periscopes, lenses, telescopes and cameras are called optical instruments.
3. **Electricity:** It is the study of charges at rest (electro statics) and charges in motion (current electricity).
4. **Magnetism**: It is the study of properties of metals that attract and repel other metals.
5. **Heat and thermodynamics**: It deals with how energy is transferred between two points depending on temperature differences between them.

6. **Modern physics**: It deals with the study of underlying process of interactions of matter, utilizing tools of science and engineering.
7. **Waves**: It deals with the study of periodic disturbances that carry energy from one point to another without permanent displacement of the medium.
8. **Earth and space physics**: it deals with the study of bodies in motion (dynamics) and those at rest (statics). This branch of physics deals with the study of solar system, moons, stars, galaxies, satellites, communication systems and the universe in general.

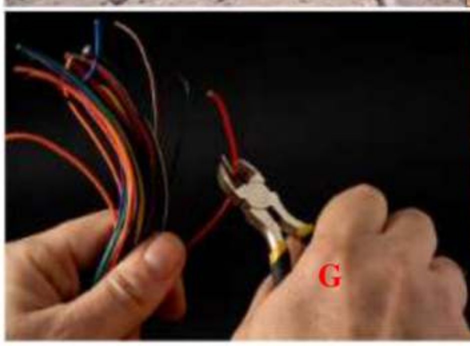
Activity 1.1

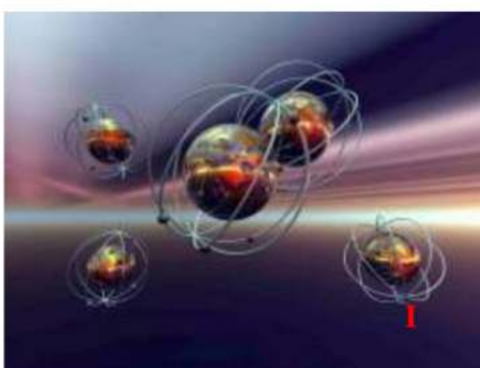
What do you want to become in future?

IMPORTANCES OF STUDYING PHYSICS (why do we study physics?)

- Physics is important for good health.eg machines like those used in hospitals to treat cancer and study the brain, broken bones and babies developing in wombs are made using the knowledge of physics.
- Physics makes communication easy. Knowledge gained from the study of physics helps to make computers, radios, television and mobile phones which all ease communication.
- Physics eases transport.eg knowledge gained from the study of physics helps to manufacture vehicles like cars, trains and aero planes.
- Physics helps us to develop experimental attitude by performing experiments.
- It helps us to understand scientific theories, principles and concepts.
- It helps us to prepare for further studies for example at university and institutions of higher learning which train different courses such as engineering and surveying.
- Physics helps us to explain the occurrence of certain phenomena e.g. lightning

Activity 1.2 *Demonstration of the branches of physics*






K

L


M

Identify the branch of Physics shown in each of the pictures above

THE PHYSICS LABORATORY

A laboratory is a room or part of a room where scientific experiments are carried out.

Apparatus is the equipment or tool needed for a particular scientific experiment.

Experiment is the step by step process undertaken to make a discovery, test, a proposal, law, theory or demonstrate a known fact.

RULES AND REGULATIONS OF THE PHYSICS LABORATORY

1. Do not enter in the laboratory with open shoes or with no shoes (bare footed).
2. Do not eat or drink anything in the laboratory.
3. Do not run while in the laboratory because you may break some apparatus.
4. Do not carry food or drink in the laboratory.
5. Do not enter in the laboratory without permission from the teacher or laboratory assistant or technician.
6. In case of any accident or injury, report it to the teacher or any other person responsible or around.
7. Do the experiment only given to you by the instructor or teacher

IMPORTANCES OF THE LABORATORY RULES AND REGULATIONS

- They help us to avoid accidents when in the laboratory.
- They help us not to break the apparatus or materials in the laboratory.
- They help us to avoid some diseases by not drinking or eating anything from or in the laboratory.

APPARATUS AND THEIR USES

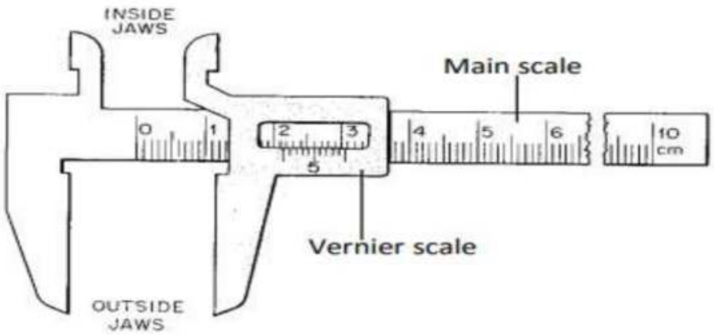
1. Metre rule

It measures short length like length or width of a table, height of a person

2. Tape measure

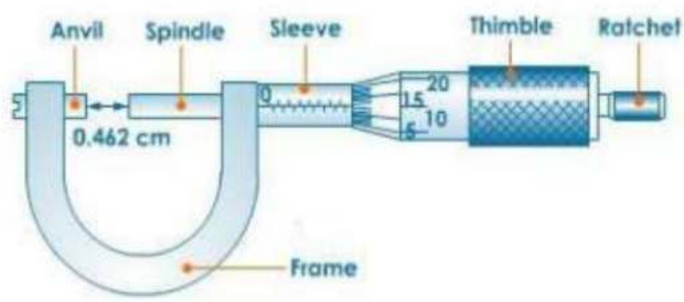
It measures long distances such as length of a football pitch, width of a classroom

3. Vernier caliper



It measures accurately small or short length such as diameter of a test tube, length or width of a glass block.

4. Micrometer screw gauge



It measures accurately very small length such as thickness of a wire, diameter of beads and thickness of a paper or glass tube or metre rule.

5. Pipette

It is used to transfer a measured volume of the liquid from one container to another.

6. Ammeter

It measures current in the electric circuit.

7. Voltmeter:

It measures voltage between two points in the electric circuit.

8. Stop clock or stop watch

It measures time.

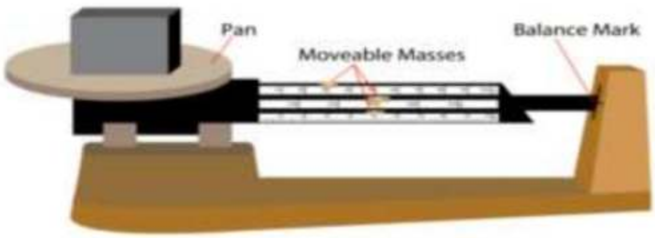
9. Tripod stand

It is used to support and hold items during heating

10. Burette

It measures volume of the liquid.

11. Triple beam balance



It used to measure the mass of the object like stone or metre rule.

12. Bunsen burner

It is used for heating during sterilization and combustion.

13. Spring balance

It measures mass and weight of an object.

14. Laboratory thermometer

It measures the temperature of the body such as temperature of water.

15. Retort stand

It is used to hold apparatus like thermometer or burette

CHAPTER 2
MEASUREMENTS IN PHYSICS

LEARNING OUTCOMES

The learner should be able to:

a. understand how to estimate and measure physical quantities: length, area, volume, mass, and time
b. explain how they choose the right measuring instrument and units; explain how to use the instruments to ensure accuracy
c. appreciate that the accuracy of measurements may be improved by making several measurements and taking an average value
d. identify potential sources of error in measurement and devise strategies to minimize them
e. understand the scientific method and explain the steps used in relation to the study of physics
f. know that practical investigations involve a 'fair test', analysis, prediction and justification of results, and observations, and apply learning in practice
g. record data in graphs and charts and look for trends
h. understand and be able to use scientific notation and significant figures

Physics is concerned with measurement of physical quantities and grouping them into group or categories according to their nature.
To measure is to find the value of a physical quantity using a scientific instrument with a standard scale.

Physical Quantities
It is a physical property that can accurately be measured.

TYPES OF PHYSICAL QUANTITIES

- Fundamental quantities
- Derived quantities

Fundamental quantities

These are physical quantities which cannot be got from other quantities.

Quantity	S.I unit	symbol
Length (distance)	metre	m
Time	second	s
Mass	kilogram	Kg
Thermodynamic temperature	kelvin	K
Amount of substance	mole	Mol
Electric current	ampere	A

NB: S.I means the international way of standard unit (system internationalle)

Derived quantities.

These are physical quantities which can be got from other quantities

Examples include;

- Volume
- Area
- Speed
- Force
- Momentum
- Moment

LENGTH

Is the distance between any two points or

Is the space between two points or

Is the distance moved by matter.

The S.I unit of length is metre (m)
Other units of length include;
Cm, Dm, dm, mm, Hm, Km

CONVERSIONS OF UNITS OF LENGTH

Activity 2.1
Convert the following;

- 200cm to Km
- 0.6145dm to dm
- 1000m to mm

GROUP ACTIVITY 2.1

In a groups of 5-10 pupils, visit the laboratory and measure your heights and record your results in a suitable table including values which are in; m, cm, Km. present the work to the rest of the class members.

TIME

Is the interval between two events or

Is the duration between two events.

The S.I unit of time is second (s).

Other units of time include;

- Years
- Centuries
- Weeks
- Microsecond
- Minute
- Hour
- Days

Instruments used to determine time

- Stop clock
- Stop watch
- Shadows
- Half- life of a radioactive substance

Conversion of units of time

Convert the following;

- ✓ 5 days to hours
- ✓ 18 months to years
- ✓ 170 minutes to hours
- ✓ 106 seconds to minutes.

MASS

Is the quantity of matter in a substance
The S.I unit of mass is kilogram **(Kg)**
Other units of mass include;

- Grams
- Milligrams
- Decagram
- Hectogram

Instruments used to measure mass

- Triple beam balance
- Lever beam balance
- Spring balance
- Weighing beam balance
- Digital beam balance

Conversion of units of mass

Activity 2.2

Convert the following;

a) 500g to kg
b) 5 tonnes to Kg
c) 120kg to g
d) 1600mg to g

NB. 1 tonne =1000Kg

AREA

Is the measure of size of the surface

The S.I unit of area is square metre (m^2).

Other units of area include;

- Km^2
- cm^2
- Dm^2
- dm^2

CONVERSION OF UNITS OF AREA

Activity 2.2

Convert the following;

a) $40m^2$ to cm^2
b) $5km^2$ to Dm^2
c) $500cm^2$ to mm^2
d) $7.5m^2$ to cm^2
e) $940mm^2$ to cm^2
f) $12000mm^2$ to m^2

TYPES OF AREA

- Cross sectional area
- Surface area

QUESTION

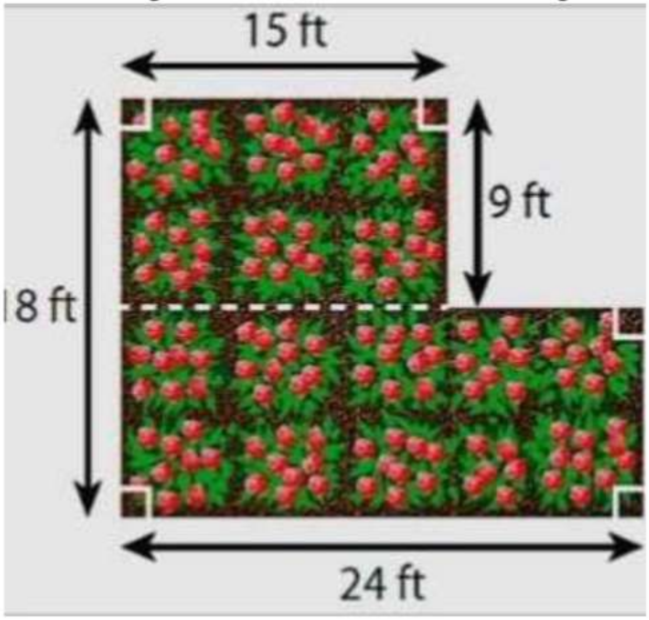
Distinguish between the types of area

Response: cross sectional area is the area you get when you cut straight through an object while surface area is the area of the exposed surface of a particular object.

AREA OF REGULAR OBJECT

Activity

From the figure below, find the area of the garden

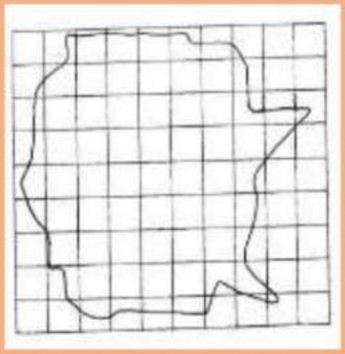


AREA OF IRREGULAR OBJECTS

Area = No of complete squares + $\frac{No\ of\ incomplete\ squares}{2}$

ACTIVITY

From the figure, find its area



Check point

Find the area of the figure below
(**NOTE**: Any irregular shape)

GROUP ACTIVITY 2.2

In groups, trace the foot of one member on a graph paper and determine the area of the foot.

VOLUME

Is the amount of space occupied by an object.
The S.I unit of volume is cubic metre (m^3).
Other units of volume include;

- ✓ dm^3
- ✓ Km^3
- ✓ mm^3

1 litre = 1000ml

Activity 2.3

- 37ml to cm^3
- $50m^3$ to litres (ANS 50,000litres)
- 3.5 litres to cm^3 (ANS $3500cm^3$)
- $15Km^3$ to m^3 (ANS $15,000,000,000m^3$)
- $2cm^3$ to m^3 (ANS $0.000002m^3$)

PRACTICAL ACTIVITY

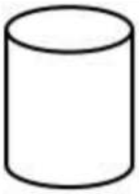
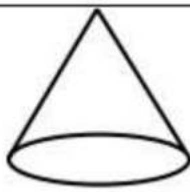
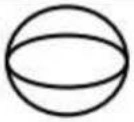
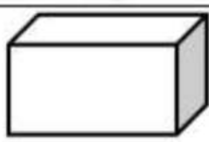
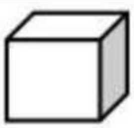
Identify and name each of the following instruments used for measuring the volume of liquids and suggest the maximum volume for each of the instrument.
(A-dropper, B-syringe, C-pipette, D-burette, E-cup, F-conical flask, G-beaker, H-measuring cylinder, I-jerry can)

VOLUME OF REGULAR OBJECTS

GROUP ACTIVITY

In groups, measure and record the length l, width w and height h of a brick or a wooden block, using the formula **V=l x w x h**, find the volume in;

i. Cm^3
ii. m^3
iii. Km^3

Figure	Name	Formula for Volume
1. 	Cylinder	$V = \pi r^2 h$
 2.	Circular cone	$V = \frac{1}{3}(\pi r^2)h$
3. 	Sphere	$V = \frac{4}{3}\pi r^3$
4. 	Cuboid	$V = lwh$
5. 	Cube (All faces are equal)	$V = S^3$

<u>VOLUME OF IRREGULAR OBJECTS</u>

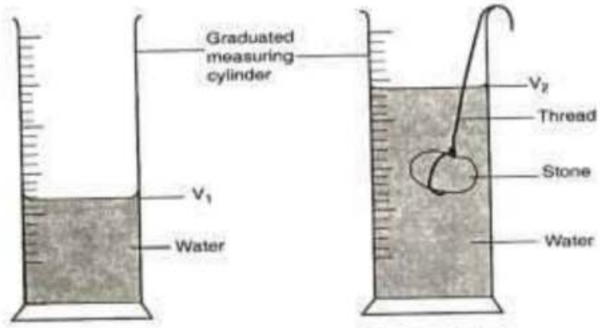
Group Assignment

You are provided with the following;

- Stone
- Measuring cylinder
- Water
- Thread

Design the procedures or steps you can follow to measure the volume of the stone. Following the procedures you have designed, carryout an experiment to measure the volume of an irregular object (stone). Record your findings and observations. **(DISPLACEMENT METHOD IS EXPECTED)**

Solution



(a) Before placing stone
(b) After placing stone

Procedures

- Pour water into the measuring cylinder up to a certain volume, V_1
- Gently lower the stone tied on the thread into the water in the measuring cylinder. Read and read the new volume of water, V_2
- Obtain the volume of the stone, V from the formula $V=V_2-V_1$

NOTE: This method is called displacement method

DETERMINING THE VOLUME OF AN IRREGULAR OBJECT USING OVER FLOW CAN METHOD

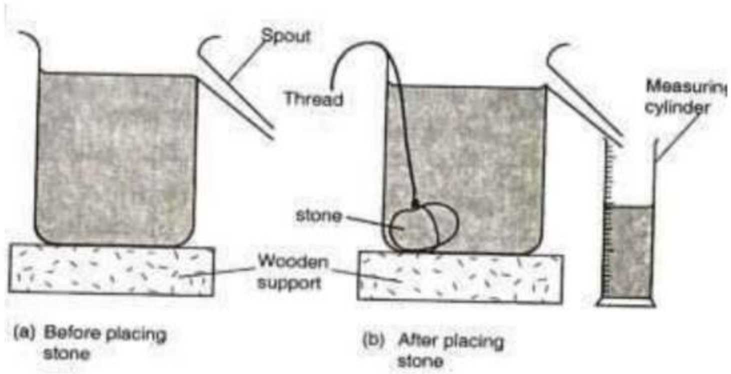
Group Assignment

You are provided with the following;

- Measuring cylinder
- Water
- A stone
- Thread
- Over flow can (Eureka Can)

Design steps or procedures you can follow to measure or determine the volume of a stone. Following the steps you have designed, carry out an experiment to determine the volume of the stone using the above materials or apparatus. Record your findings and observations.

AN EXPERIMENT TO DETERNIME THE VOLUME OF AN IRREGULAR OBJECT USING OVER FLOW CAN



Procedures

- Pour water in the overflow can until it starts to drip through the spout.
- Wait until no more drops drip
- Tie the thread on an irregular object
- Gently lower the stone using the thread into the water in the overflow can
- Read and record the volume of the displaced water that has been collected in the measuring cylinder.
  - Volume of the stone = volume of the displaced water (volume of water collected in the measuring cylinder)

SCIENTIFIC NOTATION AND SIGNIFICANT FIGURES

Decimal places refer to how many digits appear after a decimal point but significant figures actually vary depending on a number of rules.

RULES OF FINDING SIGNIFICANT FIGURES

- Any digit that is not a zero is significant, that is all numbers from 1 to 9.

Example

2453 (4 SF)

- All zeros occurring between non zero digits are significant

Example

402 (3 SF)

- Zeros to the left of the first non-zero digit are not significant. Such zeros are called leading zeros.

Example

0.000072 (2 SF)

0.00345 (3 SF)

- For numbers with decimal points, all zeros to the right of a non-zero digit are significant. (such zeros are called trailing zeros)

Example

0.5000 (4SF)

54.100 (5 SF)

- For numbers without decimal points (whole numbers), trailing zeros are not significant but place holders.

Example

400 (1 SF)

530100 (4 SF)

28021000 (5 SF)

RULES OF ROUNDING OFF NUMBERS

If the digit to be dropped is 5 or greater than 5, the preceding digit is raised by 1.

For example

3.4533 is rounded off to 3.5 (1dp)

If the digit to be dropped is less than 5, the preceding digit is left unchanged.
For example

3.444 is rounded off to 3.4 (1dp)

MANIPULATION OF NUMBERS

When multiplying or dividing numbers with differing significant figures, the result takes the lower number of significant figures used in obtaining the result.

Example

3.0 (2SF) X 456 (3 SF) =1400 (2SF)

3.5640 (5SF) ÷ 0.006010 (4 SF) = 593.0 (4 SF)

When adding or subtracting numbers with differing decimal places, the result takes the lower number of decimal point.

Example

2.45 (2dp) +5 (no dp) =7 (no dp)

5.2 (1dp) -1.345 (3dp) =3.9 (1dp)

ACTIVITY 1

a) 5.600 X 12
b) 0.56 ÷ 194.0
c) 5.6 X10^{-2} X3.464
d) 6 – 5.691
e) 9.3040 + 10.2

ACTIVITY 2.3

Find the area of a rectangle with dimensions of 3.42m by 1.645m

GROUP ACTIVITY 2.3

You are provided with the following;

- Metre rule
- Stop clock

In group of 5, let the members be learners A, B, C, D, E

1. Obtain the height, h of each learner and record the values in cm and m in the following table.

LEARNER	h (cm)	h (m)
A		
B		
C		
D		
E		

2. How many significant figures is the height of each learner in metre

LEARNER	A	B	C	D	E
No OF SF					

3. Determine the speed of, V of each learner using V = $\frac{s}{t}$

SCIENTIFIC NOTATION

Is the method used to express very large and very small numbers?

It is written as $mx10^n$ where m is any number from 1 to 9 and **n** is an integer.

Activity

1. Write the following in standard form or scientific notation

   a) 40000
   b) 0.0000945
   c) 2800000
   d) 7.40mm
   e) $\frac{1}{4}$

2. Why would you express a number in scientific notation?

SCIENTIFIC METHOD

This is the process for experimentation that is used to explore (discover) observations and answer questions.

Steps involved in doing scientific method

Question

Assume you wanted to use your motor bike but it fails, carry out the scientific method to investigate the cause

Observation

The motor bike is not working or starting

Question

Why is the motor bike not starting?

Theory

Maybe fuel is used up.

Prediction

Putting fuel in the tank will make it to start.

Experiment

Open the fuel tank and refuel the bike and kick start again

Data analysis

The motor bike starts

Conclusion

The motor bike failed to start because fuel was used up

NB: If it starts, then it was because of fuel that the bike failed to start

If it fails to start, you may develop another theory to answer your question or solve the problem. For example maybe the motor bike is not starting because the engine has a fault.

ACTIVITY 1 (Group work)

You are provided with the following;

- A calculator that cannot display figures
- Calculator battery

Following the steps, investigate the reason why the calculator is not functioning.

ACTIVITY 2 (Individual)

You are provided with the following;

- A pen that does not write
- Ink pot

Carryout an investigation to analyze why the pen is not writing of functioning.

ACTIVITY 3 (Group work)

Tr. **Clese Wiston** who teaches physics entered in S.1 class very early in the morning when the classroom was full of darkness. He instructed the class councilor to switch on the bulb to kill darkness in the classroom, to his surprise and surprise of the learners, the bulb did not light up, using the knowledge of scientific method, investigate why the bulb did not light up?

DENSITY

Density is the quantity of matter contained in a cubic metre of a substance

Density is represented by a Greek letter ρ (rho)

The S.I unit is Kilogram per cubic metre (Kgm^{-3})

Other units include; gcm^{-3}

ACTIVITY

1. A body has a mass of 9Kg and occupies a volume of $1X10^{-2}m^3$. Calculate its density, ρ

2. A body has a density of $18Kgm^{-3}$ and a volume of $6m^3$. Determine its mass.

Uses of density

- ✓ Density is used in different ways as follows;
- ✓ Identify materials
- ✓ Determine the purity of a material
- ✓ Find the volume or mass of a substance

Measurement of density

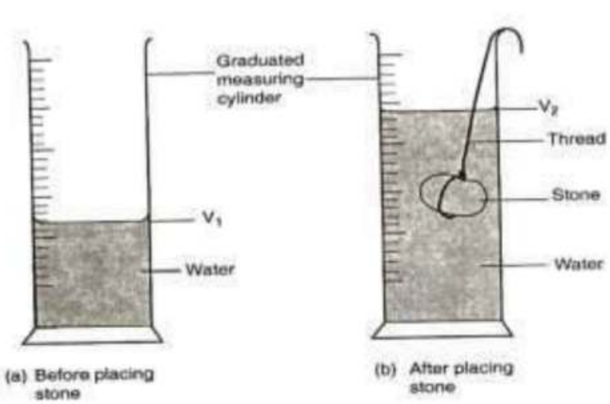
Measuring density of Liquids

Procedures

- Measure the mass, m_1 of the clean dry beaker using the weighing scale
- Measure a known volume, V of a liquid using a measuring cylinder and transfer it to the beaker.
- Measure the mass m_2 of the beaker with the liquid
- Calculate the mass of the liquid from $m=m_2-m_1$
- Therefore the density of the liquid can be got from;

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

Density of irregular objects



PROCEDURES

- ➢ Partly fill the measuring cylinder with water and note its volume V_1.
- ➢ Tie a thread on an irregular object of known mass, m
- ➢ Gently lower the irregular object in the measuring cylinder and note the new level of water V_2
- ➢ The volume of an irregular object is calculated from $V=V_2-V_1$
- ➢ The density of an irregular object is got from;
  Density = $\frac{mass}{volume}$

GROUP ACTIVITY

In groups, measure and record the mass of a wooden block.
Find its volume and density.

DENSITY OF SOME MATERIALS

Material	Density
Aluminium	2700
Glass	2600
Steel	7800
Sand	1442
Copper	8900
Polythene	910
Wood	600
Oil	900
Water	1000
Mercury	13600
Lead	11300
Iron	47860
Ice	920
Silver	1050

Factors affecting density

- **Temperature**

When the temperature of the substance increases, the density of the substance reduces. This is because as the temperatures increase, the volume of the substance also increases but the mass remains constant.

- **Pressure.**

It only affects the density of the gas

When the pressure of a given gas is increased, the gas molecules become squeezed or contract and occupy a smaller volume. This increases the density of the gas.

- **Concentration of atoms.**

In some materials, atoms are closely packed like in solids thus a material made of atoms of a lower atomic number is heavier than a material of a higher atomic number. This is because atoms are larger and spread apart more and hence a smaller volume.

- **Change of state.**

When a substance changes its state, its volume changes but its mass remains constant. This makes the density of a substance to change.

DENSITY OF MIXTURES

A mixture is obtained by putting together two or more substances that do not react with one another.

Density of mixture = $\frac{mass\ of\ mixture}{volume\ of\ mixture}$

Examples

- $100cm^3$ Of fresh water of density $1.0gcm^{-3}$ is mixed with $100cm^3$ of sea water of density $1.03gcm^{-3}$.calculate the density of the mixture. ($1.015gcm\text{-}^{3}$)
- $0.4m^3$ of liquid Y of density $900Kgm^{-3}$ is mixed with $0.35m^3$ of liquid Z of density $800Kgm^{-3}$. Calculate the density of the mixture.

OCEAN CURRENTS AND WATER DENSITY

An ocean current is a continuous directed horizontal movement of the sea water from one region to another. Ocean currents can be generated by wind.

Density differences in sea water

It is caused by temperature and salinity changes (variation in water)

NOTE: Salinity is the concentration of salt in a solution (substance).

Practical work.

You are provided with the following;

- Fresh egg
- Salt
- Clean water
- Beaker

Steps

- Put a fresh egg in a beaker containing clean water.
- State the observation.
  (The egg moves to the bottom of the beaker)
- Add salt to the clean water in the beaker and mix such that water becomes salty.
- What happen to the egg? Give a reason for that observation. *(The egg moves from the bottom and settles in the water. This is because the density of the salty water is higher than the density of the clean water which makes an egg to move up in water)*

1. You are provided with the following;

   - Small wooden block
   - Bowl
   - Salt
   - Water

Steps

- Put some water in the bowl
- Float a block of wood in it.
- Make a mark on the piece of wood where the water level is.
- Make some salt water **(sea water)** by dissolving **(mixing)** some salt in water. Use quite a lot of salt.
- Float the same block of wood in your salty water.
- Mark the water level on the wood
- Were the two levels the same? Give a reason**.** *(No, the wood floats higher in a sea water than in fresh water. This is because the density of the salty water or sea water is higher than that of the fresh water. The salt particles when mixed with water particles make it denser)*

REVISION QUESTIONS

1. Distinguish between sinking and floating

2. Why is it easier for objects to float in the sea water than in the fresh water?

3. Explain why some objects sink in water while others float?

CHAPTER 3
STATES OF MATTER

LEARNING OUTCOMES
The learner should be able to:

a. understand the meaning of matter
b. understand that atoms are the building blocks from which all matter is made; appreciate that the states of matter have different properties
c. apply the particle theory to explain diffusion and Brownian motion and their applications
d. understand how the particle theory of matter explains the properties of solids, liquids and gases, changes of state, and diffusion
e. understand the meaning and importance of plasma in physics

Matter is anything that occupies space and has weight.

Types of states of matter

- Solids
- Liquids
- Gases
- Plasma

Activity

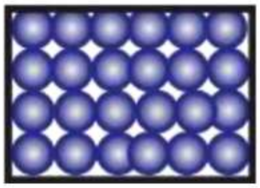
1. Copy the following table and give two examples of the items that exist in each of the states of matter.

State of matter	Examples
Solids	
Liquids	
Gases	
Plasma	

2. State what the above items have in common
3. Identify the items with definite shape

Solids

This is the state of matter where molecules are in regular patterns, held firmly in place but can vibrate within a limited area.

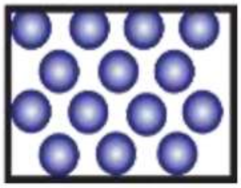


Properties of solids

- They cannot move
- The molecules are closely packed
- The inter-molecular forces of attraction between the molecules are very strong.
- They have definite shape
- They keep their shape unless forces act on them

Liquids

This is the state of matter where molecules flow easily around one another.

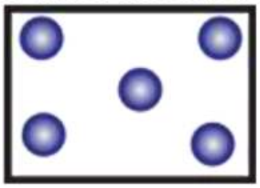


Properties of liquids

- Molecules are loosely packed
- The inter-molecular forces of attraction between the molecules are weak.
- They don't have definite shape (they take the shape of the container)
- They can flow
- They have irregular pattern
- They cannot be compressed

Gases

This is the state of matter where molecules move randomly throughout the container



Properties of gases

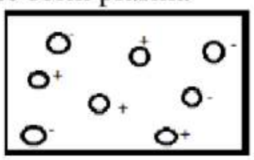
- Molecules are very loosely packed

- The inter molecular forces of attraction between the molecules are very weak are very weak
- They don't have definite shape.
- They can easily be compressed (they can change volume when squeezed)

Plasma

This is an ionized gas that is formed when very high temperatures make atoms of the gas lose their electrons and become electrified

Electrons and nuclei mix to form plasma



Properties of plasma

1. It is an ionized gas
2. It does not have definite shape
3. Particles are very loosely packed

Note: -Plasma is formed when a gas is exposed to very high or extremely high temperatures e.g. around the sun.

-Plasma is more or less a gas

Importance of plasma.

a. It helps in welding of metals
b. It is used in televisions
c. Fire flames are used to cook food and other heating purposes

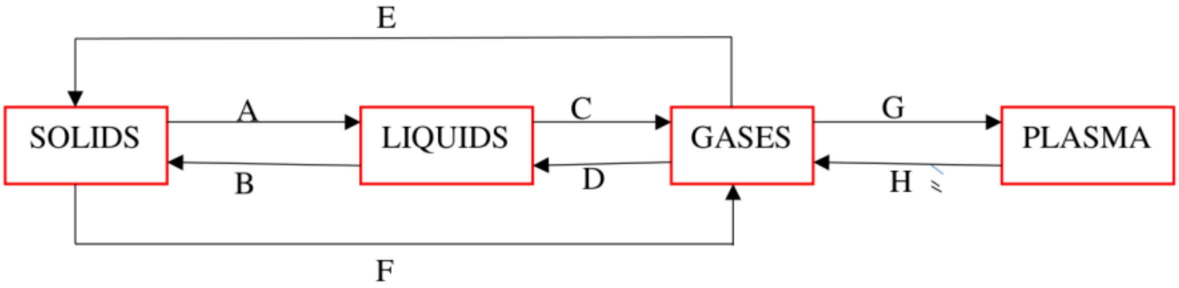
Changes of states of matter

When the temperature of matter changes, the state of matter also changes.

: Explain why ice melts to liquid when it is placed under sunshine.

This is because that the sun rays from the sun heats up the ice causing the molecules of ice to gain kinetic energy thus increasing their speeds. This causes them to vibrate more violently thus breaking or weakening the intermolecular forces between them hence causing ice to melt to liquid.

In groups, State the processes that take place for the following Changes of the states of matter



(ANS: A-Melting, B-Freezing, C-evaporation, D-Condensation, E-De-Sublimation, F-Sublimation, G-ionization, H-de ionization)

b) Name the condition for plasma state to be formed.

(ANS: Extremely high temperatures)

Activity **To investigate composition of matter**

(Work in pairs)

Materials: a piece of chalk, a piece of paper

Steps

1. Get a piece of chalk and a piece of paper.
2. Let one of you break the chalk and continue breaking until you cannot break it any further. What do you notice about the initial piece and the final particle in terms of size? Is the smallest size you have obtained the smallest possible?
3. Let your partner get the piece of paper and cut it into two halves.
4. Continue cutting the paper into smaller pieces until you cannot cut it anymore.
5. Discuss your observations in step 2 and 4 with your colleagues.
6. Discuss with your colleague what you remember about an element, compound and mixture from what you learnt in primary 4.

The smallest particle of matter that cannot be broken down further by physical means is called an atom. An atom is the smallest particle of matter that can take part in a chemical reaction. There are other smaller sub-atomic particles that are covered in other units.

Matter can be made of particles (atoms) of the same kind or a group of particles of different kinds.

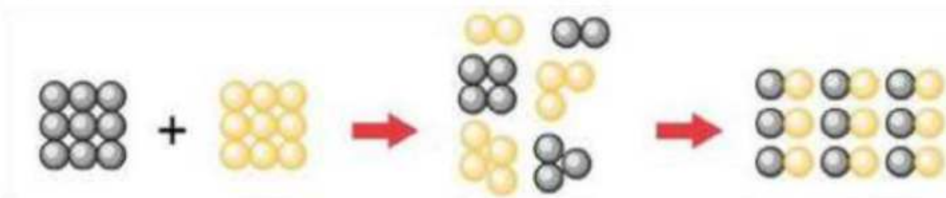
Matter is made of an **element**, **mixture or a compound.**

An element is a substance which cannot be split into a simpler substance. In other words, all the atoms in a substance have the same identity that substance is called an element e.g. copper, graphite in pencil (carbon).

A compound is a substance made of two or more elements combined together in a fixed proportion. E.g. water is made up of oxygen and hydrogen, table salt is made of sodium and chloride, chalk is made up of calcium carbonate, that is, calcium, oxygen, and carbon.

A mixture is a material made up of two or more substances that can easily be separated by physical means. E.g. salt and sand, iron and Sulphur.

Fig 1.1 illustrates the difference between a compound, an element and a mixture.



Atoms of iron | Atoms of sulphur | Mixture of iron and sulphur | Compound of iron sulphide

GROUP ACTIVITY

You are provided with the following

- Syringe
- Water
- Beaker

Steps

a) Take the piston and pull the piston outwards
b) Block the nozzle of the syringe using the thumb
c) Push the piston inwards, release the piston and record its position.
d) Repeat procedures using water
e) State your observation

(In case of air or gas, the piston can be pushed to some distance whereas in case of water, the piston does not move. this proves that gases are compressible whereas liquids are not or are less compressible compared to gases)

RESEACH WORK. You are required to visit the Google on www.youtube.com and watch videos about the states of matter. Go ahead and make notes about the videos you have watched.

THE PARTICLE THEORY OF MATTER

When a perfume is sprayed in one corner, it is smelt in the other corner because the particles of the perfume have moved from one point to the other. This shows that matter is made of particles that are constantly moving. If matter particles were not moving, then there could be nothing that could move about and mix with the water. The movement of these tiny particles is summed up in a model called the kinetic theory of matter.

THE KINETIC THEORY OF MATTER

The word kinetic is derived from the Greek word "*kineo*" which means "I move". Particles in substance are in constant motion; they possess kinetic energy, which is the energy due to movement. Therefore, kinetic theory of matter states that matter is made up of tiny particles that are continuously in random motion.

When a fast moving particle collides with a slower moving particle, it transfers some of its energy to the latter, increasing the speed of that particle. If that particle collides with another particle that is moving faster, its speed will be increased even more. But if it then hits a slow moving particle, then it will speed up the third particle while its speed decreases.

The theory explains how particles are packed in solids, liquids or gasses; the attractive forces between them; and the effect of temperature on them. The arrangement of particles in matter and the way they move determines the state of a substance, i.e. whether to be in solid, liquid or gaseous state.

The kinetic theory makes the following assumptions;

i. By observing how particles behave in water and smoke, scientists developed a model to identify decomposition of matter.
ii. The particle theory of matter states that all matter is made of extremely tiny particles called atoms.
iii. Each pure substance has its own kind of particles which are different from the particles of other pure substances.
iv. Particles of matter attract each other
v. Particles are always moving or vibrating at fixed positions.
vi. Particles at a higher temperature move or vibrate faster on average than particles at a lower temperature.

<u>Importance of the changes of state of matter</u>

1) Drying clothes and harvested crop yields under a process called evaporation.
2) Transpiration which helps in rain formation
3) Making ice cream where freezing is used
4) Disappearing of dew from grass due to evaporation.

Activity

Given clean water, freezer, heat source, how can you make use of the changes of state of matter on a hot day to earn some income.

State the process for the following importance of the changes of states of matter

1. Drying clothes-Evaporation

2. Making ice cream-Freezing
3. Formation of rainfall-Condensation
4. Formation of fire flames for cooking-Ionization
5. Drying coffee seeds-Evaporation
6. Making candles for lighting-Freezing

GROUP ACTIVITY

You are provided with the following;

- Clean water
- Freezer
- Colored sweet flour (jolly jus)
- Plastic cups

Make use of changes of states of matter and explain how you can earn an income in a desert area.

DIFFUSION

Activity

Investigating diffusion in liquids

Materials

- Source of heat
- Two glass beakers
- Toilet tissue
- Two pieces of thread
- Tea leaves

Procedures

- Pour some water in each of the glass beakers
- Heat the water in one of the beaker until it's about to boil.
- Place one tea spoon of teal leaves in each of the two pieces of toilet tissues.
- Wrap the tea leaves in the toilet tissue and tie them using a thread.
- Put a tea bag in each beaker at the same time and observe what happens.
- State the observation and conclusion

(The tea leaves in a beaker containing hot water spread to the water quickly while the beaker containing cold water spread slowly, conclusion: diffusion is faster at higher temperatures) State the factors that affect the rate of diffusion.

Temperature: Diffusion increases as temperatures increase. This is because the molecules drift or diffuse at a faster speed when temperatures are high than when temperatures are lower.

Size of the diffusing molecules: Small and lighter sized molecules diffuse faster than the bigger and heavier sized molecules.

State of the substance: Diffusion is fastest in gases and slowest in solids. This is because the speed of molecules in gases is higher than that in solids

NOTE: **Diffusion** is the process where the molecules of a fluid move from a region of higher concentration to a region of lower concentration.

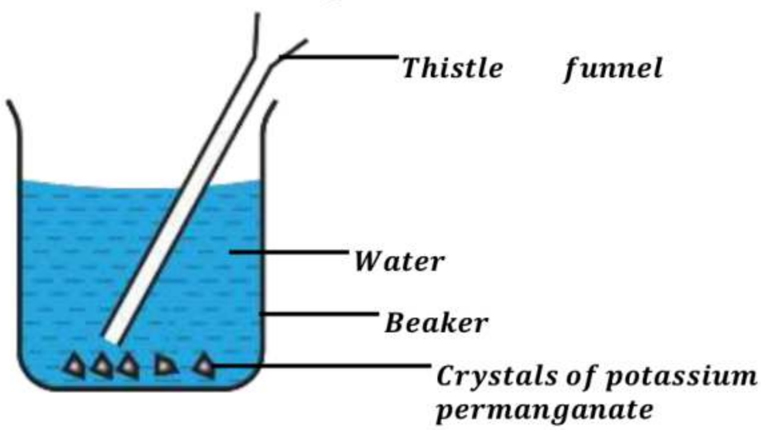
ACTIVITY

Materials

- Copper II sulphate crystals (blue in color)
- Beaker
- Water

In groups, design procedures you can follow to show diffusion in liquids.
Following the designed procedures, carry out an experiment to show diffusion

EXPERIMENT TO SHOW DIFFUSION IN LIQUIDS



Procedures

Water is placed in a clean beaker
Crystals of potassium permanganate are then placed at the bottom of the trough using a drinking straw or a thistle funnel

Observation

The crystals of potassium permanganate dissolve and
Spread throughout the water forming a purple solution.

Conclusion

This means that potassium permanganate has diffused through the water in the glass trough.

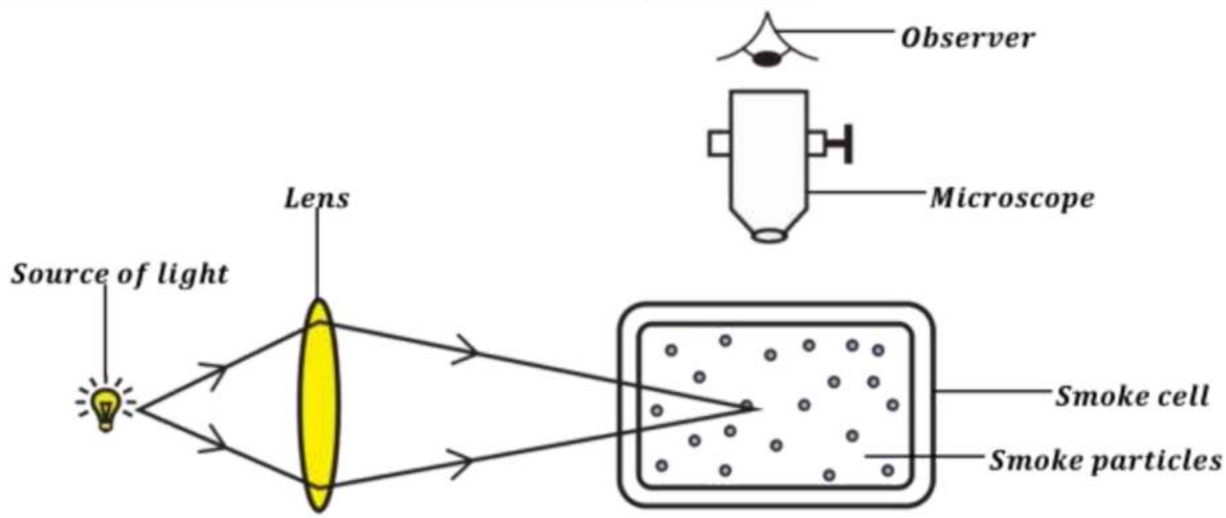
Brownian motion

This is the continuous or constant random movement of tiny particles in fluids.

Procedures

- Smoke is placed in a smoke cell and illuminated with light.
- The smoke particles are then observed from above using a microscope.

An experiment to demonstrate Brownian motion using a smoke cell



Observation

White specks (small particles) are seen in a constant random motion

Factors that affect Brownian motion

Temperature: When the temperature of the smoke cell is increased, small particles are seen moving faster and when the temperature is reduced, they are seen moving slowly.

Size of the particles: When the size of the particles is increased, Brownian motion is reduced and when the size of the particles is decreased, Brownian motion is increased.

Chapter summary

In this chapter, you have learnt that;

- Matter is anything that occupies space and has weight
- There are four states of matter i.e. solids, liquids, gases and plasma
- Matter is composed of very small particles (tiny) that are in continuous motion or vibration
- Plasma is an electrified gas – like state of matter
- Particles are more closely packed in solids than in liquids and gases.
- Diffusion is mostly affected by temperature and that it is the movement of particles from a region of higher concentration to a region of lower concentration.
- The particles in matter are in a state of continuous random motion that can be demonstrated by Brownian motion.
- Diffusion is faster in gases than in liquids and least in solids.

CHAPTER FOUR
EFEECT OF FORCES

LEARNING OUTCOMES

The learner should be to;

a. know that a force is a push or a pull and that the unit of force is the Newton
b. know the effects of balanced and unbalanced forces on objects
c. understand the existence of the force of gravity and distinguish between mass and weight
d. appreciate that the weight of a body depends on the size of the force of gravity acting upon it
e. Understand the concept of friction in everyday life contexts.
f. understand the meaning of adhesion and cohesion as forms of molecular forces
g. explain surface tension and capillarity in terms of adhesion and cohesion and their application

Key item What is a force?
Activity

Demonstration of force

Steps

i. Push a table away from you
ii. Pull the same table towards you.
iii. What happens to the position of the table in both cases?

Activity **To demonstrate the effect of a force on objects**

Materials

- A chart showing the different pictures

Steps

1. Look at the pictures in Fig 2.4.
2. Identify the effects of forces shown in the figures.

Cars colliding

Catching a moving ball

A girl sitting on a balloon

Spiking the ball

3. Discuss other cases where the affects you have identified in step 1 are also experienced
4. What do you think will happen if the amount of force in each picture was increased?

key point

Force is a pull or push that changes or tends to change a body's state of rest
Its S.I unit is **newton (N)**

Activity

Materials

- Rubber band
- Spiral spring
- Small stone
- Smooth mass
- Table
- Magnet
- Small pieces of paper
- A ruler
- A razor blade

Procedures

In groups, place a small block on a table and push or pull it.

i. Slide a smooth mass on a table
ii. Of the block and smooth mass, which one moved more easily?
iii. What could be the reason for that?
iv. Attach a small rubber band from its free end and let the small stone stay freely in the space.
v. What happens to the length of the rubber band?
vi. Slowly, swing a stone in a circle using a rubber band. Swing the stone faster.
vii. What happens to the length of the rubber band?

Stretch or compress the spiral spring at its ends. Explain what happens to the length of the spiral spring in either case?

Hold the razor blade in one hand and a piece of magnet in another hand. Try to bring them together and state what happens?

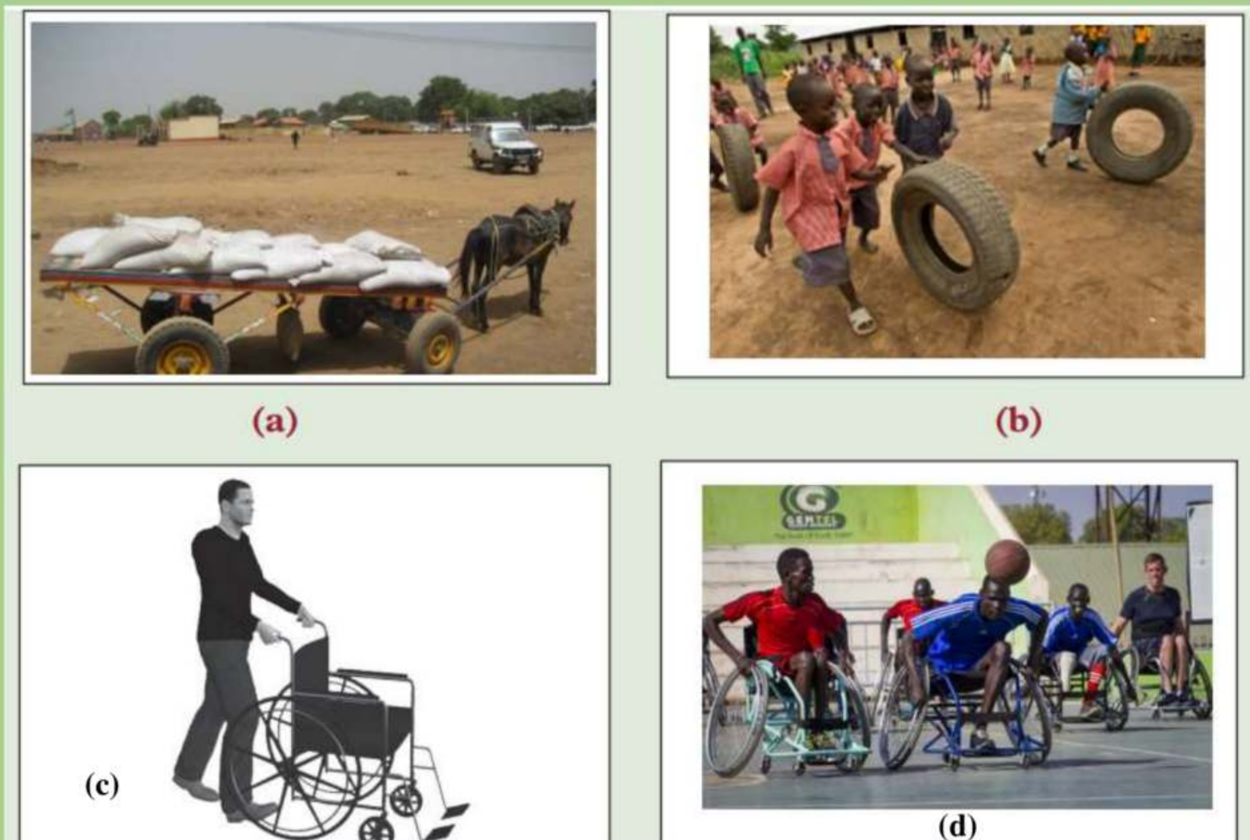
Explain your observation

Rub a ruler continuously in hair and bring it nearer to small pieces of papers. State what happens and explain the observation.

(Solution: A smooth mass has a low friction while a block has a high friction. The length of the rubber band increases, the length of the rubber band decreases, the length of the spiral spring increases, the piece of magnet attracts the razor blade, magnetic materials are attracted by the magnet, and the ruler attracts the small pieces of papers due to non-contact force)

Activity

Study the pictures shown below and discuss with your class partner what is happening in each of them.



(a) (b) (c) (d)

1. Tell your partner where a push or a pull is occurring.
2. Discuss with your partner other examples where a push or a pull occurs in our daily lives. List down in your exercise book.
3. Compare and discuss your findings with different groups in your class.

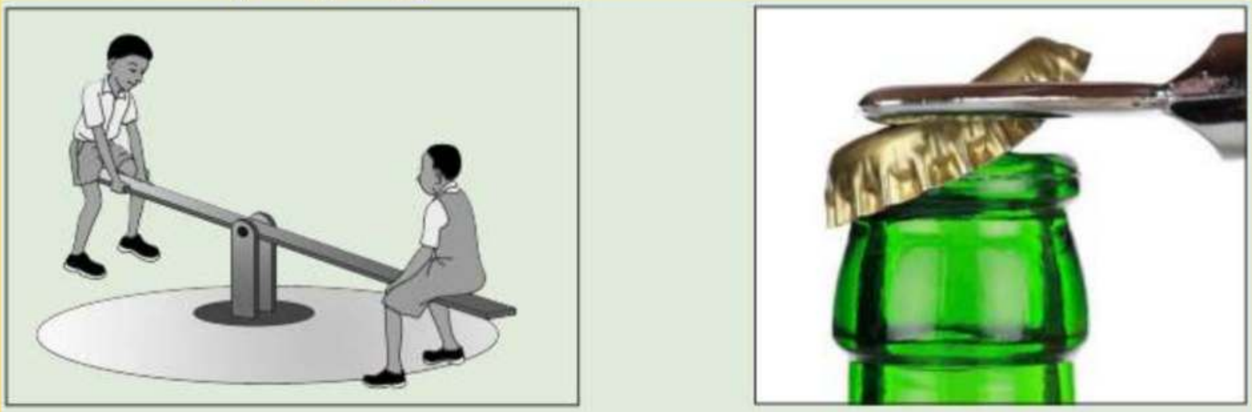
Activity *To show that force produces a turning effect on an object*

Materials

- ✓ A see saw
- ✓ A bottle opener
- ✓ Unopened bottle

Steps

1. With your colleague, try to balance on a see saw (Fig 2.5 (a)). Now try to lift your colleague on the see saw. What do you observe? How can you balance on the see saw?
2. observe the activity in Fig 2.5 (b)



(a) *Seesaw* (b) *A bottle opener*

3. Discuss with your class colleague the effects of forces shown in Fig 2.5 (b)

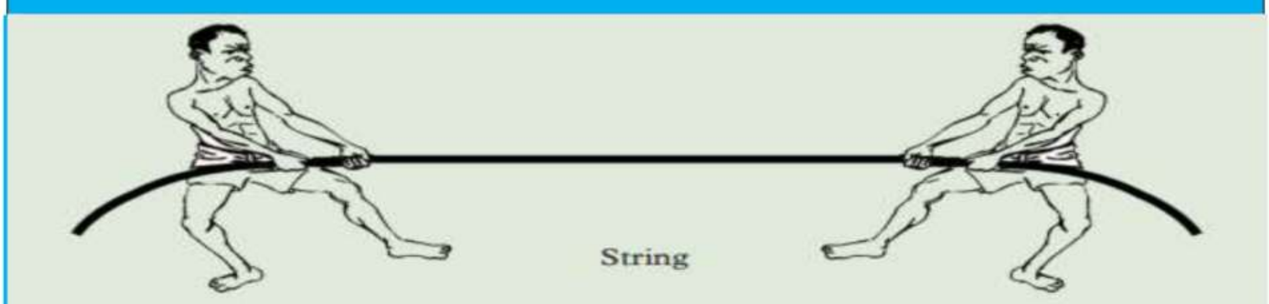
TYPES OF FORCES

There are two types of forces.
Contact forces
Non-contact forces

Contact forces
These are forces that require physical contact between objects for them to act.
Examples include;

Tensional force: This is a force that pulls apart an object and they act in opposite ends.

Demonstration of tensional forces in strings



Compressional force: This is a force that brings molecules of the particle together.

Application

- Shock absorbers
- Some beds, chairs
- In vehicle engines
- Pressing an inflated balloon
- Squeezing juice out of the fruit
- Air craft landing gears

Frictional force (friction): This is the force that opposes the relative motion between two bodies in contact.

Activity ***To demonstrate tear and wear as caused by frictional force***

Materials

- Different tyres

Steps

1. Take a close look at different tyres of vehicles within the school compound or roadside. What can you comment about their treads? Suggest a reason for their appearance.
2. Now, compare and discuss the state and condition of the tyres shown in *Fig 2.6*

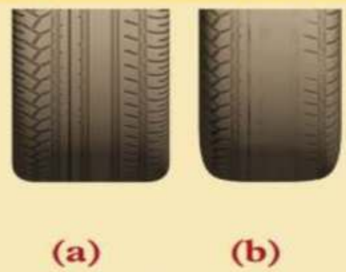


Fig. 2.6: Conditions of tyres

3. Name the effect of the force demonstrated in *Fig 2.6 (b)*. Explain how the effect demonstrated is brought about by the force.

   The tyres wear and sometimes tear because of friction between the road and the tyre when in use

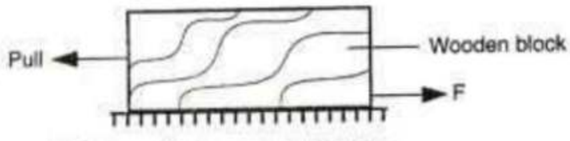
EXPERIMENT: To investigate frictional force.

Materials

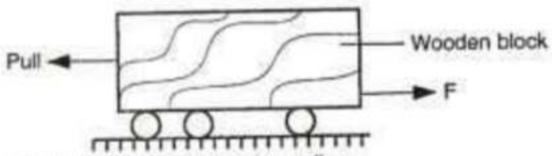
- Wooden block
- Rollers

Procedures

1. Put a block of wood on a horizontal surface such as a bench as shown.



(a) Pulling a block on a rough surface



(b) Pulling a block placed on rollers

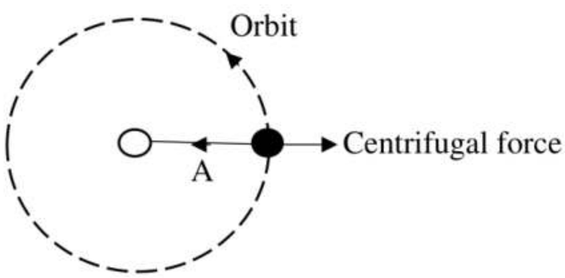
2. Pull the block gradually, increasing the force.
3. Repeat the experiment, this time resting on rollers as shown above

Conclusion

The wooden block starts to move when the applied force is just greater than frictional force between the block and the surface of the bench.
Frictional force can be reduced by using rollers, oiling and smoothening.

Application of friction
Friction helps in;
- Writing
- Walking
- Lighting fire using a match box
- Breaking speed in vehicles
- Climbing

Centripetal force: It is a force that keeps an object moving in a circular paths (curved path). It is directed towards the centre of rotation.
Centrifugal force: This is the force that is felt by an object moving in a circular path.

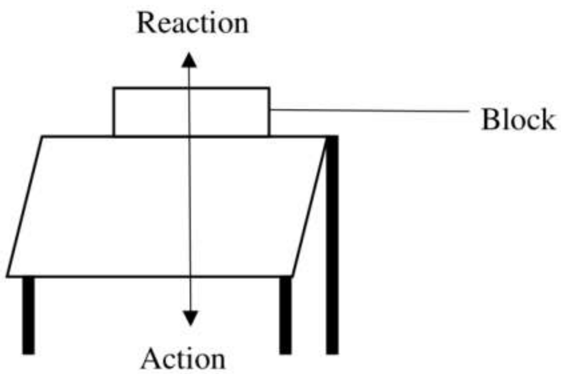


A – Centripetal force

Application of centripetal and centrifugal forces

- Riding around about
- An object swung in a circle
- The earth revolving or orbiting around the sun
- Negotiating corners
- Satellite movement

Reaction and action



When you push an object, the object pushes back an equal force. The weight of the block exerts a downward force on the table called action

The table in turn exerts an equal upward force on the block called Reaction

NON-CONTACT FORCES

This is a force applied to an object by another body that is not in contact with.

Examples include;

Gravitational force (gravitation): It is a force which pulls the body towards the centre of the earth.

Application

It keeps the moon and other satellites in an orbit around the earth.

Electro static force: It is the force that causes attraction or repulsion in an electric field due to static charges.

Application

- Printers
- Painting cars
- Vaan-der-Graff generator

Magnetic force: It is a force in a magnet that causes attraction or repulsion hence motion of objects.

Application

Magnetic force is applied (used) in;

- Motors
- Transformers

- Generators
- Loud speakers
- Dynamos

Up thrust force: It is an upward force that acts on the body immersed or put in a fluid.
Air resistance: It is the force that occurs when air pushes against a moving object and causes it to slow down.

Application

- Sky diving
- Parachutist

Cohesive and adhesive forces

Cohesive forces cause tendency in liquids to resist separation of its particles

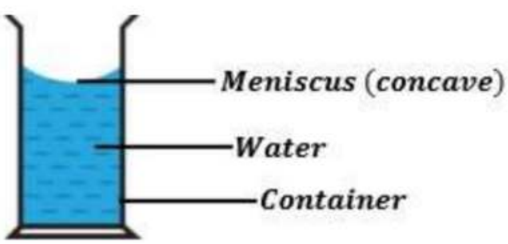
Cohesion Is the force of attraction between the molecules of the same kind

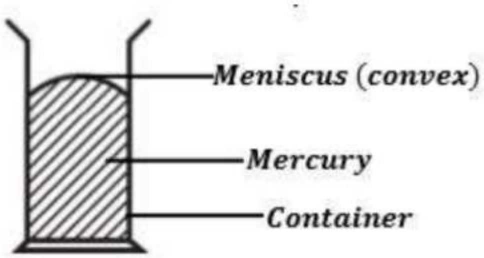
Adhesive force (adhesion): Is the force of attraction between molecules of the different kind.

Adhesion causes the liquid to cling to the surface on which it rests.

Question

Explain why water forms a concave meniscus while mercury makes a convex meniscus?





This is because molecules of mercury are more attracted to themselves than the material of the test tube. This means that there exists stronger cohesion between mercury molecules than the adhesion between the test tube and the mercury molecules.
Water molecules form a concave meniscus because the adhesion between the water molecules are stronger than the cohesion between the water molecules and the test tube.

Question.
Explain why water wets the glass and mercury does not wet the glass?

CAPILLARITY (CAPILLARY ACTION)

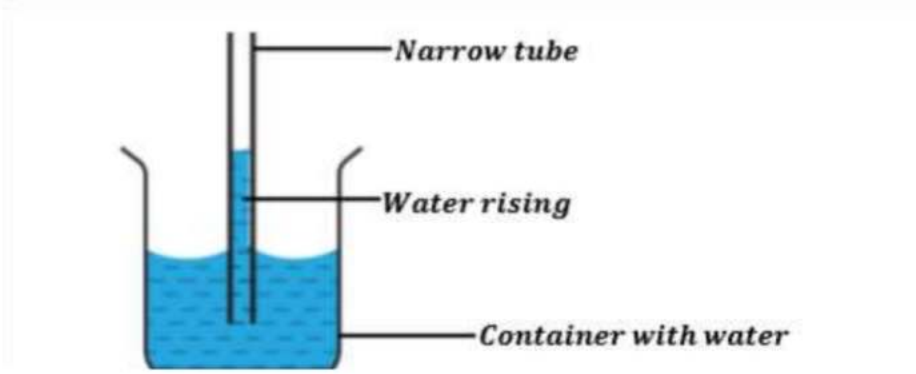
Capillarity is the tendency of a liquid in a capillary tube to rise or fall.

Application of capillarity.

NB: Capillarity leads to wetting of wood and foundations of buildings which weakens them

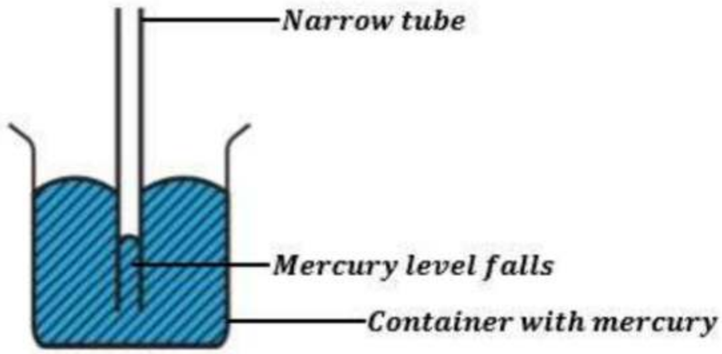
Capillary action depends on cohesion and adhesion

When adhesion is greater than cohesion



The liquid rises in the capillary tube
The meniscus curves up wards (concave)

When cohesion is greater than adhesion



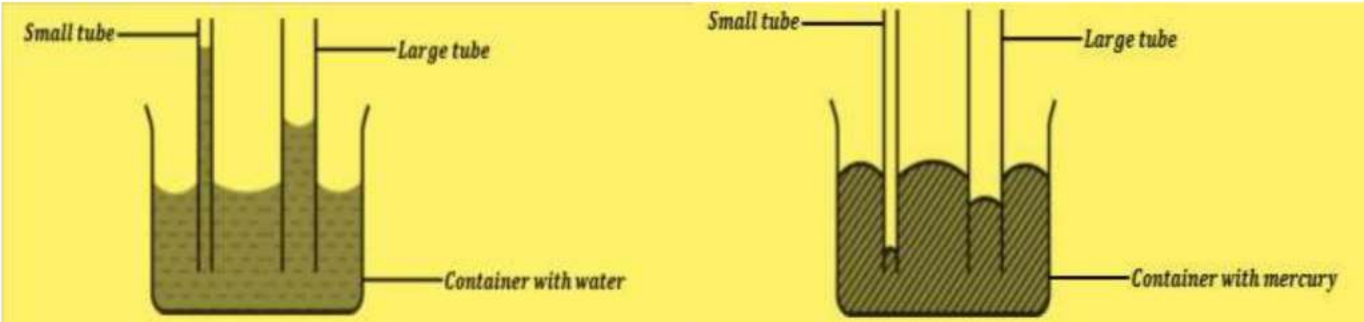
The liquid falls in the capillary tube

The meniscus curves downwards (convex)

The liquid does not wet the glass

Effect of size or diameter of the capillary tube on capillarity.

Water rises higher in a capillary tube of smaller diameter than the one of a bigger or larger diameter
Mercury falls (depresses) deeper in the capillary tube of a smaller diameter than the one of a larger one.



Activity 1.17 To demonstrate surface tension

Materials

- Tissue paper
- Greased steel pin
- Water in a beaker

Steps

1. Place a tissue paper on the surface of clean water contained in a beaker. What happens to the tissue? Explain the observation.
2. Carefully place a greased steel pin on top of the tissue paper. Take care not to touch the water. Observe what happens (fig. 1.17). What do you think will happen if you touch the water. Explain.

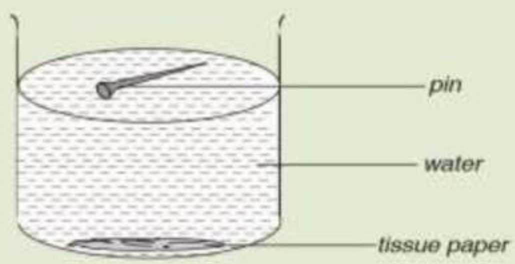


Fig.1.17: Surface tension

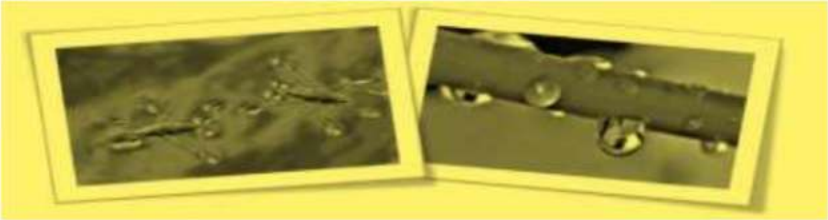
3. Put a drop of oil near the steel pin and observe what happens. Explain your observation. What is the effect of the drop of oil?

Observation and conclusion

The tissue paper absorbs water and sinks to the bottom, leaving the steel pin *floating* on the surface of the water. How does the steel pin which is denser than water float? Use a hand lens to observe the surface under the steel pin. The surface of water behaves like a stretched, thin elastic skin that is under tension. The force that causes a liquid to behave this way is called *surface tension*.

When a drop of oil is put near the steel pin, it immediately sinks. The oil has reduced the surface tension of water which supported the steel pin and hence the pin sinks. This shows that surface tension of a liquid can be reduced by introducing impurities. Raising the temperature of the liquid also reduces surface tension. Surface tension enables insects to walk on water surface. It provides a force which supports them.

This is a force acting on the surface of the liquid and makes the surface to behave like a stretched elastic skin



Activity

Materials

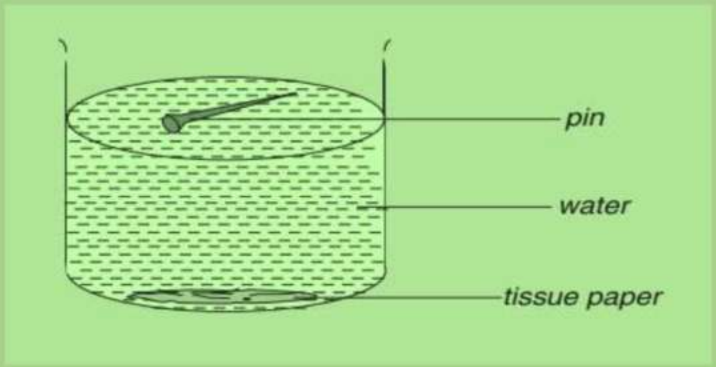
- ✓ Razorblade
- ✓ Vaseline/oil
- ✓ Filter or bloating paper
- ✓ Basin/bucket
- ✓ Clean water

Procedures

i. Pour water in the basin and leave it to settle.
ii. Carefully place the filter paper on the surface of water.
iii. Smear the razor blade with Vaseline and gently place it on top of the filter paper.
iv. Give the setup some time and state your observation

Observation: The filter paper moves to the bottom of the basin or bucket.

Experiment to demonstrate the existence of surface tension



Procedures

- Clean beaker is filed with clean water.
- The bloating paper is placed on the surface of the liquid
- A pin is then gently placed on top of the bloating paper.

Observation

After some time, the bloating paper absorbs water and sinks to the bottom. The pin remains floating on the water surface

Conclusion

The pin is held by surface tension

Factors that affect surface tension

Temperature: increase in temperature weakens or reduces surface tension

Impurities: addition of impurities such as soap solution, alcohol, reduce surface tension

Effects of surface tension

- Some birds and insects can walk on the surface of water
- A steel needle or razorblade floats on water when carefully placed on top of water.
- A drop of water from a tap forms a spherical shape

Activity

You are provided with the following;

- Beaker
- Razor blade
- Detergent
- Bloating paper
- Heat source

Precaution: Handle the heat source with care to avoid accidents

- Design steps you can follow to investigate factors that affect surface tension.
- Carry out the experiment using the above steps
- State and explain your observation

Gravitational force (force of gravity)

Bodies always fall down because of the pull towards the centre of the planet (earth). This pull is called gravitational force.

Bodies falling under the influence of gravity have a constant acceleration due to gravity. It is denoted by g.

Its value on earth is approximately $10ms^{-2}$

Acceleration due to gravity is the force that brings objects towards the centre of the earth.

Mass and weight

Activity Relationship between mass and weight

Material

- Spring balance

Steps

1. Look at the graduations of the spring balance provided to you. Deduce the relationship between the two units (i.e. Newton and gram)
2. In your group, find out 1Kg is equivalent to how many newton (N)
3. Write down an expression relating weight and mass
4. List and discuss five differences between mass and weight
5. compare and discuss your findings with other pairs in your class

Mass is the quantity of mater in a body

Weight is the pull of gravity on the body

Mass does not change from place to place

Differences between mas and weight

Mass	**Weight**
It does not change from place to place	Changes from place to place
Is a scalar quantity	Is a vector quantity
Its S.I unit is Kilogram(Kg)	Its S.I unit is newton (N)
It is measured using a beam balance or a spring balance calibrated in kilogram	It is measured using a spring balance calibrated in newton
Quantity of matter in a body	Pull of gravity on a body

Calculations

i. A boy has a mass of 20kg. What is the weight of the boy on earth if $g=10ms^{-2}$
ii. A man of mas 70Kg went to the moon where acceleration due to gravity is $6.67ms^{-2}$.Find the man's weight on the moon

Activity

An object has a mas of 57Kg on earth. What is its weight on Jupiter whose acceleration due to gravity is $25.95ms^{-2}$

Calculate the weight of;

(i) A car of mas 1.2 tonnes on earth.

(ii) A needle of mas 300g on mars(acceleration due to gravity on mars is $3.77ms^{-2}$

The following is a list of values of acceleration due to gravity on the moon and on different planets

Moon	$1.62\ ms^{-2}$
Mercury	$3.59\ ms^{-2}$
Venus	$8.87\ ms^{-2}$
Earth	$10\ ms^{-2}$
Mars	$3.77\ ms^{-2}$
Jupiter	$25.95\ ms^{-2}$
Saturn	$11.08\ ms^{-2}$
Uranus	$10.67\ ms^{-2}$
Neptune	$14.04\ ms^{-2}$
Pluto	$0.42ms^{-2}$

Use the list above to calculate the weight of a 57Kg mass on each of the planets and on the moon.

On which planet is weight greatest?

Give reasons why the weight of the body changes (varies) on different planets.

BALANCED AND UNBALANCED FORCES

When two or more forces act on the same body, then the forces are added together to get the sum

This is called the resultant force.

NOTE: Suppose the two teams pull with equal force in opposite directions, in which direction would the cloth move? Give reasons for your answer.

It will not move in any direction. This is because the forces of the two teams are balanced. What is the resultant force of such forces? What name can we give to such forces?

The resultant force would be zero and such forces are called **balanced forces.**

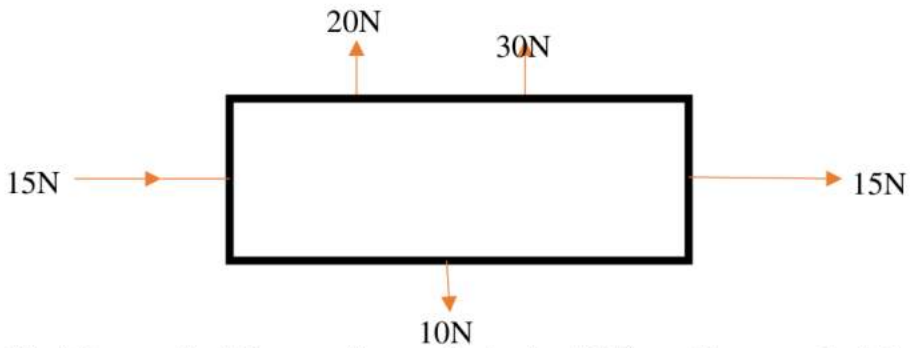
NOTE: Suppose one team was pulling with a greater force than the other, in which direction would the cloth move? What name is given to such forces?

It would go to where there is greater force and such forces are called <u>un balanced forces.</u>

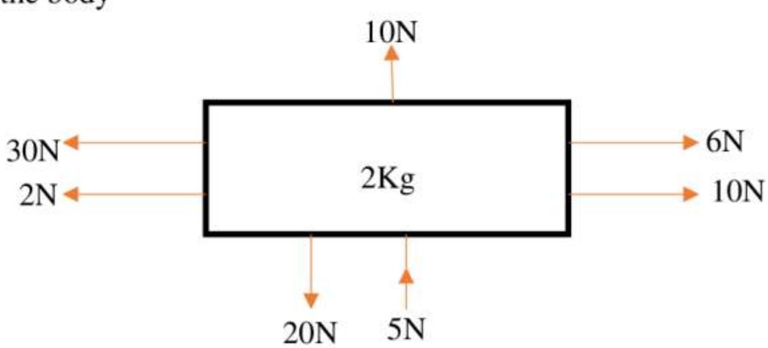
NOTE: Resultant force is the force which has the same effect as individual forces acting on the body.

Activity

1. A body is acted upon by various forces as shown. What is the resultant force acting on the body?



2. Find the resultant force acting on the body of 2Kg and hence calculate the acceleration of the body



Calculated Activity

Two oxen are pulling a heavy block along a floor in the same direction. One exerts a horizontal force of 800N and the other a force of 1000N. If the frictional force between the block and floor is 430N,

a) Draw the force diagram
b) Find the total horizontal force in (a) above
c) Find the direction of the force in (a) above

Solution

(a)

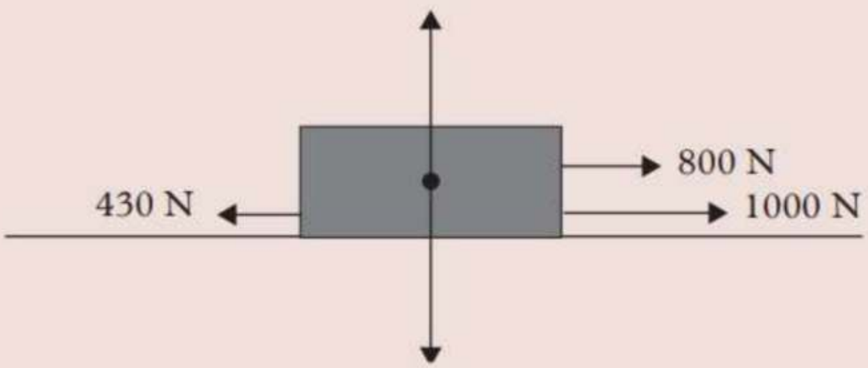


Fig. 2.15: Addition of parallel forces

(b) We shall chose the forward direction as positive since the frictional force opposes motion i.e acts backwards in the negative direction.

Force exerted by the oxen = 800 N + 1000 N

Force exerted by friction = -430 N

The total sum of force on the crate = 800 + 1000 – 430 N

= 1370 N

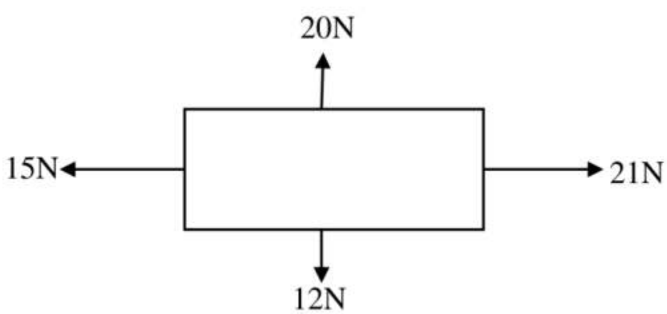
The resultant force on the crate = 1370 N

(c) Since the force is positive its direction is forward.

ASSIGNMENT

I. Distinguish between a scalar and vector quantity. State two examples of each.

II. Four forces of 20N, 21N, 15N and 12N act on the body of mass 10Kg as shown below.



Calculate the;

i. Resultant force

ii. Value of acceleration due to gravity

Topic summary

- A force is a push or a pull. The SI unit of force is the newton (N).
- Frictional force is that force that opposes relative motion between two surfaces in contact with one another.
- Weight is the gravitational pull in an object.
- A force can cause:
  - Change in the state of motion of a body.
  - Change of the shape of a body.
  - Turning effect on a body.
  - Wear and tear on a body.
- Types of forces include friction, tension, pull of gravity(weight), normal reaction force, air resistant, upthrust, action and reaction force, gravitational, magnetic and electric force.
- Contact force include tension, pull of gravity(weight), action and reaction force, air resistance etc.
- Non-contact force includes gravitational, magnetic and electrostatic forces.
- Force is a vector quantity. It has both magnitude and direction. It is normally represented by a line with an arrow ($\longrightarrow$).
- Weight is measured using a spring balance.
- Mass is measured using a beam balance.

CHAPTER FIVE
TEMPERATURE MEASUMENT

LEARNING OUTCOMES

The learner should be able to:

a. Understand the difference between heat and temperature
b. Understand how temperature scales are established
c. Calibrate a thermometer and use it to measure temperature
d. Compare the qualities of thermometric liquids

Describe the causes and effects of the daily variations in atmospheric temperature

a. understand how heat energy is transferred and the rate at which transfer takes place
b. understand what is happening at particle level when conduction, convection, and radiation take place and their application

Understand that greenhouse effect and global warming are aspects related to heat transfer on the earth surface

ACTIVITY

What is temperature?

What happens when water in the source pan is heated?

Give three examples of liquids used in thermometer

Why is water not commonly used in thermometers? Give three reasons.

What name is given to liquids used in thermometers?

Discussion questions

Why do people gather around cooking or fire places at night?

What do you feel when you are near the charcoal stove?

NOTE: Temperature is the degree of hotness or coldness of a body

OR Temperature is the degree of heat present in a substance.

Heat can be transferred from one place to another when there is temperature difference between them

Heat travels from the areas of high temperatures to areas of low temperatures.

Activity

1) What is heat?
2) Mention the different sources of heat
3) Discuss what causes the temperature of the body to change?
4) Discuss the effects of heat on different substances
5) What do you think is the difference between heat and temperature?

Solution

1. Heat is the form of energy which when absorbed by the body causes rise in temperatures or change of state of the body.
2. Candle, sun, fire, bulb
3. When heat is lost, temperature of the body decreases and when heat is gained, the temperature of the body increases
4. Heat can cause increase in temperature or change of state of the body.
5. Heat is the form of energy that causes change in temperature while temperature is a figure representing the degree of hotness or coldness on a scale.

Measurement of temperature

Activity

How hot can hot tea in a cup be?
How cold can cold water in a mineral water bottle be?

Solution

- Very hot around 100^0c
- Very cold around 0^0c

Group activity

In groups, discuss the following

What happens when you expose a plastic material to heat? What will happen to it?

Solution: The plastic material changes shape (deforms). However, if heat is supplied for a long time, it melts

Describe what happens to water in a sauce pan when heated?

Solution: water becomes hot but when exposed for a long time, it starts to boil hence forming bubbles.

Explain what happens to a bottle of water when placed in a freezer?

Solution: The bottle becomes ice cold. (Very cold)

Temperature scales

There are three types of temperature scales. I.e.;

- Fahrenheit scale
- Celsius scale (centigrade)
- Kelvin scale

Fahrenheit scale

- This scale uses *degree Fahrenheit (°F)* as the unit of measuring temperature. Two values in this scale are fixed such that the temperature at which water freezes into ice is defined as 32°F and the boiling point of water is defined to be 212°F.
- The two have a 180°F separation (under standard atmospheric process)

Kelvin scale

This scale uses *Kelvin (K)* as the unit of measuring temperature. The scale uses the absolute zero (-273°C) as its reference point. Thus, 0 K on Kelvin scale is equivalent to –273ºC on the Celsius scale. At absolute zero, a hypothetical temperature, all molecular movement stops all actual temperatures are above absolute zero. It is worth noting that a temperature change of 1 K is equal in size to a change of 1ºC.

NOTE: A temperature in degrees Celsius (^{0}c) is converted to kelvin by adding 273 to it.

Convert the following as required Temperature in K = temperature in ºC + 273

$$T_{(K)} = (T_{(°C)} + 273)K$$

Temperature in ºC = temperature in K – 273

$$T_{(°C)} = (T_{(K)} - 273)°C$$

Example

1. 37^0c to kelvin

   K= ^{0}C +273

   K =37+ 273
   37^0c = 310K

2. 273K to Celsius scale

   K= ^{0}c + 273

   273= ^{0}c +273

   273K= 0^0c

Activity

I. 238K to ^{0}c
II. -10^0c to kelvin

Group activity

In a weather forecast, UBC TV the temperature range for the next day in some towns in Uganda were as follows;

Gulu 20^0c to 27^0c

Mbale 18^0c to 25^0c

Fort portal 17.5^0c to 26^0c

Kabale 14^0c to 19^0c

What are the temperature ranges in kelvin?

What is meant by the term absolute temperature and what is its value?

It is the temperature of the body when heat or energy has been removed from the body (it is the lowest possible temperature) and its value is 0k or -273^0c

RESEARCH ACTIVITY

Using the internet or library resources, research about the place with the highest and coldest temperature ever recorded on earth and note down what temperatures they were?

Relationship between Celsius scale and Fahrenheit scale

$F = \frac{9}{5}{}^0c + 32$

$C = \frac{5}{9}({}^0F - 32)$

Examples

Convert as instructed

- 37^0c to ^{0}F (98.6^0F)
- 87^0F to ^{0}c (78^0c)

Copy and complete the table below

Centigrade (^{0}c)	Fahrenheit (^{O}F)	Kelvin (K)
0	……………	…………..
…………	212	…………..
…………	……………	0
…………	………….....	270
-10	……………	…………..

Types of thermometers and their thermometric properties

Activity 4.6 **To identify different types of thermometers**

Materials

- Reference books
- Internet
- Resource persons

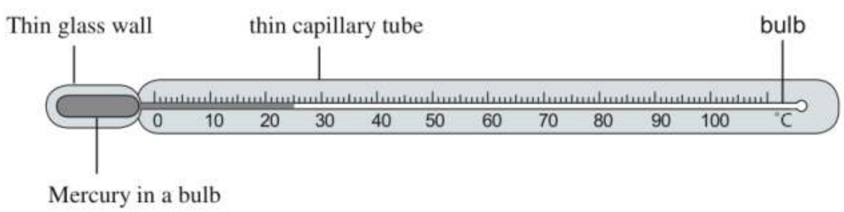
Steps

1. Conduct research from internet or reference books on types of thermometers.
2. In your research, identify the main features of each thermometer, how it is calibrated and how it is used to measure temperature of a body or a place.
3. Compare and discuss your findings with other groups in your class.

There are various types of thermometers in use. The liquid-in-glass thermometer is the most common one. Others include electrical, digital and gas thermometers. The main difference between them is in the property of the thermometric substance. In this level we shall discuss liquid-in-glass thermometers only.

Mercury-in-glass thermometer

This thermometer consists of *a thin walled bulb*, containing mercury and a thin *capillary tube (bore)* of uniform cross-sectional area. There is a space above mercury thread which is usually evacuated to avoid excess of pressure being developed when mercury expand



Mercury-in-glass thermometer

Some important precautions are taken in the construction of this type of thermometer include:

(a) The walls of the bulb should be thin. This is to ensure that the mercury can be heated easily.

(b) The quantity of mercury in the bulb should be small so that the mercury takes little time to warm up.

(c) The thin capillary tube should be of uniform cross-section so that the mercury level changes uniformly along its length.

Alcohol-in-glass thermometer

The alcohol-in-glass thermometer uses coloured alcohol instead of mercury.

Volume of alcohol changes uniformly and easily when heated. The change in volume of alcohol is about six times more than that of mercury for the same change in temperature.

The range of temperatures that can be measured with this thermometer is limited, as alcohol boils at 78ºC. However this thermometer is ideal for measuring low temperatures since alcohol freezes at –114ºC.

Using a laboratory thermometer

Before using a laboratory thermometer, you should note its initial reading (i.e room temperature reading) and while measuring temperature, ensure that its bulb is always in contact with the substance whose temperature is to be measured. Avoid direct heating of the bulb.

Clinical thermometer

Activity **To observe the working of a clinical thermometer**

Material: Clinical thermometer

Steps

1. Hold the thermometer provided to you and note the following:
   - **(a)** The range of the scale.
   - **(b)** Minimum and maximum values on the scale.
   - **(c)** Features of the thermometer.
2. Now, note the reading of the thermometer and place it in your armpit for a couple of minutes.
3. While still in the armpit, note the reading where the liquid becomes steady. What is the value? Record it down.
4. Compare and discuss your findings with other groups in class

Thermometers base on different physical properties for their accuracy.
The physical property varies (changes) linearly and continuously with temperature and is constant at constant temperature.

The physical property upon which the accuracy of the thermometer depends on is called **thermometric property**
A thermometric property is the physical property of the substance whose value changes with temperature.

OR A thermometric property is the physical property of the substance whose value changes linearly and continuously with temperature and is constant at constant temperature.

Thermometers use liquids called thermometric liquids such as water, mercury, alcohol.

Type of thermometer	Thermometric property
Gas thermometer	Volume or pressure of the gas
Clinical thermometer	Volume of a liquid
Bi-metallic strip thermometer	Volume of a solid
Constant volume gas thermometer	Pressure of a fixed mass of a gas
Constant pressure gas thermometer	volume of a fixed mass of a gas
Thermo - couple	Changes in e.m.f
Resistance thermometer	Changes in electrical resistance
Pyrometer	Quality of radiation

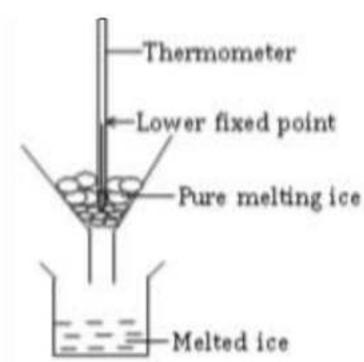
Calibrating a thermometer
A thermometer has two reference points of temperature called fixed points
A fixed point is the unique temperature where a certain physical event is always expected to take place
A thermometer has two fixed points i.e. upper fixed point (steam point) and lower fixed point (ice point)

Upper fixed point
Is the temperature at which pure water boils under normal atmospheric pressure

Lower fixed point
Is the temperature at which pure water freezes under normal atmospheric pressure

NOTE: The upper fixed point of a thermometer is 100^0c and the lower fixed point is 0^0c

An experiment to determine the lower fixed point of a thermometer.



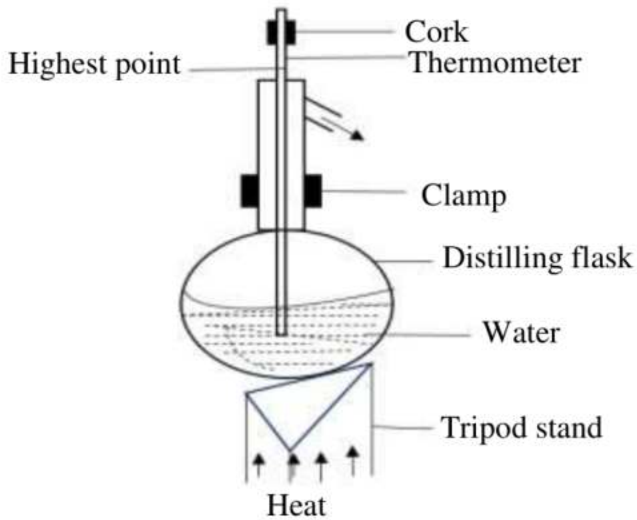
- Fill the filter funnel with ice cubes
- Insert the un calibrated thermometer in the ice cubes

- Place the beaker below the filter funnel to collect the melted ice
- Give the set up some time until you observe that the mercury thread is steady (constant)
- Mark the level of mercury on the glass of the un calibrated thermometer using a marker
- This will be the lower fixed point of the thermometer.

NOTE: If pure ice is used, it will be 0^0c

UPPER FIXED POINT OF A THERMOMETER

An experiment to determine the upper fixed point of a thermometer



Procedures

- Half fill a distilling flask with water
- Fix the thermometer in the hole of a cork so that the thermometer reaches in the water.
- Place a distilling flask on top of a tripod stand and apply heat from the bottom
- Allow the set up some time until water in the flask starts boiling.
- Observe the level of mercury thread in the thermometer at the boiling of water.
- Mark the level of mercury on the glass of the thermometer using a thermometer when the mercury thread becomes constant
- This level is the upper fixed point of the thermometer

NOTE: The length between the upper fixed point and lower fixed point is called **fundamental interval**

Determining temperature using un calibrated thermometer

Un known temperature is represented by a Greek letter theta, θ.

$$\theta = \frac{\text{length of mercury thread}}{\text{fundamental interval}} \times 100$$

$$\boldsymbol{\theta = \frac{l_{\theta} - l_0}{l_{100} - l_0} \times 100}$$

Examples

Tony used un calibrated thermometer to get the temperature of his water bath and he observed them as follows;

Length of mercury in ice l_0 = 3cm

Length of mercury in water bath l_θ = 12cm

Length of mercury in steam l_{100} = 20cm

Determine the temperature of his water bath.

$$\boldsymbol{\theta = \frac{l_{\theta} - l_0}{l_{100} - l_0} \times 100}$$

$$\theta = \frac{12-3}{20-3} \text{x} 100$$

$\boldsymbol{\theta = 52.94^0c}$

The lower fixed point of mercury in glass thermometer is 40mm from the bulb and the upper fixed point is 190mm. what is the temperature when the scale reads 70mm.

$$\theta = \frac{l\theta - l0}{l100 - lo} \text{ x } 100$$

$$\theta = \frac{70-40}{190-40} \text{ x } 100$$

$\theta = 20^0$c

The 0^0c and 100^0c marks on the liquid in glass thermometer are 10cm apart. What would be the temperature if the liquid fell 2cm below 0^0c?

$$\theta = \frac{-2}{10} \text{ x } 100$$

$\theta = -20^0$C

Activity **To demonstrate how to calibrate a mercury thermometer**

(a) Lower fixed point

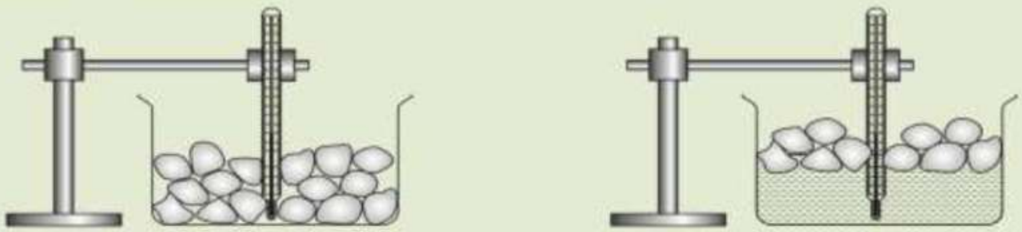
Steps

1. Immerse the bulb completely inside a beaker containing pure melting ice as shown

Why is it necessary to completely immerse the bulb? What can you note about the reading on the thermometer.

2. Wait for sufficient time for the mercury to attain the temperature of the melting ice (Fig. 4.8 (b).
3. When there is no more change in the level of mercury, mark its position on the stem. Suggest the name given to the marked position.

The point marked is the lower fixed point. Mark it as 0°C. Note that the melting point of ice is exactly 0°C at standard atmospheric pressure (760 millimetres of mercury).



(a) Pure ice at 0°C (b) Pure melting ice at 0°C

Fig. 4.8: Calibrating the lower fixed point

(b) Upper fixed point

Steps

1. Expose the bulb to steam just above the boiling water as shown in Fig. 4.9.

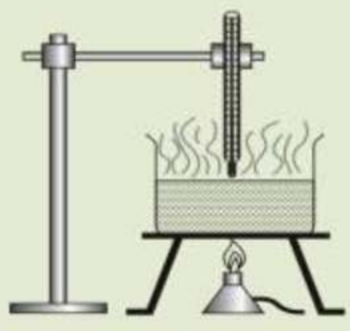


Fig. 4.9: Calibrating the upper fixed point

2. Give it time for the mercury to attain the temperature of the steam.
3. When there is no more change in the level of mercury, mark its position on the stem.

The point marked is the upper fixed point. Mark it as 100°C. The temperature of steam is exactly 100°C at standard atmospheric pressure (760 mmHg).

Qualities of a good thermometric liquid

- It should not freeze nor boil in the working range
- It should not be corrosive to the container
- It should not be poisonous
- It needs to be clearly visible and easily readable in the tube
- It should have a uniform thermal expansion
- It should have a low freezing point

Qualities of a good thermometric property

- It should vary/change linearly with temperature
- It should change continuous with temperature
- It should change or vary over a wide range of temperature
- It should be constant at constant temperature

Advantages of mercury as a thermometric property

- It is a good conductor of heat (It has a high thermal conductivity)
- It does not wet the glass
- It has a high boiling point
- It has a visible meniscus
- It has a uniform expansion
- It responds quickly to temperature changes

Disadvantages

- It is expensive
- It is poisonous
- It has a small thermal expansion
- It has a high freezing point (it cannot be used in places that are very cold)

Advantages of using alcohol as a thermometric liquid

- It is cheap
- It has a low freezing point.
- It has a high expansivity (it can easily expand)
- It is a safe liquid

Disadvantages

- It has a low boiling point (78^0c)
- It does not react quickly
- It has a non-uniform expansion
- It needs to be dyed since it is colorless
- It wets the glass

Disadvantages of using water as a thermometric liquid

- It is a poor conductor of heat
- It wets the glass (it sticks on the glass)
- It has a narrow range of temperatures i.e. it has a freezing point of 0^0c and a boiling point of 100^0c
- It has an anomalous expansion and so does not vary linearly and continuously with temperature.

Reasons for daily temperature changes.

Atmospheric temperature is the measure of temperature at different levels of the earth's atmosphere

Atmospheric temperature changes with time varying or changes from season to season, from day to night.

The following are reasons for the daily temperature variation;

1) The solar energy received by any region changes with time of the day and seasons.
2) Variation with latitude. The sun is more overheated in the equatorial regions as compared to the higher latitudes. This is the reason why temperature varies from equator to the poles.
3) Clouds abstract the receipt and loss of insolation causing low temperature in clouded region.
4) The clear `sky in desert regions cause higher temperatures because insolation is received without abstraction in the day and lost without abstraction in the night.
5) Snow bound regions absorb less and reflect more insolation (solar radiation) causing low temperatures.
6) A high altitude region has high temperature range because in this region, air is thin which brings great loss of insolation into the night.
7) Distance from the sea. The interior regions of land masses receive higher temperatures while regions nearest the sea have moderate temperatures due to sea breeze.
8) Warm and cold winds disturb the temperature ranges

NOTE: *Insolation refers to amount of solar radiation received on a given surface area over a specific period of time.*

Topic summary

- Temperature is the degree of hotness or coldness of a body. It is also defined the average kinetic energy of the molecules of a substance.
- The SI unit of temperature is Kelvin (K).
- A thermometer is an instrument used to measure the temperature of a body.
- Liquid-in-glass thermometers commonly use mercury or alcohol as their thermometric substance.
- Clinical thermometer is special type of liquid-in-glass thermometer used to measure the temperature of a human body.
- Lower fixed point is the temperature of pure melting ice at 0ºC at standard atmospheric pressure.
- Upper fixed point is the temperature of steam above pure boiling water at 100ºC at standard atmospheric pressure.
- Different thermometers use thermometric substances of different properties.
- Absolute zero is the temperature at which gases appears to have zero volume.
- Temperature in Kelvin = (temperature in ºC + 273).

  Temperature in ºC = (temperature in K – 273).
- Heat is a form of energy which passes from a body of high temperature to a body of low temperature. The SI unit of heat is joules (J).

CHAPTER SIX
HEAT TRANSFER

LEARNING OUTCOMES

The learner should be able to:

a. understand how heat energy is transferred and the rate at which transfer takes place
b. Understand what is happening at particle level when conduction, convection, and radiation take place and their application.
c. understand that greenhouse effect and global warming are aspects related to heat transfer on the earth surface

Methods of heat transfer and rate at which the transfer takes place

There are different types of heat transfer i.e.

- Conduction
- Convection
- Radiation

Conduction

This is the transfer of heat from a point of higher temperature to a point of lower temperature without the movement of the medium.
For example, transfer of heat energy from one end of the metal to the other end.
Conduction occurs majorly in solids although it occurs in liquids like mercury.

Investigating heat transfer by conduction

Materials

- Small metal rod or nail
- Heat source

Steps

- Light up the heat source
- Place one end of a metal rod or nail on to the heat source while holding the other free end with your figures
- Hold the metal rod for some time.

What do you feel in your fingers?

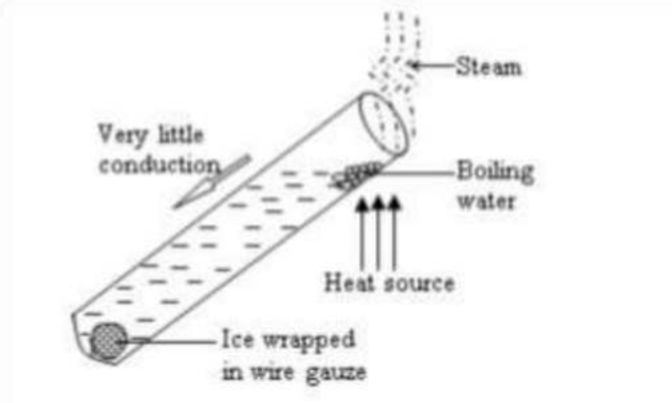
How does heat reach your fingers?

Solution: Heat reaches the fingers and warmth is felt.

Solution: Heat has been transferred from one end on a heat source to the other end where fingers are placed due to conduction.

Investigating conduction of heat by water

An experiment to show that water is a poor conductor of heat



Steps

- Wrap ice cubes in the wire gauze and place it at the bottom of the boiling tube
- Clamp the boiling tube inclined at a certain angle
- Pour water in the boiling tube to almost full and heat from the top

Observation

Water at the top starts to boil but ice cubes remain un melted

Conclusion

This shows that water is a poor conductor of heat

Kinetic theory of conduction

Kinetic theory is about matter being made of molecules in a constant state of vibration

When one end of a solid is heated, molecules vibrate rapidly or vigorously and these vibrations are transmitted or taken to the nearby molecules which makes the other end acquire heat.

Good and bad conductors of heat

Good conductors of heat

These are materials that allow heat to move from one point to another easily

Examples include;

- o Copper
- o Lead
- o Brass
- o Silver
- o Aluminium
- o Mercury

Bad conductors of heat (Insulators)

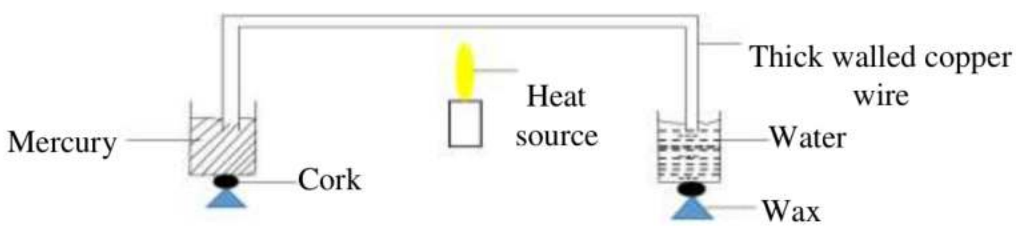
These are materials that do not allow heat to move from one point to another easily.

Examples include;

o Plastics
o Rubber
o Wood
o Cork
o Cotton
o Water

NB: Solids that have free electrons are called good conductors of heat while solids which do not have free electrons are called insulators.

An experiment to show that mercury is a good conductor of heat



- ➢ Corks are attached at the bottom of each container, one having mercury and another one having water by means of un melted wax
- ➢ A piece of copper wire is bent twice at right angle and dipped in both liquids

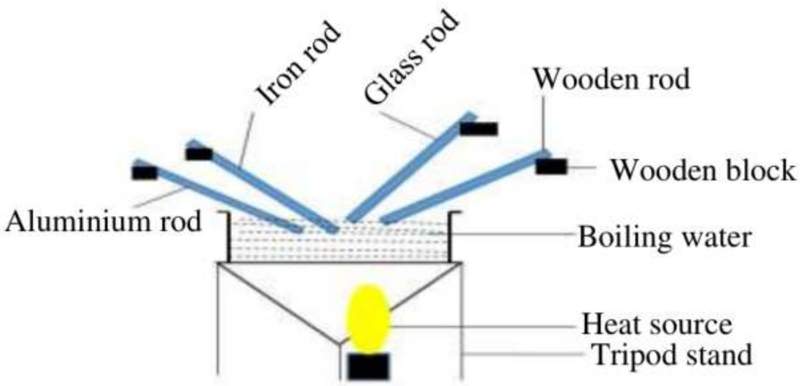
Observation
After some time, the wax on the container of mercury melts and the cork falls off while the cork on the container of water remains

Conclusion
This means that mercury attracts heat faster than water hence mercury is a good conductor of heat
Rates of conduction in different materials

An Experiment to compare rates of conduction by different materials

Apparatus (materials)

- Rods of iron, aluminum, glass and wood of the same size
- Heat source
- Candle wax
- Beaker



Procedures
- Heat the candle wax until it melts
- Smear all the rods completely with candle wax and
- Allow it to solidify
- Put water in the beaker and put the beaker on the tripod stand
- Arrange the rods around the beaker and heat the water until it boils

Observation
The candle wax on the aluminum rod melts faster and is slowest on the wooden rod

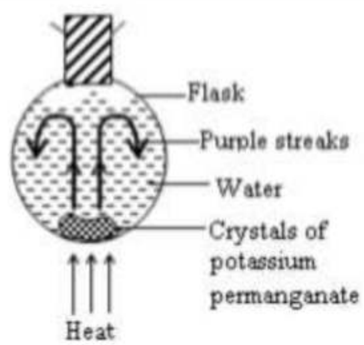
Conclusion
Aluminium is the best conductor of heat (it has a high conductivity) while wood is a poor conductor of heat. (It has a low conductivity)

Convection
It is the process of heat transfer through liquids and gases by the movement of the medium itself

Convectional current

It is the cyclic movement of rising hot water and falling of cold water.

An experiment to demonstrate convectional current in liquids.



Steps

A crystal of potassium permanganate is put in a flask containing water such that it is at the bottom of the flask.

When water is heated from the bottom, after a short time, a colored water moves up wards and the colorless water moves down.

This is because when water is heated, it becomes less dense.

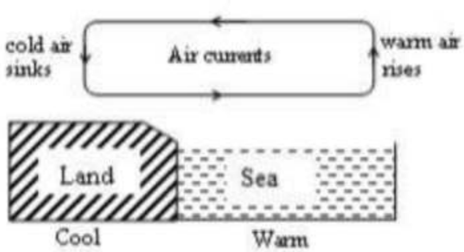
The upward movement of hot water and downward movement of cold water is called convectional current.

Application of convectional currents

It is applied in;

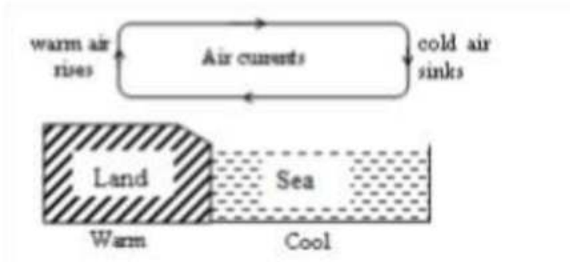
- Sea breeze
- Land breeze
- Ventilation

Land breeze



At night the land cools faster than the sea. This is because during the day, water is heated to the greatest depth than the land. The warm air above the sea rises and it is replaced by cool air from the land hence forming convectional currents

Sea breeze



During the day, the land is heated with much temperature because it is a good absorber of heat and has a lower specific heat capacity. The air above the land rises and it is replaced by cool air from the sea hence forming convectional currents

Ventilation

Buildings are constructed with openings called ventilators such that warm and less dense air rises and flows out.

At the same time, cold and denser air enters through the window and door hence forming convectional currents

Kinetic theory of convectional current

The molecules of a liquid and gas which are not in a container are free to move everywhere.

When heat is applied at the bottom of a fluid, molecules gain energy and their vibrations increase

Molecules also expand and become less dense. Hot molecules move upwards colliding with other molecules in the path losing some of the energy to them.

The molecules on the upper part where temperatures are low, they are denser and move down to replace hot molecules. This results into movement of hot molecules upwards and cold molecules. downwards hence forming convectional currents

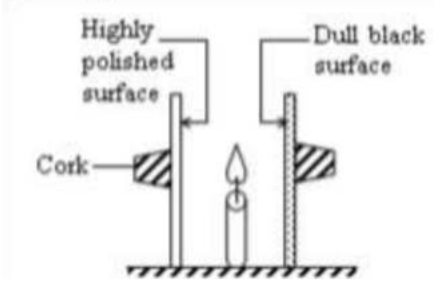
Radiation.

This is the process by which heat is transferred by the electro-magnetic waves.

Electro-magnetic waves are waves that do not require a material medium for their transmission

NB: Radiation is the process of heat transfer from one point to another without affecting the immediate medium.

An experiment to compare good and bad absorbers of heat



Steps

Stick two pieces of cork using molten wax on the vertical parallel metal plates.
The heat source is placed between the vertical plates so that the same amount of radiation is received by the two surfaces.

Observation

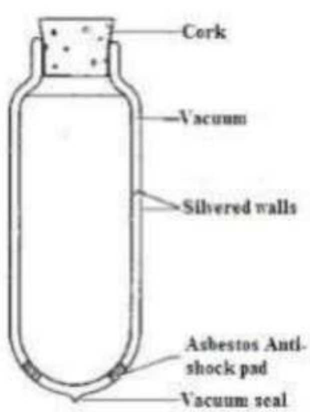
After some time, the wax on the dull black surface melts and the cork falls off faster than that of the highly polished surface.

Conclusion

This indicates that dull black surface is a good absorber of radiation.

Application of heat radiation

The vacuum flask (thermos flask)



A vacuum flask or a thermos flask keeps hot liquids hot and cold liquids cold
It consists of double walled glass vessel having the vacuum between the walls
Both walls are silvered on the side
The liquid can be kept hot or cold because heat loss by;

Conduction and convection is minimized by the vacuum space between the double walled glass vessel
Conduction by the hot liquid upwards to the outside is reduced by the cork or plastic stopper.

Radiation is prevented by slivered glass wall. Here, heat is reflected back when it tries to escape through vacuum.

NB: A thermos flask can be considered useless when the vacuum seal breaks. This is because the vacuum will no longer be there and heat can be lost by radiation, convection and conduction

Greenhouse effect and global warming

A green house is used in providing appropriate conditions for plants in cold regions to grow well. It is made of glass or transparent material or roof.
It stays warm inside even at night or during winter. When the sun's radiation reaches the earth's atmosphere, some heat is reflected back and the rest is absorbed by the earth's ground.
The absorbed heat warms the atmosphere and the surface of the earth.

NB: Global warming is the gradual increase in the average temperature of the earth.

CHAPTER SEVEN

EXPANSION OF SOLIDS, LIQUIDS AND GASES

(Thermal expansion of matter)

LEARNING OUTCOMES

The learner should be able to;

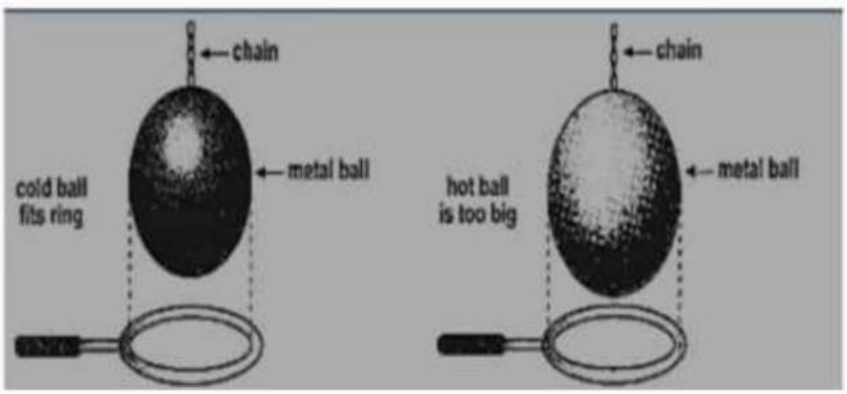
a. understand that substances expand on heating, and recognise some applications of expansion

b. understand the effect and consequences of changes in heat on volume and density of water

c. know about the anomalous expansion of water between 0°C and 4 °C and its implications

This is the increase in the size of matter in all directions when it is heated.

Expansion of solids



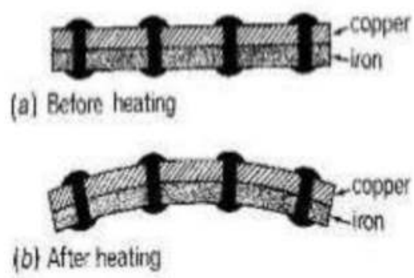
The metal ball passes through the ring when it is cold but when it is heated, it does not pass through the ring.

This shows that the ball has expanded. When the ball is cooled, it passes through the ring again. This shows that the metal ball contracts when it loses heat

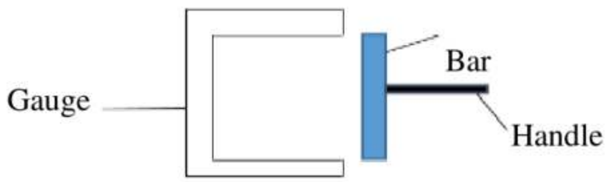
BI-METALLIC STRIP

Different metals expand at different rates when equally heated. This can be shown using a metal strip made of two metals such as copper and iron bounded tightly (Bi-metallic strip)

When a Bi-metallic strip is heated, the copper expands more than iron and the strip bends as shown below



An Experiment to demonstrate expansion using a bar and gauge apparatus.



- ❖ Fit the length of a brass bar into the gauge when both are at room temperature.
- ❖ Remove a brass bar and heat it for some time.
- ❖ Try to fit the length of the brass bar back into the gauge when it is heated.

Observation

The brass bar does not fit in the gauge again.

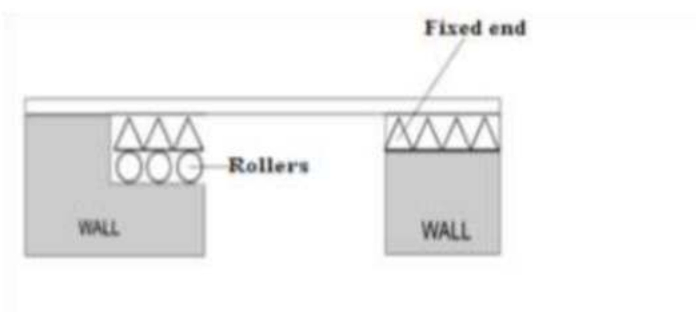
Conclusion

This indicates that the length of the brass bar has expanded

Disadvantages of expansion of solids in everyday life

Steel bridge

Bridges are constructed with one end fixed and the other side placed on the rollers in order for a structure (bridge) to expand or contract freely with change in temperature without damaging the bridge.

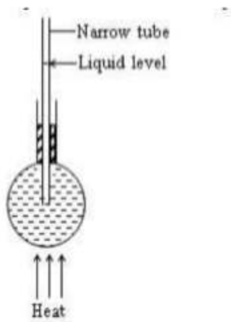


Railway lines

Railway lines are constructed with gaps between the consecutive rails to allow free expansion and contraction of the rails as a result of temperature changes.

Electricity transmission cables
The wires which are used for the transmission of electricity or telephone wires are usually sagging in order to allow them free expansion and contraction when temperatures change.

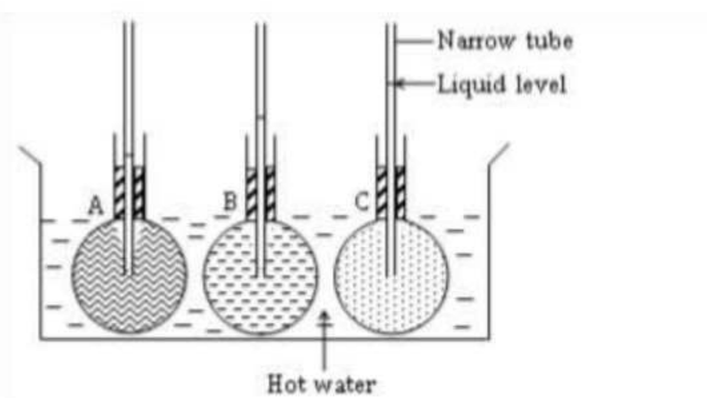
Experiment to demonstrate expansion in liquids



- Fill the flask with water.
- Pass the narrow tube through the hole of the cork and fix the cork tightly to the flask
- Note the first level of water on a narrow tube
- Heat from the bottom of the flask and observe the new level of water on the narrow tube

Observation
The water level increases in the narrow tube
Conclusion
This shows that water has expanded after heating since there is rise in the water level in the narrow tube

Experiment to compare expansion of different liquids



- ✓ Three identical flasks are filled with alcohol, kerosene and water respectively
- ✓ Fit a narrow tube in each flask through the cork
- ✓ Cool the flasks to the same temperature
- ✓ Adjust the levels of the liquid to be the same and mark the original levels
- ✓ Place the flasks in the trough of hot water

Observation

After some time, the liquids rise to different levels

Conclusion

This shows that liquids expand differently when heated at the same temperature

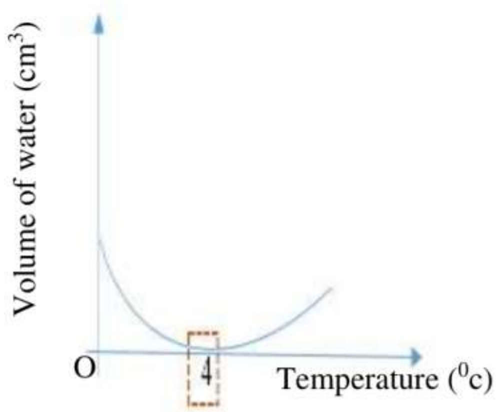
ANOMALOUS EXPANSION

Liquids expand on heating and contract on cooling. But water exhibits an exceptional behavior.

When it is heated from 0^0c, it contracts rather than expanding up to 4^0c.

The volume of water is minimum at 4^0c. Beyond 4^0c, water starts expanding. This behavior of water between 0^0c and 4^0c is called ***anomalous expansion of water.***

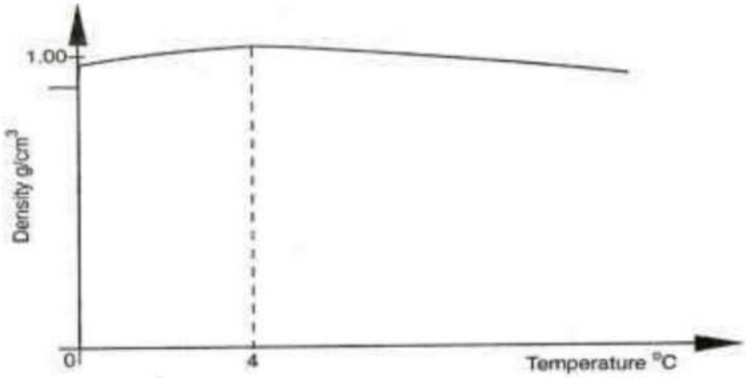
If a graph of volume against temperature is plotted, it looks like the one below.



It is observed that the volume of water decreases as temperature increases (rises) from 0^0c to 4^0c and then its volume starts to increase after 4^0c.

At 4^0c, the volume of water is minimum and therefore its density is maximum

If a graph of density against temperature is plotted, it looks like the one below

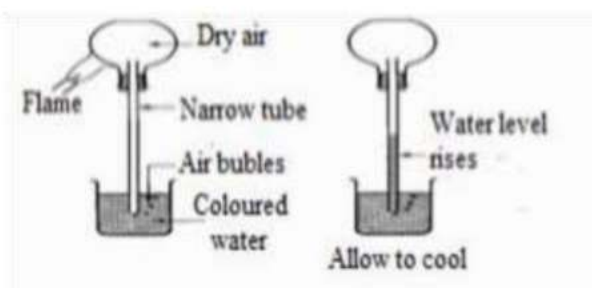


We observe that the density of water increases as its temperature rises from 0^0c to 4^0c and then its density starts to decrease after 4^0c

EXPANSION IN GASES

When a gas is heated, its molecules gain kinetic energy and move with high velocities (speeds) making them occupy wider volume
If this gas is trapped, like in a balloon or vehicle tyre, it causes them to bulge (burst)

An experiment to show expansion in gases



- Fill the beaker with clean water
- Pass the glass tube through the cork and insert it in around bottomed flask.
- Clamp the neck of the flask with a tube dipped in the water.
- Heat the flask for some time.
- Allow the flask to cool while the tube is still in water.
- Observe the water level in the test tube

Observation

Air is seen bubbling out of the flask. This is because the air inside expands when heated.

When the flask cools, water in the beaker rises in the tube. This is because air in the flask contract when it cools.

Application of expansion in gases

When an inflated balloon is tied at the outlet and exposed to sunshine or put near fire, it eventually bursts or bulges. This is because the air inside it expands beyond the capacity of the balloon.

During very hot days, car tyres may burst because the gas inside them expands

<u>LINEAR EXPANSIVITY</u>

It is the extent to which a material expands when its temperature changes by one kelvin

Linear expansivity, $\propto = \frac{linear\ expansion}{original\ Length\ \times temperature\ change}$

$$\propto = \frac{l_2 - l_1}{l_1(\theta_2 - \theta_1)}$$

The S.I unit of linear expansivity is per kelvin (K^{-1})

Examples

1. In an experiment to measure the linear expansivity of a material of 800mm is found to expand by 1.36mm when the temperature rise from the 15^0c to 100^0c. Find the linear expansivity of a material
2. A metal rod has a length of 100cm at 200^0c. At what temperature will its length be 99.4cm if the linear expansivity is $0.00002K^{-1}$ (**ANS 173K)**
3. A still bridge is 2.5m long. If the linear expansivity is $1.1X10^5c^{-1}$. How much will it expand when the temperature rises by 5^0c (**ANS 137500.2m**)

CHAPTER EIGHT

NATURE OF LIGHT, REFLECTION OF LIGHT AT PLANE SURFACES

LEARNING OUTCOMES

The learner should be able to:

a. Know illuminated and light source objects in everyday life
b. understand how shadows are formed and that eclipses are natural forms of shadows
c. understand how the reflection of light from plane surfaces occurs and how we can make use of this

Light is the form of energy that enables our eyes to see. It is often from very hot bodies with the exception of the glow worms.

When light falls in our eyes, it causes a sense of vision.

Light travels in a straight line through vacuum.

In the absence of light, we are unable to see anything.

Speed of light

Light belongs to the family of waves called electro-magnetic waves.

Light travels at a speed of $3.0X1^{0}8ms^{-1}$

Sources of light

Natural luminous sources

These are objects that produce their own light e.g. sun, glow worms

Artificial luminous sources

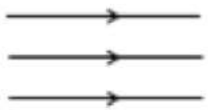
These are sources that do not produce their own light e.g. moon and mirror

RAYS AND BEAMS

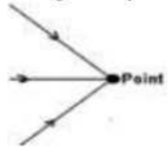
A ray is the direction of path of light. It is often represented by a line with an arrow on it.

A beam is the collection of light rays. A beam maybe parallel, divergent or convergent.

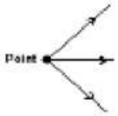
Parallel beam: These are represented by rays which will never meet.



Convergent beam: these are light rays that tend to meet at one point from different points



Divergent beam: these are light rays that originate from the same point and travel out in different directions



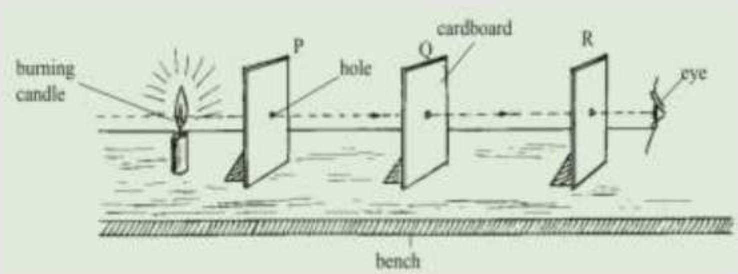
Properties of light

- ❖ Light can be reflected
- ❖ Light can be refracted
- ❖ Light travels in a straight (Rectilinear propagation of light)

Rectilinear propagation of light

It states that light travels in a straight line

Experiment to show that light travels in a straight line



Procedures

- Prepare card boards with a hole in each of the same size
- Place the card boards in a straight line using a thread through the holes and then pulled out.
- Place a source of light at one end and observe from the other end

Observation

The observer is able to see light

If one card board is displaced such that they are no longer in a straight line, the observer does not see light.

Conclusion

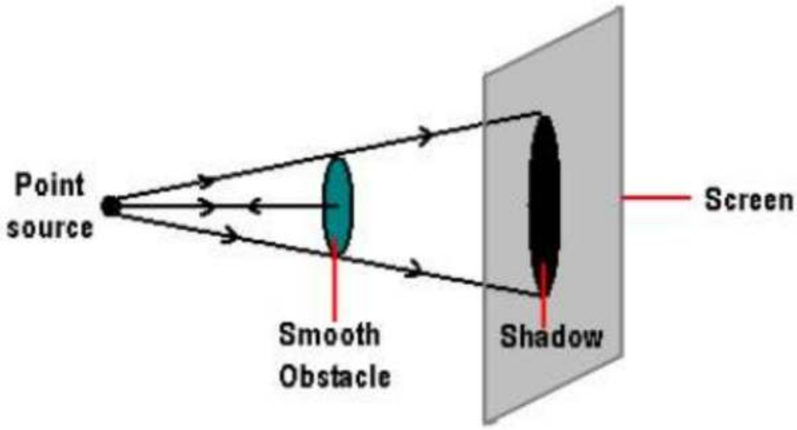
This shows that light travels in a straight line.

Shadows

A shadow is an area formed when an opaque object obstructs the source of light. **OR**
A shadow is an image of an object which does not allow light to pass through.
Shadows are formed when an object stops light from reaching the opposite side.

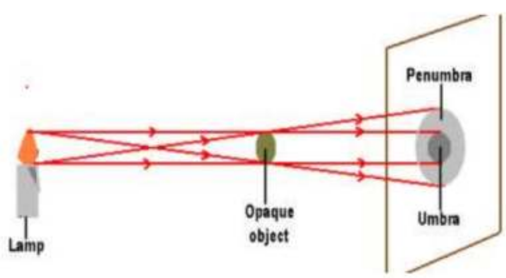
A shadow from a point source of light

When an object is placed in the path of light, the shadow formed on the screen is uniformly dark (umbra)



Shadow from an extended source of light

When an object is placed in a path of light from an extended source, a shadow formed tends to have edges with a boarder of partial darkness (penumbra) and total darkness in the centre (umbra)



ECLIPSE

An eclipse is formed when the sun, moon and the earth align themselves in a straight line.

Eclipses occur when light from the sun is stopped from reaching the earth by the moon or the moon by the earth.

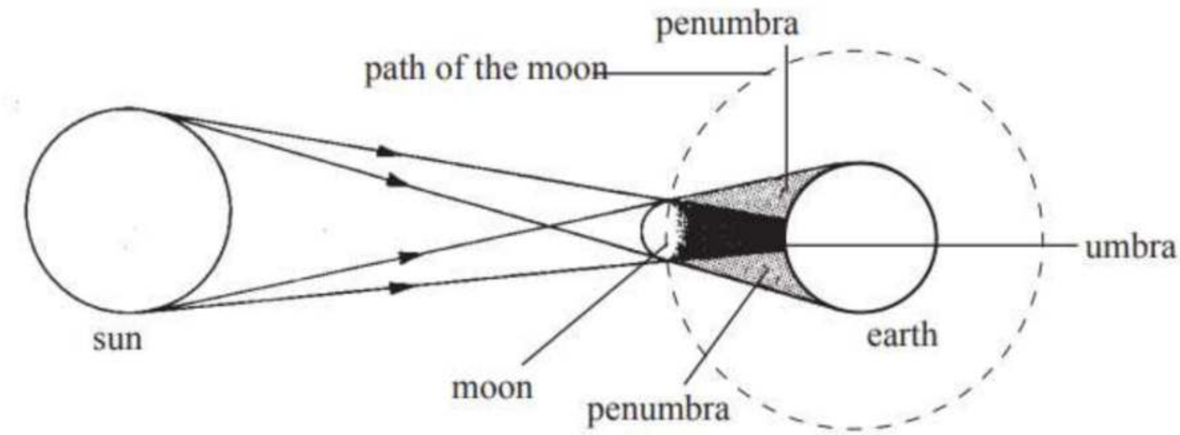
The earth rotates around the sun and the moon rotates around the earth. The path of their rotation are called their orbits

Types of eclipses

- Solar eclipse
- Lunar eclipse
- Annular eclipse

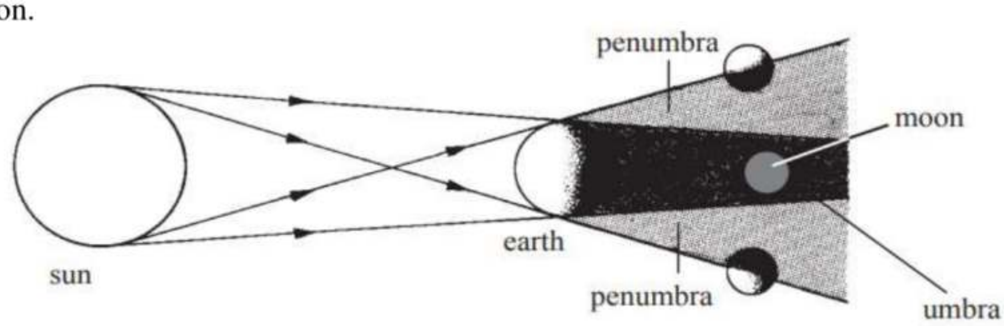
Solar eclipse

It occurs when the moon is in between the sun and the earth



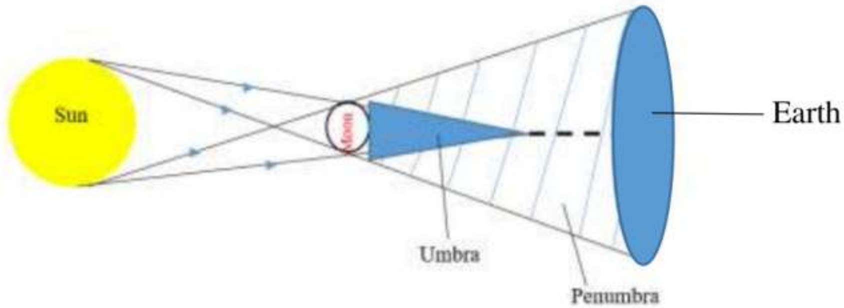
Lunar eclipse

It occurs when the earth is in between the moon and the sun. The image of the earth is casted on the moon.

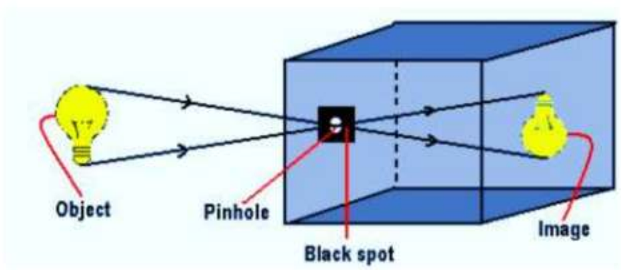


Annular eclipse

This is a special eclipse of the sun that occurs such that the tip of the umbra fails to reach the earth's surface. This is because the moon tends to be far away from the earth



PIN-HOLE CAMERA



A pin-hole camera consists of a closed box with the small hole on a face and a screen of a tracing paper on the opposite side

Characteristics of images formed by pin-hole camera (properties)

- The image is diminished (the image is smaller than the object)
- The image is inverted (upside down)
- The image is real (formed on the screen)

NB: When the object is closer to the pin hole, the size of the image increases but the image becomes less bright

MAGNIFICATION OF A PIN-HOLE CAMERA

Magnification is the ratio of image height to object height

Magnification, M = $\frac{image\ height}{object\ height}$

$$M = \frac{H_I}{H_O}$$

OR Magnification is the ratio of image distance to object distance

Magnification, M = $\frac{image\ distance}{object\ distance}$

$$M = \frac{V}{U}$$

NOTE: Magnification has no units because it is a ratio of similar quantities

Examples.

1. An object of height 5cm is placed 20cm from the pin-hole camera. If the image of the object is 1.25cm in the camera, calculate the magnification

   Solution

   H_o = 5cm

   U = 20cm

   H_I = 1.25cm

   M =?
2. A girl is 1.6m tall and stands 4m away from the pin-hole camera that is 20cm long. Find the height of the girl's image and hence determine the magnification

   Solution

   H_o=1.6m

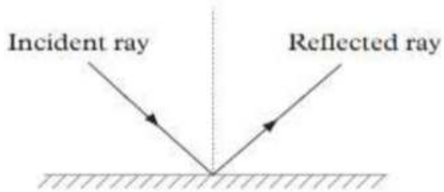
   U=4m

   V=20cm H_I=?

   M=?

Reflection of light

Reflection is the bouncing off of light rays after meeting a shiny surface.

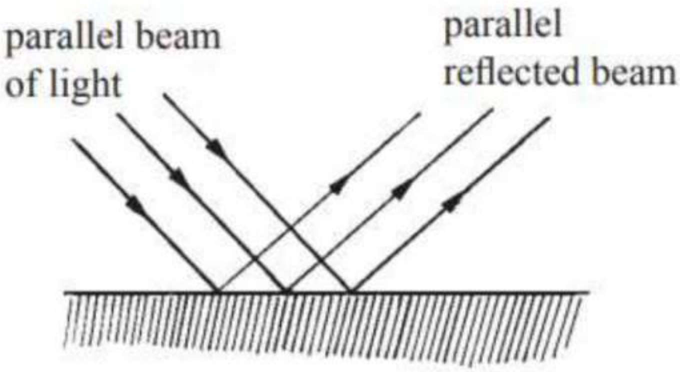


Types of reflection

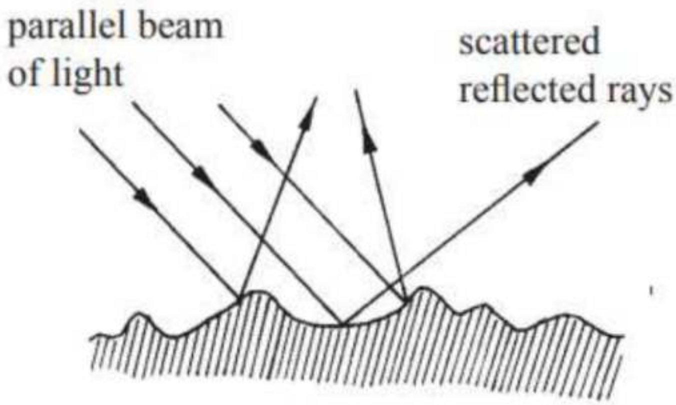
Regular reflection

Irregular reflection

Regular reflection: This is the type of reflection that occurs when a parallel beam of light falls on a smooth surface and is reflected as a parallel beam.



Irregular reflection (Diffuse reflection): This is the type of reflection that occurs when a parallel beam of light falls on a rough surface and is reflected as a scattered beam



Laws of reflection

1st law: The incident ray, the reflected ray and the normal at the point of incidence all lie in the same plane

2nd law: The angle of incidence is equal to the angle of reflection

Differences between regular and irregular reflection

Regular reflection	Irregular reflection
It occurs on a smooth surface (polished surface)	It occurs on a rough surface
Reflected rays are parallel	Reflected rays are scattered
The angle of incidence is equal to the angle of reflection	The angle of incidence is not equal to the angle of reflection

Number of images formed by two plane mirrors inclined at an angle θ

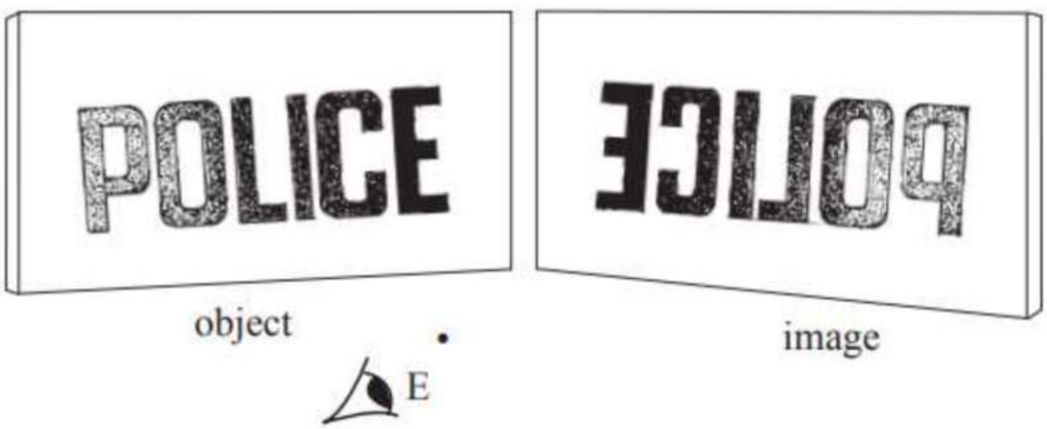
When an object is placed between two plane mirrors inclined at a certain angle θ, the number of images formed are calculated from; $n = \frac{360}{\theta} - 1$

Examples

Find the number of images formed when an object is placed between two mirrors inclined at angle;

a. 30^0
b. 36^0
c. 90^0
d. 60^0

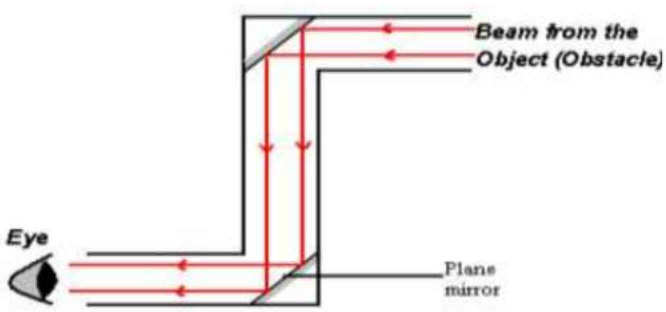
Properties of images formed in a plane mirror



- The image distance is equal to the object distance
- The image is erect (upright)
- The image formed is virtual (not formed on the screen)
- The image size is same as object size
- The image is laterally inverted (the right side of the object appears to be on the left)

Application of plane mirrors

Periscope

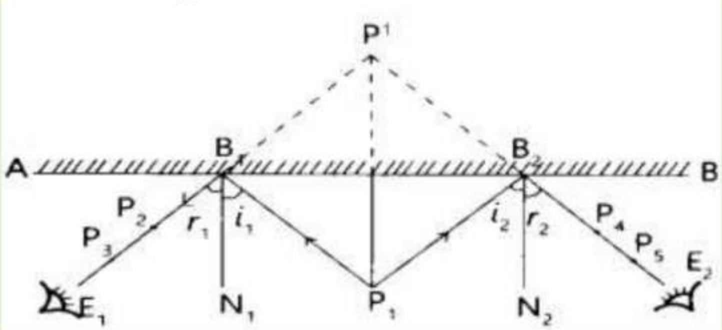


It consists of two plane mirrors inclined at an angle of 45^0 to the line joining them and are parallel to each other.

Light from the object is reflected by the upper mirror which is subsequently reflected by the lower to the observer

This enables the person to see an object that would not be seen when put behind an obstacle like a wall.

An experiment to investigate the laws of reflection



i. Fix a sheet of paper on the drawing board using the drawing pins
ii. Draw a straight line AB as shown in the figure.8.10 such that the silvered surface faces you.
iii. Fix pin P_1 in front of the mirror about 3cm from line AB
iv. With one eye closed, view the image of pin P_1 from position E_1 and fix two P_2 and P_3 such that they are in a straight line with the pin P_1.
v. Remove the two pins P_2 and P_3
vi. Repeat procedures with the eye in position E_2
vii. Remove the mirror
viii. Join points P_2 and P_3, P_4 and P_5 to meet line AB at B and B_2 respectively
ix. Using dotted lines, extend the lines to intersect at P^1
x. Draw the normal B_1, N_1 and B_2, N_2.
xi. Measure angles l_1 and r_1 and angle l_2 and re_2

S.2 PHYSICS NOTES

CHAPTER ONE
WORK, POWER AND ENERGY

LEARNING OUTCOMES

The learner should be able to:

a. know that the sun is our major source of energy, and the different forms of energy
b. know that energy can be changed from one form into another and understand the law of conservation of energy
c. understand the positive and negative effects of solar energy
d. Understand the difference between renewable and nonrenewable energy resources with respect to Uganda.
e. know and use the relationship between work done, force, and distance moved, and time taken
f. understand that an object may have energy due to its motion or its position and change between kinetic and positional potential energy
g. know the mathematical relationship between positional potential energy and kinetic energy, and use it in calculations

Work is the product of force and distance moved by the body in the direction of force.

Work done depends on;

- Amount of force applied on the body
- Distance moved by the body

Work done = force × distance moved in the direction of force

$\mathbf{W} = \boldsymbol{F} \times \mathbf{S}$ **or** $\mathbf{F} \times \mathbf{d}$

When force is in newton (N) and distance in metre (m), the unit of work done is **Nm**

The S.I unit of work done is **joule (J)**

A joule is the work done when a force of 1N moves a body through a distance of 1m in the direction of force.

Examples

1. A boy rides a motorcycle with an engine that exerts a force of 400N. The work done by the motorcycle is 96KJ. Find the distance moved by the body. **(Ans: s = 240m)**
   - Points to note
   - Change 96KJ to J by multiplying 1000
2. A girl of mass 50kg runs up a stair case of 20 steps each 8.0cm high. Find the work done by the girl. (Acceleration due to gravity = $10ms^{-2}$)

   Solution

   m = 50kg

   F = ma

   = 50 x 10

   = 500N

   Distance, $s = 20 \times \frac{8.0}{100}$

   = 1.6m

   Work done = F x s

   Work done = 500 x 1.6

   = 800J

Power

Power is the rate of doing work. **OR**

Power is the rate of transfer of energy

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

If work done is in joules (J) and time is in seconds (s), the unit of work done is joule per second (Js^{-1}).

The S.I unit of work done is **watt (W)**

A watt is the rate of doing work at $1Js^{-1}$

NOTE:

- $1Js^{-1} = 1W$
- 1Nm = 1J
- 1KJ = 1,000J
- 1MJ = 1,000,000J

Examples

1. A girl of mass 50kg climbs a flight of a straight stair case having 40 steps each of 30m high in 10s. Calculate the power developed by the girl.
2. A force of 600N pulls a load through a distance of 20m in 2 minutes. Calculate the power developed.

Solution

1. M = 50kg
   F = ma
   = 50 x 10
   = 500N
   Distance = 40 x 30
   = 1200m

   Work done = Fs
   = 500 x 1200
   = 600,000J
   Power = $\frac{work\ done}{time\ taken}$
   = $\frac{600,000}{10}$
   = **60,000W**
2. Force = 600N
   Distance = 20m
   Time taken = (2 x 60)s
   = 120s
   Power = $\frac{work\ done}{time\ taken}$
   = $\frac{600\ x\ 20}{120}$
   = **100W**

3. The figure below shows a body acted upon by the forces indicated

Find the;

(i) Resultant force
(ii) Acceleration due to gravity of the body
(iii) Work done by the resultant force if the body moves a distance of 20m

Solution

(i) RF = 2,000 – 500
= **1500N to the right** (1500N →)

(ii) F = ma
1500 = 1000 x a
a = **1.5ms^{-2}**

(iii) wd = F x s
= 1300 x 20

= **30,000J**

Activity 1.1

The table below shoes the results obtained in an activity to determine power. Fill in the spaces.

Pulling force (**N**)	Distance moved (**m**)	Time taken (**s**)	Power (**W**)
40	400	…………………..	16
………………..	150	3	20
80	………………….	20	52

ENERGY

Energy is the ability of the body to do work

The S.I unit of energy is **joules (J)**

Finding Out the Forms of Energy

Material	**Energy**
Burning wood	Heat energy
Dry wood	Chemical energy
Drum	Sound energy
A person in a swing	Mechanical energy (**K.E+ P.E**)
Bulb	Light energy

Other forms of energy include;

- **Electrical energy:** is the energy produced by electrons moving through a substance
- **Radiant energy:** is the combination of heat and light energy
- **Chemical energy:** is the form of energy stored in food, wood and fuels
  It is the form of energy that can be converted to heat by burning.
- **Sound energy:** is the energy produced by vibrating objects.
- **Mechanical energy:** is the combination of potential and kinetic energy.
- **Atomic energy:** is the energy produced when atoms are split
  A tremendous amount of energy is released when this happens e.g. atomic bombs.

Sources of energy

- Running water
- Bio gas
- Fossil fuel
- Wind
- Sun

Other forms of energy

- Geo- thermal
- Ocean waves
- Nuclear energy

RENEWABLE AND NON - RENEWABLE SOURCES/ RESOURCES

Renewable resources

These are sources of energy which can be re used without getting exhausted.

These resources can replace themselves quickly.

They include;

- ✓ Wind energy
- ✓ Solar energy from the sun
- ✓ Ocean energy inform of waves
- ✓ Hydro power from moving water
- ✓ Bio - mass from plants

Non – renewable resources

These are sources of energy which cannot be re used after being exhausted.

They include;

- Nuclear energy
- Fossil fuels such as coal, natural gas, petroleum

Energy source	Advantages	Disadvantages
Moving water	• Reliable • Cheap to run • Readily available • Does not produce emissions/ radiations	• High initial costs • Susceptible to drought • Hinders water transport
Bio gas	• Simple and low cost technology • Reduces soil and water pollution	• Less suitable for a large population • Affected by temperature changes
Wind	• Cheap to run • Does not produce polluting gases	• Expensive to install • It produces noise
Sun	• Readily available • Cheap to run • Does not produce emissions	• High installation costs • Un reliable source
Nuclear	• Produces more energy • Does not produce emissions	• Expensive to install • Produces dangerous wastes

NB: Sources of energy are systems, materials or bodies from which we can obtain energy in a certain way.

SOLAR ENERGY

The sun is the major source of energy required to sustain life on earth.

The energy from the sun is called solar energy

Solar energy can be installed everywhere on every house and it is safer to use than hydroelectricity.

Disadvantage of solar energy

- The amount of energy produced depends on the weather
- The initial costs for the material and installation is relatively high.
- Solar energy uses a lot of space as the amount of electricity needed increases

NOTE: There are different technologies available to trap solar energy such as;

- ✓ Solar panels
- ✓ Solar cookers
- ✓ Solar heaters

POTENTIAL AND KINETIC ENERGY

All bodies are either in a state of motion or rest. Bodies at rest possess potential energy while bodies in motion possess kinetic energy.

Potential Energy

Is the energy possessed by the body which is at rest. **OR**

Is the energy possessed by the body as a result of its position above the earth.

Potential energy **= mgh**

Where;

m – Mass of the body (kg)

g – Acceleration due to gravity (ms^{-2})

h – Height above the ground / distance (m)

Kinetic Energy

Is the energy possessed by the body as a result of its motion. **OR**

Is the energy possessed by moving objects.

Kinetic energy = $\frac{1}{2}mv^2$

Where;

m – Mass (kg)

v – Velocity / speed (ms^{-1})

Examples Of Bodies Which Store Potential Energy.

- Energy stored in a book resting on top of a desk
- Energy possessed by a person standing on the ground
- Energy stored in a jack fruit hanging on the branch of a tree

Examples of Bodies Which Store Kinetic Energy

- A ball falling on the ground
- Energy possessed by running water
- Energy possessed by moving vehicles

NB: Potential energy increases with increase in distance (height) above the ground while kinetic energy increases with increase in speed (velocity) of the body.

The law of conservation of energy

It states that energy can neither be destroyed nor created but changes from one form to another.

Examples

- Lighting a bulb using a battery or a dry cell (heat energy to light energy)
- Loud speaker converts electrical energy to sound energy

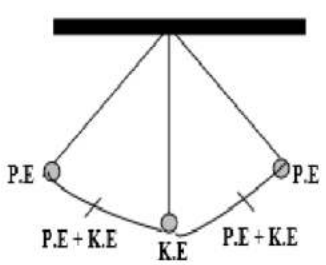
NB: As energy is changing from one form to another, the energy converter (device) is required to ease conversion.

Examples of these devices include;

Energy change	**Converter (device)**
Chemical to electrical	Dry cell or battery
Light to electrical	Solar panel
Electrical to heat	Flat iron, cooker
Heat to electrical	Thermo – couple
Sound to electrical	Microphone
Electrical to sound	Loud speaker
Electrical to kinetic	Electric motor
Kinetic to electrical	Electric generator

Inter - conversion of energy between potential and kinetic energy

A simple pendulum bob



- The bob has maximum potential energy at two entrance ends.
- At the intermediate points, the bob has both kinetic and potential energy
- As it passes the rest position, the bob has a maximum kinetic energy

Calculations

1. A bullet of mass 500g is fired at a speed of $1.5ms^{-1}$. How much energy does it have? (Ans: **0.5625J**)
2. An object of mass 2kg dropped from the top of the building hits the ground with the kinetic energy of 900J. Calculate the height of the building.
   Solution
   m = 2kg
   KE = 900J
   h =?
   PE lost = KE gained
   mgh = 900
   2 x 10 x h = 900
   h = 45m

Activity 1.2

1. John raised a mallet of 1kg to a height of 0.3m. Calculate the potential energy of the mallet. (Ans**: PE = 3J**)
2. A boda boda cyclist is riding at a velocity of $20ms^{-1}$. A motorcycle moves with a KE of 1.0×10^4J. What is the mass of the motorcycle and cyclist? (Ans: **m = 50kg**)
3. Jane's mother who is 55kg walks at a speed of $1.5ms^{-1}$. Calculate the kinetic energy she exhibits while walking. (Ans: **KE = 61.875J**)

Energy Changes in the Falling Body

P.E ⟶ P.E + K.E ⟶ K.E ⟶ sound + heat

The velocity with which the body hits the ground when it falls freely can be calculated from;

PE lost = KE gained

$$mgh = \frac{1}{2}mv^2$$

$$\frac{mgh}{m} = \frac{\frac{1}{2}mv^2}{m}$$

$$V = \sqrt{2gh}$$

Examples

1. The body falls freely through a distance of 3m. Calculate the velocity with which it hits the ground.

Solution:

From; v = $\sqrt{2gh}$

V = $\sqrt{2 \, x \, 10 \, x \, 3}$

V = 7.7ms^{-1}

2. A 200g ball falls from a height of 0.2m. calculate the kinetic energy just before it hits the ground

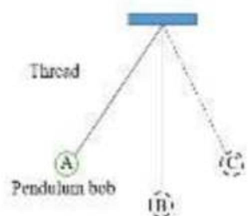
   Solution
   PE lost = KE gained
   mgh = KE
   0.2 x 10 x 0.2 = KE
   KE = 0.4J

Activity 1.3

A block of mass 2kg falls freely from rest through a distance of 3m. Calculate the kinetic energy of the block. (Ans: **KE = 60J**)

INDIVIDUAL ACTIVITY 1.4

In an experiment to investigate energy changes in a swinging pendulum, learners observed the motion of the diagram in the figure below.



1. (a) Describe energy changes when the bob is released from A to C
   (b) A student of mass 40kg climbs a stair case in a school library to a height of 14.0m above the starting point in 55.0s.
      (i) How much force does the student exert in getting to the higher level (Ans: **P = 101.81W**)
      (ii) Calculate the students power
2. A man in a hunting field released an arrow from a bow with kinetic energy of 3.2J. If the mass of the arrow is 25g, what was the initial velocity of the arrow. (Ans: **V = 16ms^{-1}**)

CHAPTER TWO
SIMPLE MACHINES

LEARNING OUTCOMES

The learner should be able to:

a. understand the meaning of machines and explain how simple machines simplify work
b. understand the principles behind the operation of simple machines

A machine is a device that simplifies work.

Common terms used
Mechanical advantage (MA)
It is the ratio of load to effort

MA = $\frac{load}{effort}$

MA = $\frac{L}{E}$

Velocity ratio (VR)
It is the ratio of effort distance to load distance

VR = $\frac{effort\ distance}{load\ distance}$

VR = $\frac{Ed}{Ld}$

OR
It is the ratio of distance moved by the effort to distance moved by the load

NB: MA and **VR** have no units because each is a ratio of similar quantities.
For the **VR**, the load must move in the same direction as the effort.
Work input and work output of a machine
Work input is the work done by the effort **OR**
Is the work done on the machine.
Work output is the work done by the load **OR**
Is the work done by the machine.

Work input = **Effort x Effort distance**
Work output = **Load x Load distance**

Questions 2.1

1. Give reasons why the work output of a machine is always less than the work input?
   - Some energy is wasted in overcoming friction between the movable parts of the machine
   - Some energy is wasted in lifting useless loads of the machine
2. Give ways how the work output of the machine can be improved (increased)
   - By reducing friction between the movable parts of the machine through oiling or greasing
   - By reducing on the weight of the useless loads on the machine

Efficiency of the Machine

It is the ration of work output to work input expressed as a percentage. The S.I unit of efficiency is percentage $(\%)$

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

$$= \frac{Load \times Load\ distance}{Effort \times Effort\ distance} \text{ x } 100$$

$$= \frac{L \times Ld}{E\ X\ Ed} \times 100$$

$$= \frac{L}{E} \times \frac{Ld}{Ed} \times 100$$

$$= \boldsymbol{\frac{MA}{VR} \times 100}$$

Therefore, efficiency is the ratio of MA to VR expressed as a percentage

Question 2.2

John put 50Nm in a machine but he realized that the machine produced 40Nm of the work

(i) Define the term work wasted
(ii) Calculate the work wasted by the machine

Solution

Work wasted is the difference between work input and work output which makes the machine to be less than 100% efficient.

Work wasted = work input – work output

= 50 – 40

= 10Nm

Calculations

1. A machine has a velocity ratio of 8.it is used to lift a load of 300N using an effort of 60N. calculate the;
   (i) Mechanical advantage (**MA= 5**)

(ii) Efficiency of the machine (**62.5%**)

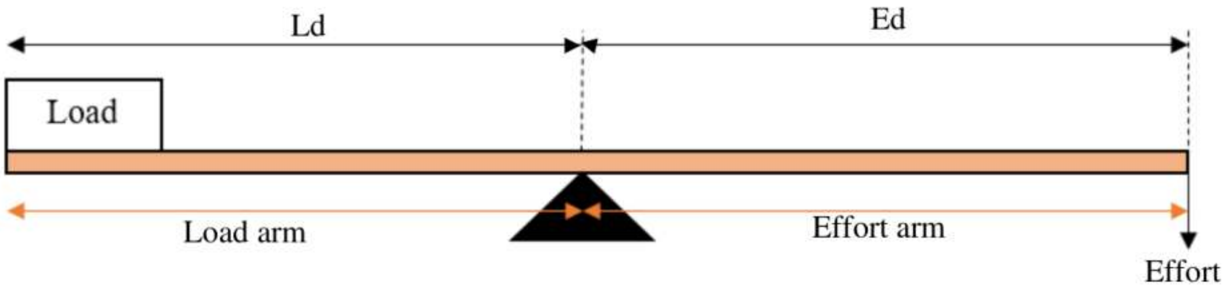
2. A machine lifts a mass of 120kg through a height of 5m. An effort of 800N applied passes through 10m so as to overcome the load. What is the efficiency of the machine? (**75%**)
3. An effort of 250N rises a load of 900N through 5m while using a simple machine. The effort moves a distance of 25m. what is the;
   (i) Work output (**4500Nm**)
   (ii) Work input (**6250Nm**)
   (iii) Efficiency (**72%**)
4. A man lifts a load of 300N on a wheel barrow through a load distance of 100mm with a force of 100N through an effort distance of 400mm. determine the;
   (i) Work input into the machine (**40Nm**)
   (ii) Work output (**30Nm**)
   (iii) Mechanical advantage (**MA = 3**)
   (iv) Velocity ratio (**VR = 4**)
   (v) Efficiency of the machine (**75%**)

Questions 2.3

1. Explain why the efficiency of the machine is always less than 100% efficient?
   - Some energy is wasted in overcoming friction between the movable parts of the machine
   - Some energy is wasted in lifting useless loads of the machine
2. Explain how the efficiency of the machine can be improved
   - By reducing friction between the movable parts of the machine through oiling or greasing
   - By reducing on the weight of the useless loads on the machine

LEVERS

A lever is a rigid bar which is free to move about a fixed point. This fixed point is called a fulcrum or pivot



From the principle of moments,

Sum of clockwise moments = sum of anti - clockwise moments

$$\frac{E\ X\ Ed}{L} = \frac{L \times Ld}{L}$$

$$\frac{E}{L} \times \frac{Ed}{Ed} = \frac{Ld}{Ed}$$

$$\frac{E}{L} = \frac{Ld}{Ed}$$

$$\frac{L}{E} = \frac{Ed}{Ld}$$

MA ≈ VR

Since **MA ≈ VR**, the lever system is more efficient compared to other machines.

Classes of levers

First class levers

This is the lever system where the pivot (fulcrum) is between the load and effort.

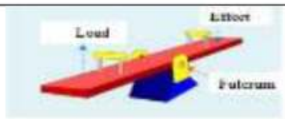
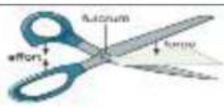
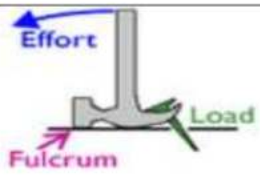
Second class levers

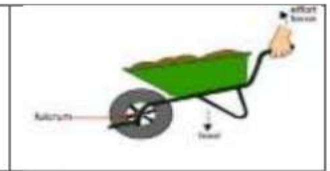
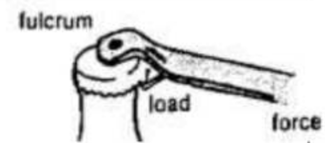
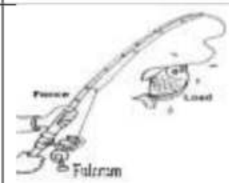
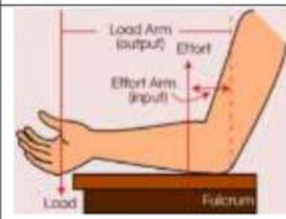
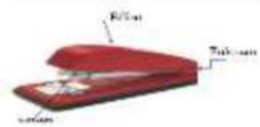
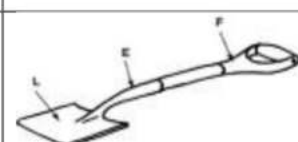
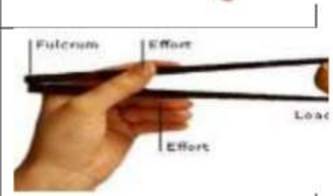
This is the lever system where the load is between the pivot and the effort.

Third class levers

This is the lever system where the effort is between the pivot and the load.

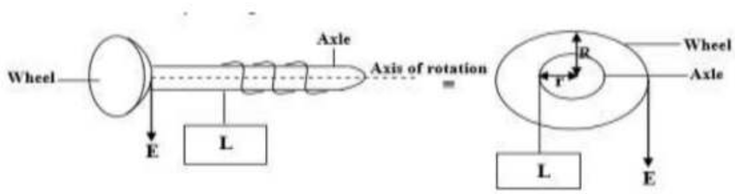
A table showing types of levers with their examples

LEVER	EXAMPLE	DIAGRAM
First class	See – saw	
	Pair of pliers	
	Pair of scissors	
	craw hammer	
	nut cracker	

Second class	wheelbarrow	
	bottle opener	
Third class	Fishing rod	
	Human arm	
	stapler	
	Spade	
	spoon or fork	
	Pair of tongs	

WHEEL AND AXLE MACHINE

This consists of two wheels of different radii on the same axis. The axle has the same attachment on the wheel. The effort is attached to the wheel and the string attached to the axle that raises the load.



Velocity ratio = $\frac{distance\ moved\ by\ the\ effort}{distance\ moved\ by\ the\ load}$

$= \frac{circumference\ of\ the\ wheel}{circumference\ of\ the\ axle}$

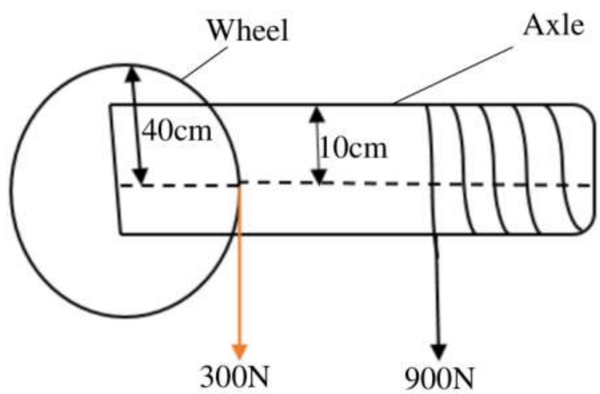
$= \frac{2\pi R}{2\pi r}$

VR $= \frac{\boldsymbol{R}}{\boldsymbol{r}}$

Thus, VR = $\frac{radius\ of\ the\ wheel}{radius\ of\ the\ axle}$

Examples

1.



From the figure above, calculate the,

(i) M

(ii) VR

(iii) Efficiency

Solution

(i) MA = $\frac{Load}{Effort}$

$= \frac{900}{300}$

$= \mathbf{3}$

(ii) $VR = \frac{Radius\ of\ the\ wheel}{Radius\ of\ the\ axle}$

$= \frac{R}{r}$

$= \frac{40}{10}$

$= \mathbf{4}$

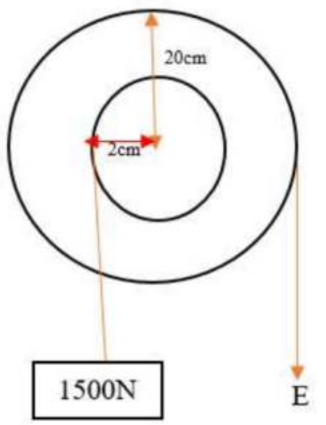
(iii) $Efficiency = \frac{MA}{VR} X\ 100$

$= \frac{3}{4} x\ 100$

$= \mathbf{75\%}$

2. A machine consisting of a wheel of radius 50cm and axle of radius 10cm is used to lift a load of 400N with an effort of 100N. calculate its;
   (i) MA (**Ans: 4**)
   (ii) VR (**Ans; 5**)
   (iii) Efficiency (**Ans: 80%**)

3. The efficiency of the machine below is 75%.



Calculate its;
   (i) VR (**Ans: 10**)
   (ii) MA (**Ans: 7.5**)
   (iii) Effort applied (**Ans: E = 200N**)

4. A wheel and axle machine is constructed from a wheel of diameter 20cm and mounted on an axle of diameter 4cm. calculate the;
   (i) VR of the machine
   (ii) Greatest possible value of the MA
   (iii) Explain why the MA is likely to be less than that value.

Solution

(i) $VR = \frac{Radius\ of\ the\ wheel}{Radius\ of\ the\ axle}$

$= \frac{10}{2}$

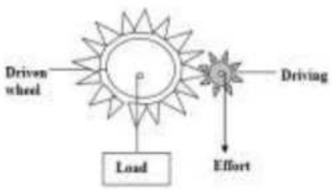
$= \mathbf{5}$

(ii) MA ≈ 5

- This is due to friction between the moving parts of the machine
- Some energy is wasted in lifting useless loads on the machine

GEAR SYSTEM

A gear is a device consisting of toothed wheels. If the effort is applied on a smaller gear, it drives a large gear which has a load attached on it.



$VR = \frac{No.of\ teeth\ of\ the\ driven\ wheel}{No.of\ teeth\ of\ the\ driving\ wheel}$

$\mathbf{VR = \frac{N}{n}}$

Examples

1. Two gear wheels A and B with 20 and 40 teeth respectively lock into each other. They are fastened on the axles of equal diameters such that the weight of 400N attached to a string wound around one axle raises a load of 600N attached to a string wound around the other axle. Calculate the;

(a) VR of the system when;
   (i) A drives B
   (ii) B drives A

(b) Efficiency when,
   (i) A drives B
   (ii) B drives A

Solution

(a) (i) $VR = \frac{No\ of\ teeth\ of\ the\ driven}{No\ of\ teeth\ of\ the\ driving}$

$= \frac{N_B}{n_A}$

$= \frac{40}{20}$

$= \mathbf{2}$

(iii) $VR = \frac{No\ of\ teeth\ of\ the\ driven}{No\ of\ teeth\ of\ the\ driving}$

$= \frac{NA}{nB}$

$= \frac{20}{40}$

$= 0.5$

(iv) $MA = \frac{L}{E}$

$= \frac{600}{400}$

= 1.5

(b) (i) Efficiency $= \frac{MA}{VR} X\ 100$

$= \frac{1.5}{2} x\ 100$

75%

(iii) Efficiency $= \frac{MA}{VR} x\ 100$

$= \frac{1.5}{0.5} x\ 100$

= 300%

Activity 2.4

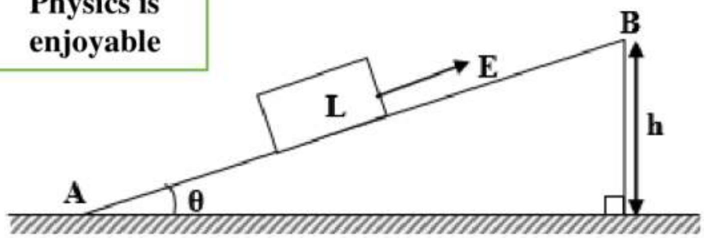
1. A driving wheel of 25 teeth engages with a second wheel of 100 teeth and has an efficiency of 85%. Calculate the;
   (i) VR (**Ans: VR = 4**)
   (ii) MA of the machine (**Ans: MA = 3.4**)
2. Two gear wheels P and Q with 25 and 50 teeth respectively lock into each other. They are fastened on the axles of equal diameter such that a weight of 200N attached to the string wound around one axle raises the load of 300N attached to a string wound around the other axle. Calculate the;
   (i) VR and efficiency when Q drives P (**Ans: VR = 0.5, effi = 300%**)
   (ii) VR and efficiency when P drives Q (**Ans: VR = 2, effi = 75%**)

INCLINED PLANES

Research work

Using any resource, make notes about inclined planes (its velocity ratio, applications and why they are used)

An inclined pane is a slope which allows a load to be raised more gradually or easily using a smaller effort than when lifting vertically upwards.



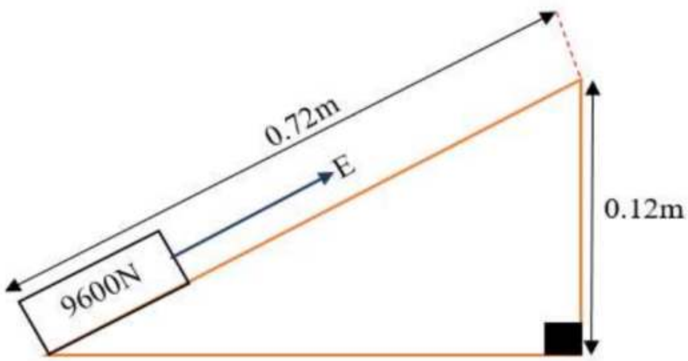
$$\text{VR} = \frac{\textit{distance moved by the effort}}{\textit{distance moved by the load}}$$

$$\text{VR} = \frac{\textit{length of the plane}}{\textit{height of the plane}}$$

$$\mathbf{VR} = \frac{l}{h}$$

Example

The figure below shows an inclined plane which is 80% efficient.



Calculate the;

(i) VR
(ii) MA
(iii) Effort required to raise the load
(iv) Work input
(v) Work output

Solution

(i) $VR = \frac{l}{h}$

$= \frac{0.72}{0.12}$

$= \mathbf{6}$

(ii) $Efficiency = \frac{MA}{VR} \times 100$

$80 = \frac{MA}{6} \times 100$

MA = **4.8**

(iii) Effort required

$MA = \frac{L}{E}$

$4.8 = \frac{9600}{E}$

E = **2000N**

(iv) Work input = E x Ed

= 2000 x 0.72

= 1440J

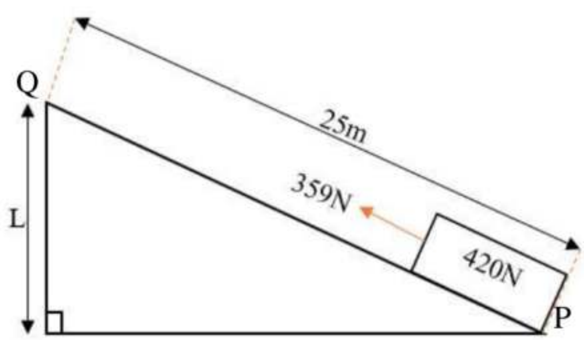
(v) Work output = L x Ld.

= 9600 x 0.12

= 1152J

INDIVIDUAL ACTIVITY 2.5

1. The figure below shows an inclined plane used to lift a load from point P to Q



If the work input of the plane is 8,750J, find the;

(i) Height of the plane
(ii) Velocity ratio of the plane
(iii) Work done against friction as the load is raised

(iv) Efficiency of the plane

Solution

(i) Height of the plane

From; l x ld = E x Ed

420 x ld = 8750

420Ld = 8750

Ld = **20.83m**

Therefore, the height of the plane is 20.83m

(ii) From VR = $\frac{l}{h}$

$= \frac{25}{20.83}$

= 1.20019

(iii) Efficiency = $\frac{MA}{VR}$ x 100

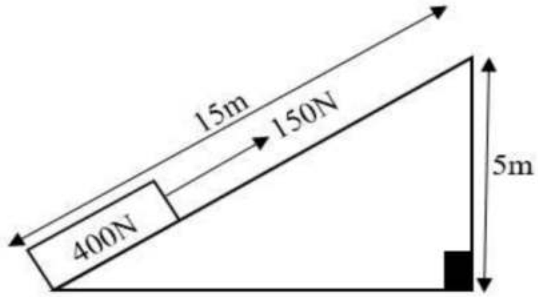
$= \frac{1.2}{1.20019}$ x 100

= 99.9

≈ **100%**

Activity 2.6

A load of 400N is pulled along the plane as shown below

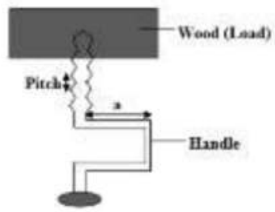


Calculate the;

(i) VR (**Ans: VR = 0.03)**
(ii) Work input (**Ans: 22.5J)**
(iii) Work output (**Ans: 2000J)**
(iv) MA (**Ans: 2.6667)**

Screws

A screw is a nail or bolt with a thread like windings



Pitch is the distance between any two successive (consecutive) threads of a screw. In one complete turn, the screw moves through linear distance equal to 1 pitch (1P). This is the load distance.

The effort moves through a distance equal to the circumference of the handle.

Velocity ratio = $\frac{effort\ distance}{load\ distance}$

$= \frac{circumference\ of\ the\ handle}{1P}$

$= \frac{2\pi r}{1P}$ **OR**

$= \frac{2\pi l}{1P}$

Examples

In a screw jack, the length of the handle is 56cm and a pitch of 2.5mm is used to raise a load of 2000N. If the MA is 1408, calculate the;

(i) Effort required to raise the load.
(ii) VR
(iii) Efficiency of the screw, hence explain the significance of your value of efficiency.

Solution

(i) L = 56cm =0.56m
1 pitch = 2.5mm = 0.0025m
MA = $\frac{L}{E}$

1408 = $\frac{2000}{E}$

E = **1.4205N**

(ii) VR = $\frac{2\pi l}{1P}$

$= \frac{2\pi x 0.56}{0.0025}$

= 1408

(iii) Efficiency = $\frac{MA}{VR}$ x 100

$= \frac{1408}{1408}$ x 100

= 100%

The MA is equal to VR. So the work input is equal to work output

Question 2

A certain screw machine has a pitch of 3.5mm. The effort is applied using a handle which is 45cm long. Calculate its VR **(Ans: 790.2041)**

Question 3

A screw jack with a lever arm of 56cm has threads which are 2.5mm apart is used to raise a load of 800N. If the efficiency is 25%, find the;

(i) VR **(1408)**
(ii) MA **(352)**

Activity 2.7

A load of 800N is raised by a screw jack whose arm is 49cm and the distance between the consecutive threads is 2.5mm. If the machine is 40% efficient, calculate the;

(i) VR **(1232)**
(ii) MA **(492.8)**

PULLEY SYSTEM

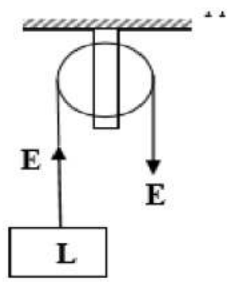
A pulley is a wheel with a grooved rim over which a string passes.

Types of pulleys

- ✓ Single fixed pulley
- ✓ Single movable pulley
- ✓ Block and tackle pulley system

Single fixed pulley

This is the type of pulley fixed on a rigid support.



It is applied in;

- Raising a flag
- Lifting building materials during construction

NB: load distance = effort distance

Tension in the string is the same throughout

If there is no friction, load = effort

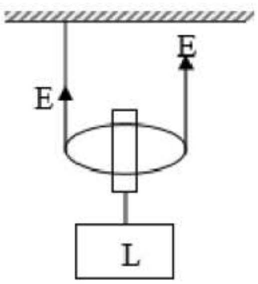
This means that **MA= 1**

In practice, **MA** and **VR** are less than **1** because;

Some energy is wasted or lost in lifting useless loads like threads

Some energy is wasted or lost in overcoming friction between the movable parts of the machine

Single movable pulley



Here, the effort distance = 2 load distance

Tension is the same throughout the string

VR = $\frac{effort\ distance}{load\ distance}$

If there is no friction, load = effort

At balance, sum of upward forces = sum of downward forces

$$E + E = L$$

$$2E = L$$

$$MA = \frac{2E}{E}$$

$$= \mathbf{2}$$

MA of a single movable pulley maybe less than **2** because;

- Some energy is wasted or lost in lifting useless loads like threads
- Some energy is wasted or lost in overcoming friction between the movable parts of the machine

BLOCK AND TACKLE PULLEY SYSTEM

This consists of two blocks having one or more pulleys combined together to form a machine.

This is done in order to have a high **MA** and **VR**

It is applied in;

- Break downs
- Lifts
- Cranes

Note: If the effort is 6N, the tension acting is also 6N.

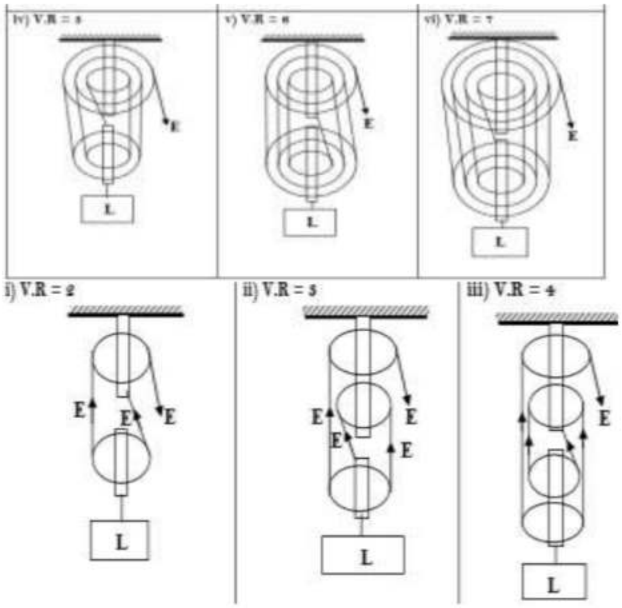
For an odd number of pulleys in a system, the upper block must contain one more pulley than in the lower block.

- In addition, the string starts from the lower block
- For even number of pulleys, the number of pulleys in each block must be the same.
- In addition, the string starts from the upper block.
- The direction of the tension must be towards the fixed point (rigid support)

Group Activity 2.8

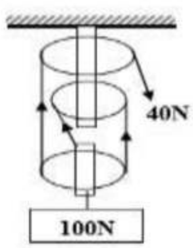
Draw a block and tackle pulley system with the following VR

(i) 3
(ii) 2
(iii) 4
(iv) 7
(v) 8
(vi) 6



Examples

1. The minimum effort required to raise a load of 100N is 40N as shown below



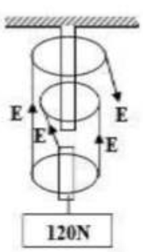
Calculate the;

(i) MA **(2.5)**

(ii) VR **(3)**

(iii) Work done by the load if it moves through a distance of 6m **(600J)**

2. In the pulley system below, each pulley has a mass of 0.6kg



Calculate the;

(i) Effort, E

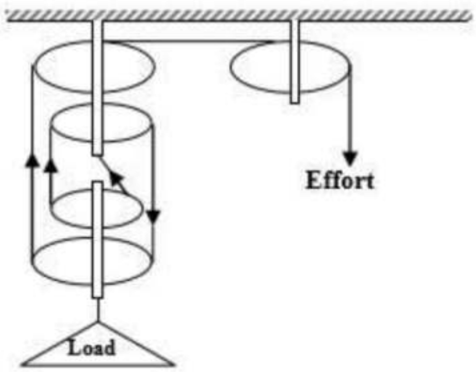
(ii) MA

(iii) Efficiency

Exercise

1. Draw a pulley system of VR 5 lifting a load of 500N using an effort of 50N and determine the efficiency of the pulley system.
2. A block and tackle pulley system with a velocity ratio of 5 and 60% efficient is used to lift a load of mass 60kg through a vertical distance of 2m. What effort must be exerted? **(Ans: E = 200N)**

Experiment to measure the ma of the pulley system

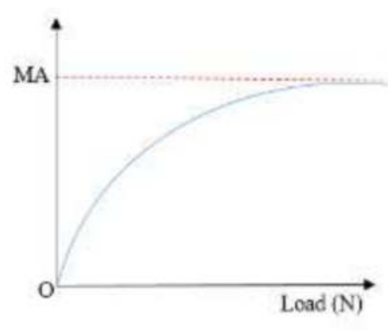


Procedures

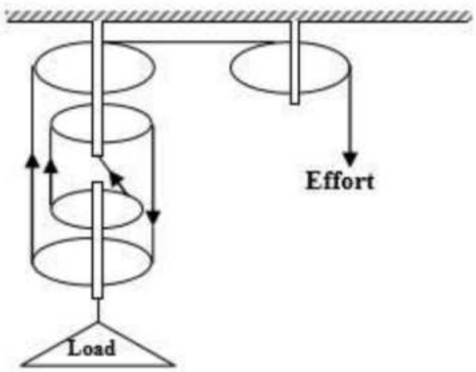
- A known load is put on the load pan and a known effort is put on the effort pan
- The experiment is repeated using other known loads
- The respective values of effort added are noted and the results are tabulated

Load (N)	Effort (N)	MA = $\frac{L}{E}$
…………	………..	………
…………	………..	………

A graph of MA against L is plotted



Experiment to measure the efficiency of the pulley system

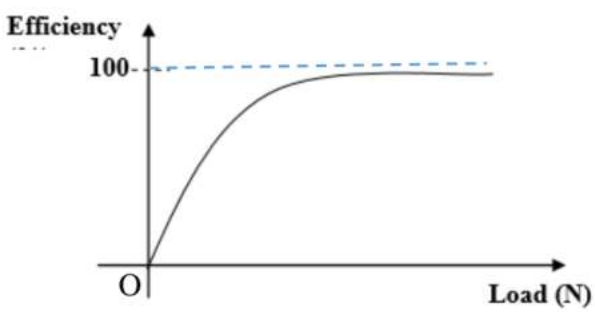


Procedures

- A known load is put on the load pan and a known effort is put on the effort pan.
- The experiment is repeated using other known loads
- The respective values of effort added are noted and the results are tabulated

Load (N)	Effort (N)	MA = $\frac{L}{E}$	Efficiency = $\frac{MA}{VR}$ x 100 (%)
……….	………	………	……………
……….	………	………	……………

A graph of efficiency against the Load is plotted



CHAPTER THREE

TURNING EFFCT OF FORCES, CENTRE OF GRAVITY AND STABILITY

LEARNING OUTCOMES

The learner should be able to;

a. understand the turning effect of forces and its applications
b. understand and apply the concept of centre of gravity

Centre of gravity

It is the point where the whole weight of the body appears to act from **OR**

It is the point of application of the resultant force acting on the body due to the earth's attraction on it.

Centre of mass

It is the point on the body where the resultant force produces acceleration but no rotation.

Centre of gravity for irregular objects.

For objects with regular shapes and uniform thickness, their centre of gravity is determined and found at the middle.

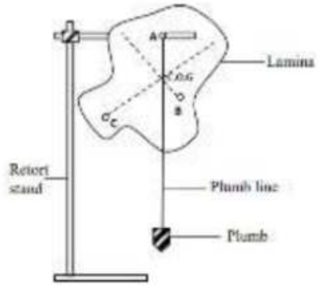
To determine the centre of gravity of regular object, the line of symmetry is considered and its point of intersection is the centre of gravity (c.o.g)

Examples of regular objects include; metre rule, square, circle, rectangle, book

Determining the c.o.g of irregular objects

Irregular objects are objects that do not have definite shape and uniform thickness.

Experiment to determine the centre of gravity of an irregular object using a plumb line method



Procedures

- Three holes A, B and C are made near the edge of an irregular object at different points.
- The irregular object is suspended from one hole A on a retort stand.
- The plumb line is also suspended from the same point. The outline of the plumb line is made on the irregular object.
- The procedures are repeated for other hole B. the point of intersection of the outlines of the plumb line is the centre of gravity

Note: The third hole is for checking the accuracy of finding the cog.

A lamina is the body whose thickness is very small compared to other dimensions e.g. a sheet of paper, book cover, and protractor.

STABILITY

This is when the body has the ability to maintain its original position or

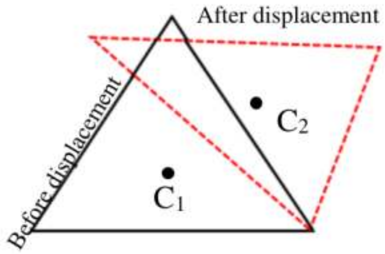
It is the state of rest of the body.

Types of stability

- Stable stability
- Unstable stability
- Neutral stability

Stable stability

This is when the body returns back to its original position after it has been displaced.



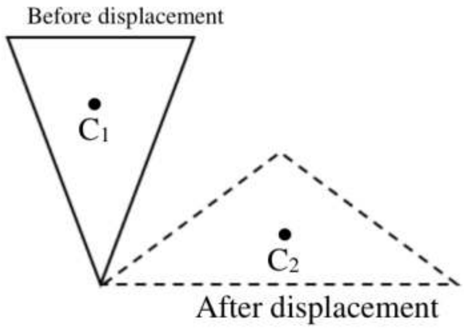
$C_2 > C_1$

The c.o.g is as low as possible.

It should be above the base or near the geometric centre of the body.

Unstable stability

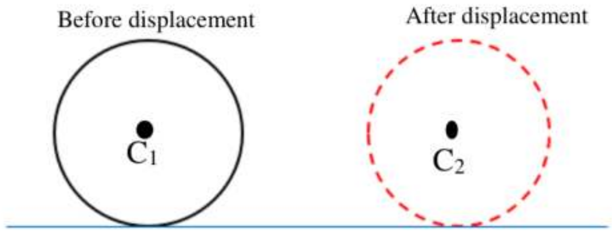
This is when the body does not return to its original position after being displaced.



$C_2 < C_1$

Neutral stability

It is where the displacement has no effect on the centre of gravity and the body is free to move.



$C_2 = C_1$

Note: For neutral stability

- The area of contact is very small
- The centre of gravity is always the same

APPLICATION OF STABILITY

- In manufacture of racing vehicles
- In manufacture of passenger vehicles
- In construction of tall buildings to safe guard them from the earth quakes.

Conditions for stability

- The base must be widened
- The c.o.g must be low.

Ways of increasing stability on the body.

- Widening the base
- Lowering the centre of gravity.

Moments

Moment is the turning effect of force about the fixed point. or

It is the product of force and perpendicular distance about the fixed point

Applications of moments

- Opening and closing the door or window
- Turning the pages of the book
- Tightening the metal or nut using a spanner
- Pedaling the bicycle.

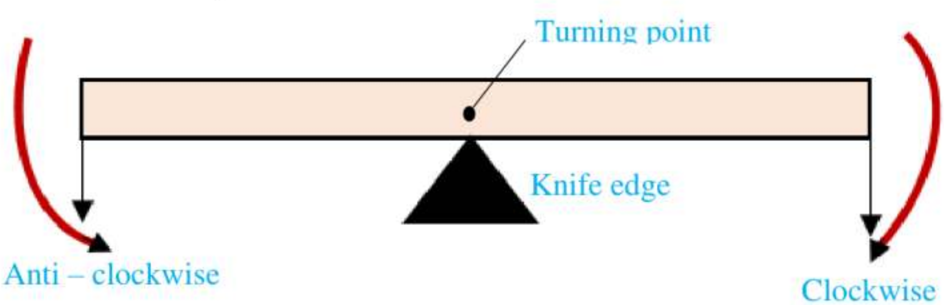
The S.I unit of moment is newton metre (Nm)

Factors which affect moments.

- Magnitude of force
- Perpendicular distance from the turning point.
- Direction of force

Types of moment of force

- Clockwise moment: Is the turning effect towards the right (direction of the clock)
- Anti-clockwise moment: Is the turning effect of force towards the left (opposing the direction of the clock)



NOTE: Sum of clockwise moment = Sum of anti-clockwise moment

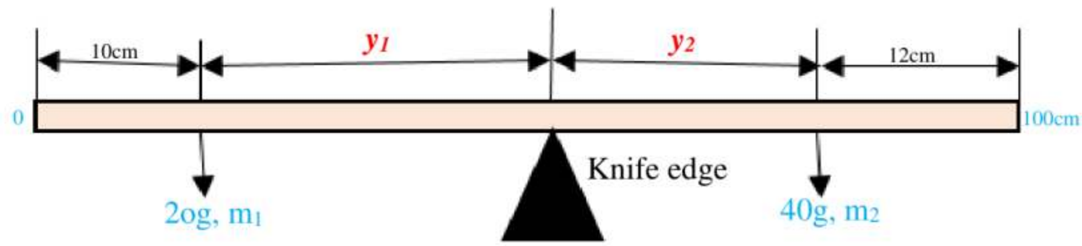
ACTIVITY 3.1

What you need

- ✓ A knife edge
- ✓ One metre rule
- ✓ Two pieces of thread (each of about 20cm)
- ✓ 20g masses (6 of them)

What to do

- Balance the metre rule provided horizontally on the knife edge and note the position of the point of balance.
- Use a piece of thread to suspend a 20g mass, 10cm from one end of the metre rule and another mass of 40g on the other side of the knife edge.
- Adjust the position of the of the 40g mass until the metre rule balances horizontally.
- Measure and record the distance y_1 and y_2 of the 20g and 40g masses respectively from the knife edge



- Repeat the experiment by hanging different masses at different points on either side of the knife edge
- Record your results in the table below and include values of the products of the weight W_1 and W_2 respectively of the masses **(in N)** and distances measured **(in m)**

M_1(g)	W_1(N)	Y_1(cm)	Y_1(m)	M_2(g)	W_2(N)

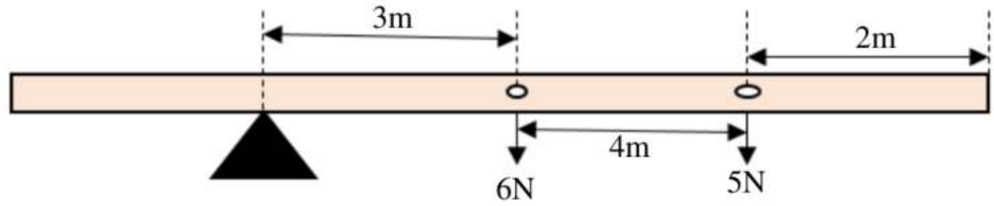
Y_2(cm)	Y_2(m)	W_1Y_1(Nm)	W_2Y_2(Nm)

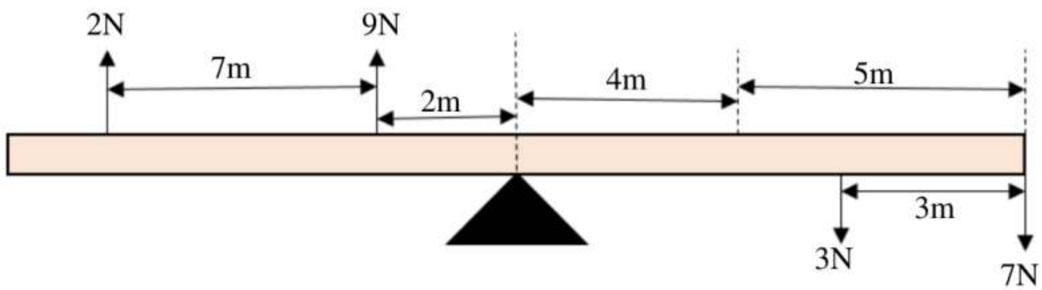
- What is your comment about the columns for the products of the weighted and respective distances from the knife edge?

- Give everyday life examples where the principle of moments is applied.

CALCULATIONS

(a) Find the moments of the following (clockwise moment)

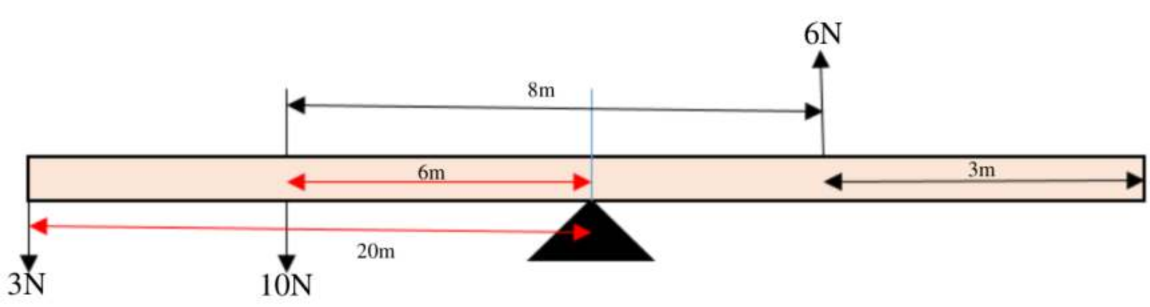
1.


2.


Solution

1. Moment = Force x distance
   = (6x3) + (5x7)
   = 43Nm
2. Moment = Force x distance
   = (3x6) + (7x9) + (9x2) + (2x9)
   = 117Nm

(b) Find the anti-clockwise moment of the following



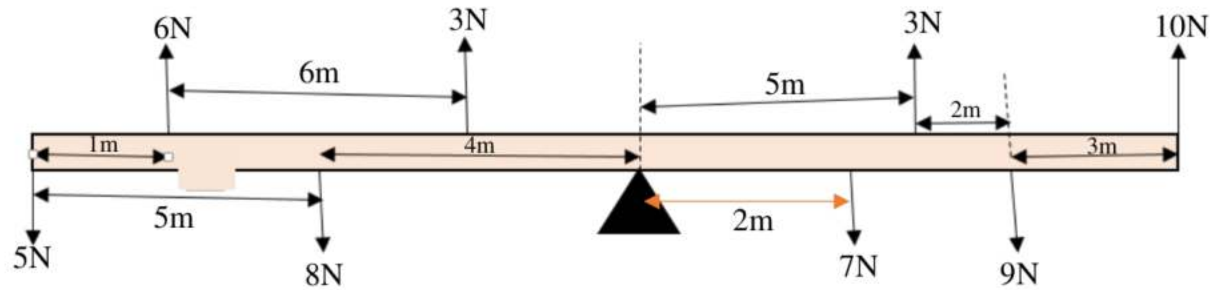
Solution

Moment = Force x distance

= (6x2) + (10x6) + (3x20)

= 132Nm

(c) Find the clockwise and anticlockwise moment for the following



Solution

Clockwise moment

Moment = (6x8) + (3x2) + (9x7) + (7x2)

= 131Nm

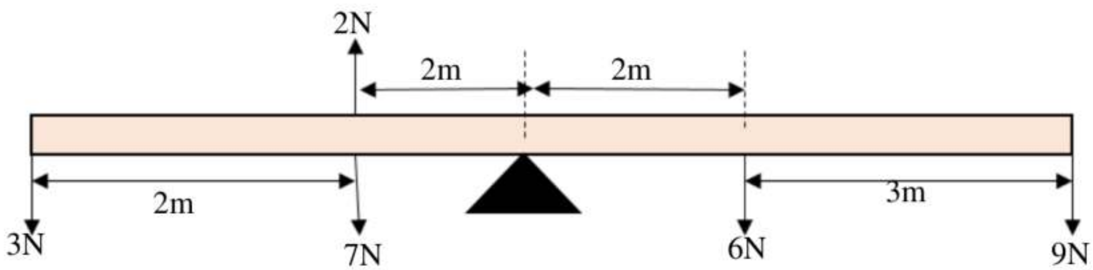
Anti-clockwise moment

Moment = (5x9) + (8x4) + (10x10) + (3x5)

= 192Nm

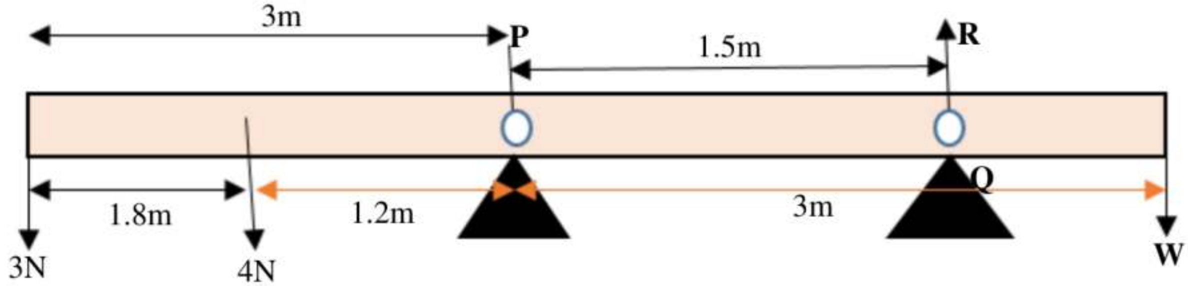
Exercise 3.2

1. Find the clockwise moment and anti-clockwise moment for the following **(Ans: cwm= 61Nm, Acwm = 26Nm)**



More examples

In the figure below, the uniform rod of negligible weight balances when weights of 3N, 4N and W are suspended at points A, B and C. Find W when;



(i) No reaction by Q on the metre rule.
(ii) Reaction by Q on the metre rule is 2N

Solution

(i) sum of clock wise moment = sum of anti-clock wise moment

W x 3 = (3 x 3) + (4 x 1.2) + (R x 1.5)

W = 4.6N

(ii) sum of clock wise moment = sum of ant clockwise moment
W x 3 = (3 x 3) + (4 x 1.2) + (2 x 1.5)
W = 5.6N

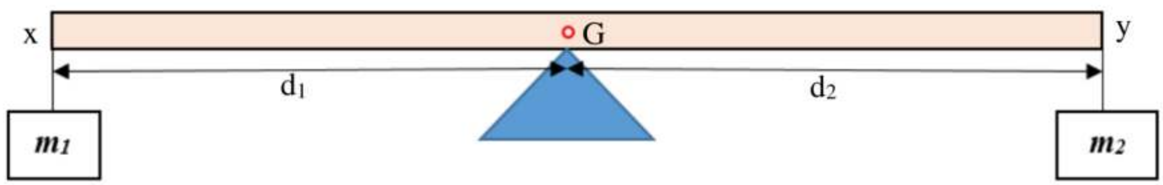
The principle of moments

It states that, the sum of clock wise moment about any point is equal to the sum of anti-clock wise moment about the same point.

Application of the principle of moment

- In opening and closing of windows and doors
- In tightening a nut using spanners
- In see – saw
- In removing nails from wood using a claw hammer
- In beam balance to measure masses and weights of objects
- In determination of mass of a uniform metre rule
- In determination of relative density of solids and liquids

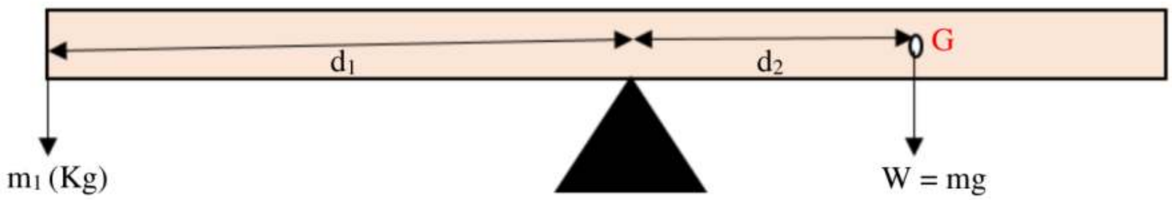
Experiment to verify the principle of moments



- Balance the metre rule on a knife edge horizontally
- Mass, M_1 is hung from one side of the metre rule, x and mass M_2 is hung from the other side of the metre rule, y
- Balance the metre rule again horizontally and distances d_1 and d_2 are obtained
- At balance, sum of clockwise moment = sum of anticlockwise moment

$m_2 d_2 = m_1 d_1$, this verifies the principle of moments

Experiment to determine the mass of the uniform metre rule



- Balance the metre rule on the knife edge horizontally to obtain its centre of gravity
- A known mass M1 is attached from one side of the metre rule
- Distances d1 and d2 are obtained after balancing the metre rule again horizontally
- At balance, sum of clockwise moment = sum of anti-clockwise moment

$W \times d_2 = M_1 g \times d_1$

$mg \times d_2 = M_1 g \times d_1$

$$m = \frac{M1gd1}{d2}$$

Where m is the mass of the uniform metre rule.

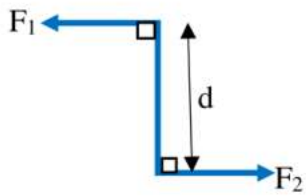
Couples

A couple is a pair of equal and opposite parallel forces from a point.

A couple produces a rotation (turning effect) called moment of a couple

Moment of a couple

It is the product of one force and perpendicular distance between the force



Moment of a couple = ***F x d*** *or* ***F x s***

The S.I unit of a couple is newton metre **(Nm)**

Example

Find the moment of a couple if the distance between the parallel forces is 10cm

Solution

Moment of a force = F x d

= 3 x 0.1

= 0.3Nm

Note: The measure of the turning effect of a force is called torque

Examples of torque

- Steering wheel
- Opening of a tap
- Handles of a bicycle
- Riding a bicycle

Conditions for a body to be in mechanical equilibrium

- The sum of clockwise moment about any point must be equal to the sum of anti-clockwise moment about the same point.
- The sum of upward forces must be equal to the sum of downward forces (the resultant force must be zero)

Parallel forces in equilibrium.

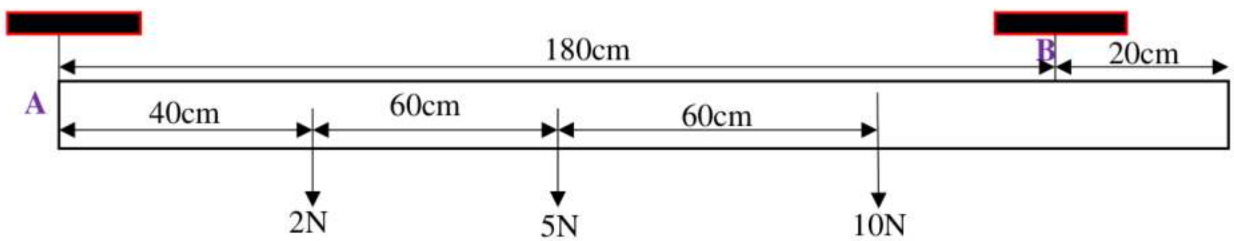
Parallel forces are forces where lines of action are parallel.

For such forces,

- ✓ The sum of clockwise moment is equal to the sum of anti- clock wise moment at balance
- ✓ The sum of forces acting in one direction is equal to the sum of forces acting in an opposite direction.

Example

A body of mass 0.2kg and length 2m is supported by two strings A and B as shown below. Find the value of A and B



Solution

Taking moments about A,

Sum of clockwise moment = sum of anti-clockwise moment

(2 x 0.4) + (10 x 1.6) + (5 x 10) = (B x 1.8)

B = 12.111N

Sum of upward forces = sum of downward forces

A + B = 2 + 5 + 7

A +12.111 = 17

A = 4.8889N

OR

Taking moments about B,

Sum of clockwise moment = sum of anti-clockwise moment

A x 1.8 = (10 x 0.2) + (5 x 0.8) + (2 x 1.4)

A =4.8889N

Sum of upward forces = sum of downward forces

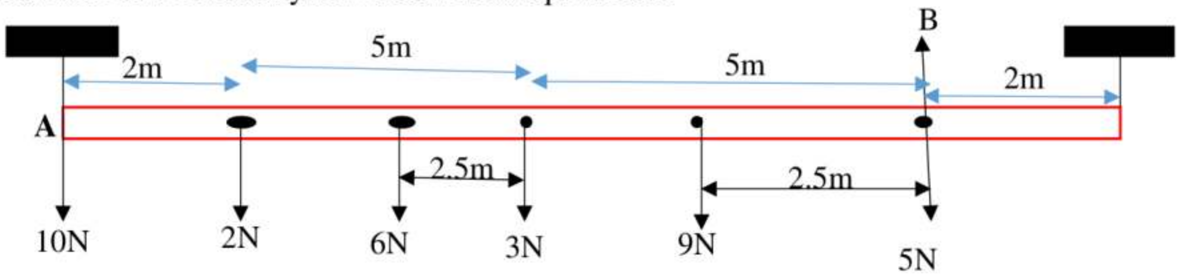
A + B =2 + 5 + 10

4.8889 +B = 17

B = 12.111N

TAKE HOME ACTIVITY

Find the tension in A and B if the system below is in equilibrium



Solution

Taking moments about A,

Sum of clockwise moment = sum of anti-clockwise moment

(10 x 0) + (2 x 2) + (6 x 4.5) = B x 12

B = 16.4583N

Sum of upward forces = sum of downward forces

A + B = 10+2+6+3+9+5

A + 16.4583 = 35

A = 18.5417N

NOTE: *You can also take moments about B*

CHAPTER FOUR
PRESSURE

LEARNING OUTCOMES

The learner should be able to:

a. understand that pressure is the result of a force applied over an area
b. understand the effect of depth on the pressure in a fluid and the implications of this
c. understand the nature of the atmosphere and how atmospheric pressure is measured
d. know the structure of the atmosphere and the significance of the different layers
e. understand the use of the Bernoulli effect in devices like aerofoils and Bunsen burner jets
f. understand the concept of sinking and flotation in terms of forces acting on a body submerged in a fluid

understand and apply the Archimedes' Principle in different situations

Pressure is the force acting normally per unit area

The S.I unit of pressure is Nm^{-2} (newton per square metre) or pascal (Pa)

Pressure = $\frac{Force}{Area}$

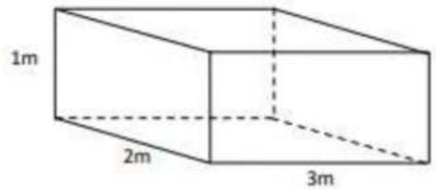
$$\mathbf{P} = \frac{F}{A}$$

A pascal is a pressure exerted when a force of **1N** acts normally on a body of cross section area **1m²**

NB: When calculating pressure, the cross section area must be in square metre **(m^2)**

Calculations involving pressure in solids

1. Calculate the pressure exerted by the figure of sides 5m x 2m x3m if its weight is 20N **(Ans: 2Pa)**
2. A body of mass 5Kg rests on the ground as shown above. Calculate the pressure exerted by the body**. (Ans: 25Pa)**



Minimum and maximum pressure

Activity *Examples of forces acting on different areas*

The figures show examples of forces acting on different areas. In pairs discuss the resultant pressure in each example given.

Pressure increases as area decreases and pressure decreases as area increases.

Minimum pressure, $P_{min} = \frac{Force}{A_{max}}$

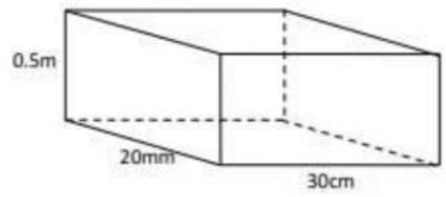
Maximum pressure, $P_{max} = \frac{Force}{A_{min}}$

A_{min} = shortest side x next shortest side

A_{max} = longest side x next longest side

Examples

1. The figure below shows a cuboid of mass 5Kg

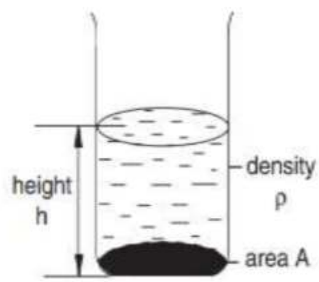


Calculate the;

(i) minimum pressure
(ii) maximum pressure

Pressure in fluids

Consider a cylinder of radius r and height h filled with fluid to the full capacity as shown below



$A = \pi r^2$

$V = \pi r^2 h$

F = mg

$\rho = \frac{m}{V}$

$m = \rho V$

$m = \rho\pi r^2 h$

$P = \frac{F}{A}$

$P = \frac{\pi r^2 h\rho g}{\pi r^2}$

$\mathbf{P = h\rho g}$

Where h – height of the liquid column

ρ – Density

g – Force of gravity

Factors that affect pressure in fluids

- Height of the liquid column
- Density of the liquid

Factors that affect pressure in solids

- Force
- Cross section area

NB: A tractor with wide tyres is able to pass over the soft ground because the wide tyres exert less pressure.

A person putting on a high heel shoes is able to crack the floor because the shoes exert high pressure on the ground.

Questions

1. Explain why a person feels more pain when pricked with a needle than with a nail?
2. Explain why a sharp knife cuts well than a blunt knife?
3. Explain why a hippopotamus is able to walk on a muddy ground easily
4. state the assumption made for all the above observations

Solution

- This is because a needle has a small surface area which exerts high pressure while a nail has a large surface area which exerts a low pressure.
- Force applied is the same

Calculate the pressure exerted by the liquid of density $900Kgm^{-3}$ filled in the cylinder of height 50m. **(Ans: 450,000Pa)**

ATMOSPHERIC PRESSURE

The layer of air surrounding the earth is called the atmosphere.

Atmospheric pressure is the pressure exerted by the weight of air on all objects on the earth's surface.

NB: Though the value of atmospheric pressure is large, we don't normally feel it. This is because;

- ✓ Blood pressure is slightly greater than the atmospheric pressure.
- ✓ Atmospheric pressure acts equally in all directions

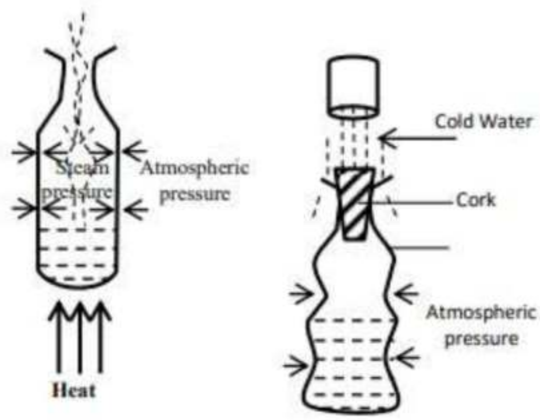
The density of air above the earth decreases as the altitude increases which makes the atmospheric pressure to decrease

Questions

1. Explain why a person experiences nose bleeding when he or she climbs the mountain?
   This is because the atmospheric pressure decreases as one climbs the mountain while the blood pressure remains constant which makes the blood veins to burst thus making the person to bleed.

2. Describe the operation of a crushing can experiment in demonstrating the existence of atmospheric pressure

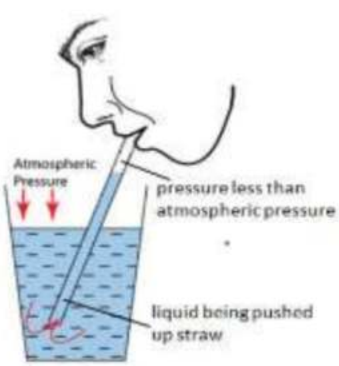
An Experiment to demonstrate atmospheric pressure



- A small quantity of water is heated in a can until steam is formed.
- The steam drives out all the air inside the can hence reducing pressure inside the can.
- The cork is then tightly fixed on to the can and heat source is removed.
- Cold water is poured over the can which causes the steam inside the can to condense.
- The excess atmospheric pressure outside the can causes it to collapse inwards. This shows the presence of atmospheric pressure.

Importance of atmospheric pressure (Applications)

1. Drinking using a straw



When sucking, the lungs expand and air is driven out from the inside of the straw to the lungs.

This reduces pressure inside the straw. The atmospheric pressure acting on the surface of the liquid in the bottle is greater than the air pressure in the straw.

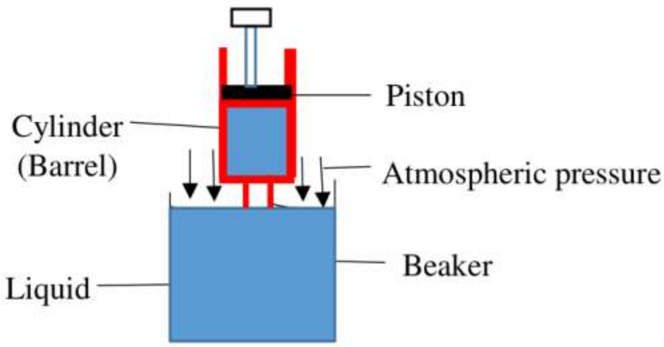
This forces the liquid up to the mouth

Question 4.1

Why do mountain climbers go with oxygen cylinders when climbing the mountains?

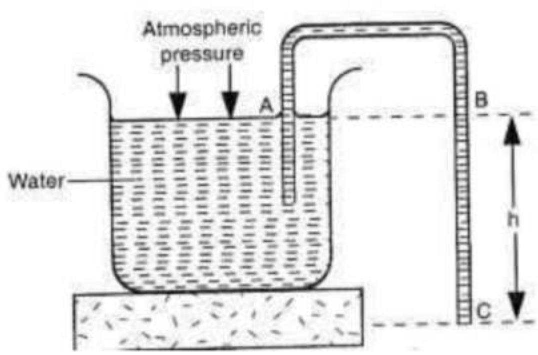
This is because in the upper layers of the atmosphere there is little air thus less oxygen for breathing.

2. **Syringe**



- ✓ It consists of a tight fitting piston and a cylinder called barrel.
- ✓ When the piston is moved backwards, the pressure inside the cylinder is reduced.
- ✓ The atmospheric pressure acting on the surface of the liquid becomes greater than the pressure inside the cylinder.
- ✓ This forces the liquid to move up and occupy the space below the piston in the cylinder.

3. **Siphon**

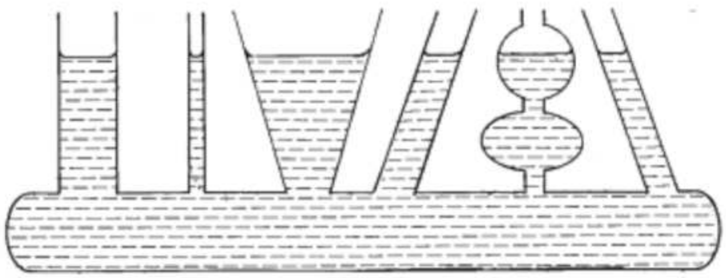


- ✓ A siphon consists of a long rubber tube

- ✓ One end of the rubber tube is dipped in the tank and the other end left outside below the tank.
- ✓ Since end C of the tube is below the surface A by height h, pressure at C is greater than that at the surface.
- ✓ When air is removed from the inside of the tube by suckling, the atmospheric pressure becomes greater than the pressure inside the tube.
- ✓ This forces the liquid to move out of the tube.

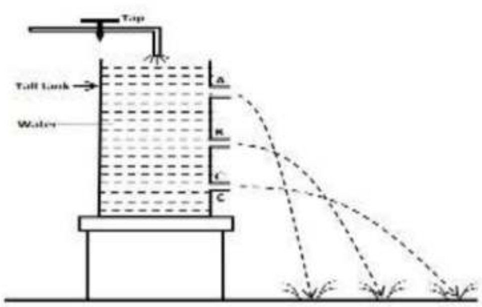
Properties of fluid pressure

1. **A liquid finds its own level**



- A liquid is put in communicating tubes of different cross section area
- The liquid is found to stand at the same level in each tube.
- This shows that pressure at the same level is the same because the atmospheric pressure acting on the surface of the liquid in each tube is the same.

2. **Pressure increases with depth below the surface.**

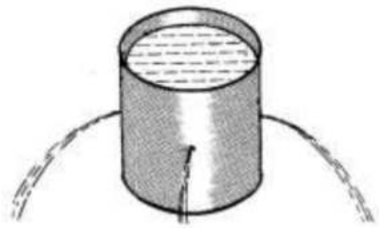


- ➢ Holes A, B and C of the same size are made on one side of the tall jar at different heights.
- ➢ The holes are covered using a cello tape.
- ➢ Water is put in the jar up to the top and cello tapes are removed at the same time.
- ➢ The liquid jets (comes) out from C fastest and lands furthest followed by the liquid from hole B and the liquid from hole A comes out slowest and lands at a very small distance from the jar

Conclusion

This shows that pressure is highest at C and slow at A

3. **Pressure acts equally in all direction**



- Holes of the same size are made on the jar at the same level.
- The holes are covered with cello tape
- Water is put in the jar and the cello tapes are removed at the same time.
- Water comes out in all the holes at the same rate

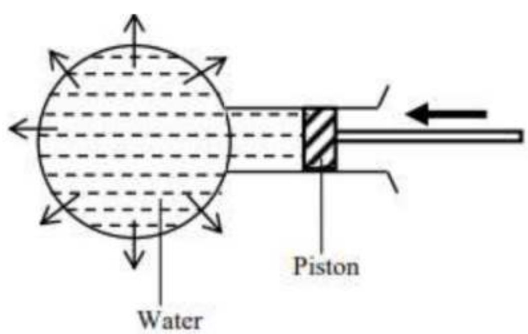
Conclusion

This shows that pressure acts equally in all directions

PRINCIPLE OF TRANSMISSION OF PRESSURE IN FLUIDS *(PASCAL'S PRINCIPLE)*

It states that when pressure is applied to the enclosed non viscous incompressible fluid, it is transmitted equally throughout the fluid.

Experiment to show Pascal's principle



- Holes of the same size are made on a round bottomed flask
- The holes are covered with cello tape.
- The flask is filled with water and the piston is pushed inside.
- The liquid jets out in all holes at the same rate.

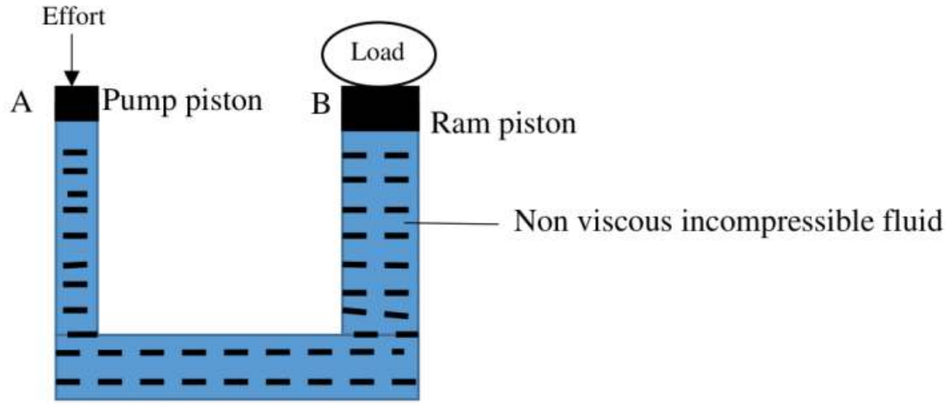
Conclusion

This shows that the pressure acting in the liquid is the same.

APPLICATIONS OF PASCAL'S PRINCIPLE

Hydraulic press

It consists of two cylinders of different bores filled with a fluid



Mode of operation (how it works)

- ✓ It consists of two pistons i.e. pump piston and ram piston.
- ✓ When a force is applied on a small piston, pressure is created and transmitted through the fluid to the big piston
- ✓ This pressure forces the ram piston to move upwards with greater force there by pressing the load.

Note: In hydraulic press, when a small force is applied on a small piston, greater force is created at the bigger piston.

Pressure applied at A = Pressure applied at B

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

Calculations

1. A force of 50N is applied on a pump piston of cross section area $0.02m^2$. if a ram piston has an area of $0.5m^2$, calculate the;
   (i) pressure exerted at the ram piston
   (ii) force applied on the ram piston

Soln

(i) pressure at A = pressure at B

Pressure at B $= \frac{F_A}{A_A}$

$= \frac{50}{0.02}$

= 2,500Pa

(ii) Pressure at B = $\frac{F_B}{A_B}$

$2{,}500 = \frac{F_B}{0.5}$

F_B = 1,250N

2. In a hydraulic press, a pump has a diameter of 49cm while a ram piston has a diameter of 98cm. if the load of 10,000N is raised by the big piston, calculate the force exerted on the pump piston.

Solution

$A_A = \pi r^2$

$= \frac{22}{7} \times \left(\frac{0.49}{2}\right)^2$

$= 0.18865 m^2$

$A_B = \pi r^2$

$= \frac{22}{7} \times \left(\frac{0.98}{2}\right)^2$

$= 0.7546 m^2$

$P_A = P_B$

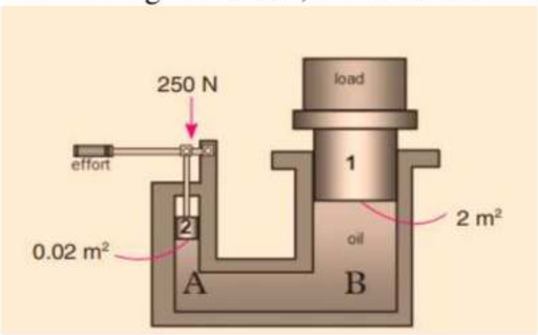
$\frac{F_A}{A_A} = \frac{F_B}{A_B}$

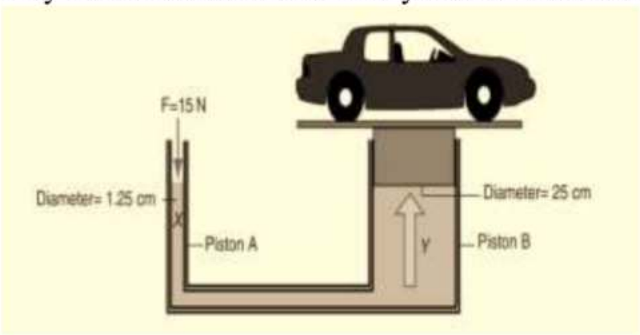
$\frac{F_A}{0.18865} = \frac{10{,}000}{0.7546}$

$\mathbf{F_A = 2{,}500N}$

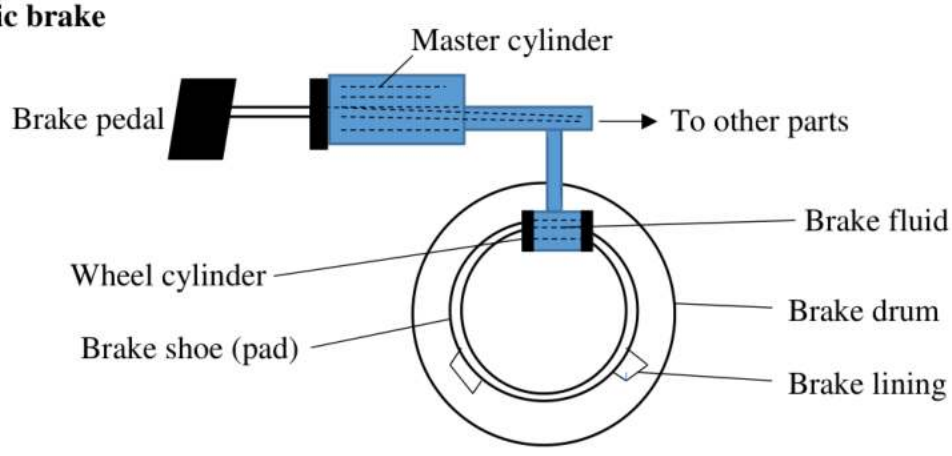
Activity

From the figures below, find the Load lifted by the forces shown for the hydraulic lifts shown





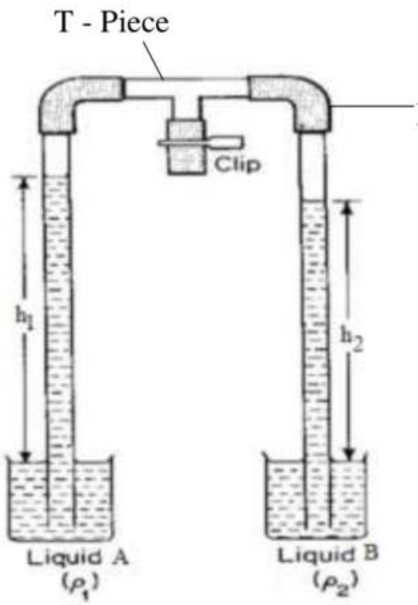
Hydraulic brake



How it works

- ✓ When the brake pedal is pressed, the pressure exerted inside master cylinder is transmitted equally to the wheel cylinder.
- ✓ At the wheel cylinder, a pressure acts on the brake shoe (pads)
- ✓ This presses the brake shoes against the brake drum hence creating friction which opposes the rotation on the wheel.
- ✓ This results in stopping the car.

Comparison of densities by Hares apparatus



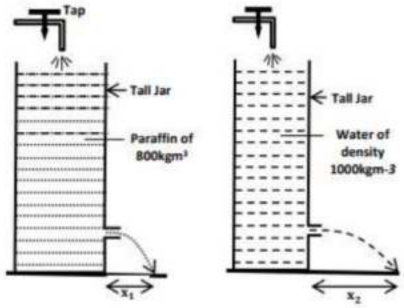
- ✓ Hare's experiment (apparatus) consists of two glass tubes of the same cross section area connected to the T- piece using the rubber tubing.
- ✓ The tubes are dipped into the liquids of different densities
- ✓ Some air is removed from the tubes by suckling.
- ✓ This forces the liquids to move up in the tubes.
- ✓ The liquids rise too different levels because they different densities.
- ✓ When the levels of the liquids have settled,

Pressure due to h_A = pressure due to h_B

$$h_A\rho_A g = h_B\rho_B g$$

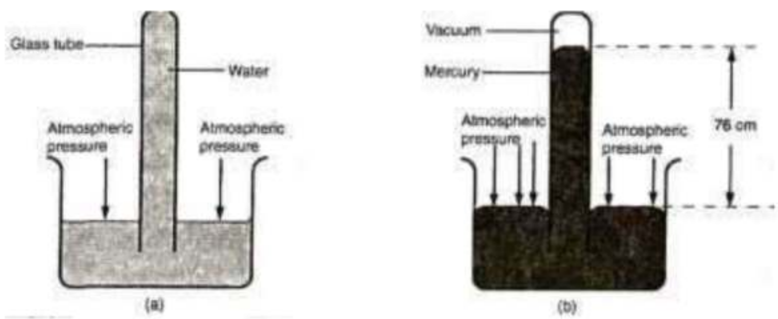
$$h_A\rho_A = h_B\rho_B$$

Experiment to show that pressure depends on density



- Two identical tall jars are used
- Identical holes are made at the same height on each tall jar and covered with cello tape.
- Two different liquids with different densities are put in the tall jars up to the top.
- The cello tapes are removed at the same time
- The liquid with high density comes out at a high speed and lands at a far end.
- The liquid with low density comes out with a low speed
- Therefore pressure increases as density increases.

Measurement of atmospheric pressure using mercury barometer



- Fill a graduated glass tube with mercury up to the brim
- Cover the open end of the glass tube with a small glass plate
- Invert the tube vertically with its end below the surface of mercury in the beaker.
- Remove the glass plate
- Wait until the mercury level becomes constant.
- Measure he height, H of the mercury column in the glass tube
- His height is the atmospheric pressure.

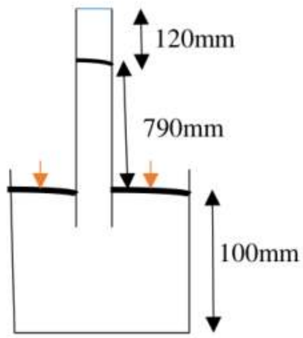
Note: The vertical height column of mercury remains constant even when the tube is tilted at a certain angle

Note: It is more convenient to use mercury barometer than water barometer because;

- The density of water is lower than that of mercury therefore a large volume of water is required to sustain the atmospheric pressure
- Reading the water level in the glass column may be difficult

Question 4.2

The diagram below shows a mercury barometer



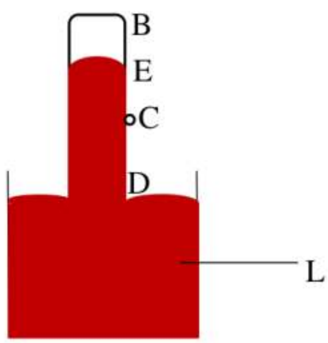
(a) Find the atmospheric pressure

- *790mmHg*

(b) What would happen to the level of mercury if the tube is tilted?

- *The height of mercury remains the same*

2. The diagram below shows an instrument used to measure atmospheric pressure



(a) Name the instrument

❖ *Mercury barometer*

(b) Name the liquid L and state its property that make it suitable liquid for this case

❖ *Mercury*

❖ *It has a high density which withstands the atmospheric pressure*

❖ *It is easy to take readings*

(c) What measurement in the diagram would you take to calculate the pressure of the atmosphere?

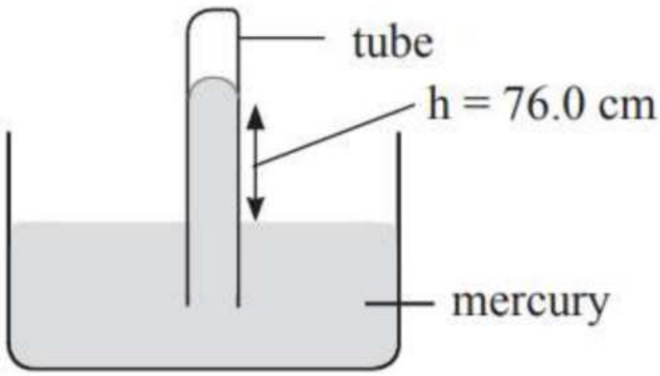
❖ *From E to D*

(d) What would be the height of the liquid column if a hole was made at C?

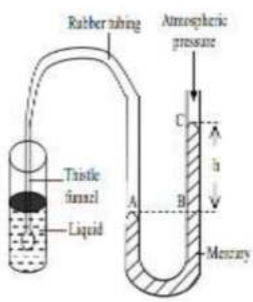
❖ *From C to D*

Activity 4.3

From the figure below, find the value of atmospheric pressure



Measurement of liquid pressure

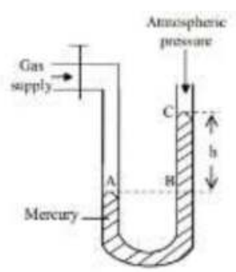


One arm of the manometer is connected to a thistle funnel whose base is covered with a thin membrane and the other end remains open to the atmosphere.

The difference in liquid surface levels, h gives the pressure at point A and it is called absolute pressure.

Absolute pressure = H + hρg, where H is the atmospheric pressure

Measurement of gas pressure



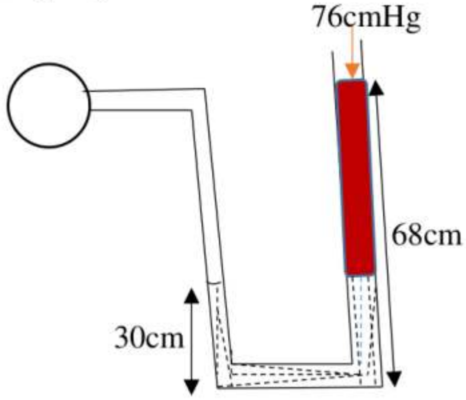
- ❖ Connect a manometer to a gas supply
- ❖ Turn on the gas supply
- ❖ The gas exerts pressure at point A. This causes the liquid to rise in the opposite arm until the pressure in both arms is the same.
- ❖ The gas pressure in one arm is equal to the pressure in the opposite arm.

Gas pressure = H + hρg
Examples

1. If the pressure of 76cmHg acts on the surface of mercury in a manometer and it rises by 54.4cm. calculate the gas pressure if the density of mercury is 13,600Kgm^{-3}
   Convert your answer to Pascal

   Solution
   Gas pressure = H + hρg
   = 76 + 54.4
   = 130.4cmHg
   P = hρg
   = $\frac{130.4}{100}$ x 13600 x 10
   = 177,344Pa

2. A fixed mass of a dry gas is trapped in container A. calculate the total pressure of the air from the diagram below in pascal (density of mercury = 13,600Kgm^{-3}, density of water = 1,000Kgm^{-3})



Gas pressure = H + excess pressure
= 76 + (68-30)

=114cmHg

Pressure = hρg

= $\frac{114}{100}$x13, 600x10

= 155,040Pa

3. An open U-tube pressure gauge containing water shows difference in levels as 15cm when connected to the gas supply. find the excess pressure in newton per square metre (Nm^{-2})

Excess pressure = $h\rho g$

$= \frac{15}{100} \times 1000 \times 10$

= 1500Nm^{-2}

4. In a school laboratory, the gas supply causes the levels in water manometer to differ by 60cm. if the atmospheric pressure is 1.0 x 10^{4}Pa, calculate the gas pressure exerted by the gas

Gas pressure = H + $h\rho g$

= 100,000 + 0.6 x 1000 x10

= 106000Pa

5. Express the following in Nm^{-2}
   (i) 0.6mHg
   (ii) 71mHg
   (iii) 60cmHg
   (iv) 0.7mmHg

CHAPTER FIVE
MECHANICAL PROPERTIES OF MATERIALS

LEARNING OUTCOMES

The learner should be able to;

a. understand how the mechanical properties of common materials can be utilized in physical structures

b. understand that the tensile strength of materials is determined by the properties of the substances they are composed of

understand that heating changes the structure and properties of some materials

Mechanical properties of matter are concerned with the behavior of such materials under the action of forces

COMMON TERMS USED

Elasticity: It is the ability of a material to return to its original shape and size when the deforming forces have been removed e.g. a spring

The deforming forces can be tension or compression

Strength: It is the ability of the material to withstand the applied forces before breaking e.g. iron bars

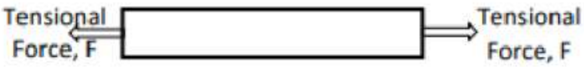
Stiffness: It is the ability of the material to resist being bent e.g. a piece of chalk

Ductility: It is the ability of the material to be hammered, bent or rolled into different shapes without breaking e.g. binding wires

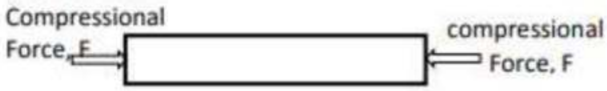
Toughness: It is the ability of the material to resist crack

Brittleness: It is the ability of the material to break suddenly without warning e.g. a concrete

Tensional forces: These are forces which act on the body by stretching it apart

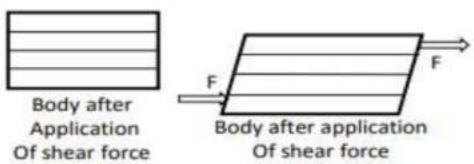


Compressional forces: These are forces which act on the body by bringing it together or squeezing it.



Hardness: It is the ability of the material to resist scratch

Shear forces: These are forces which change the body by making its layers slide over each other.



ELASTIC AND PLASTIC DEFORMATION

Elastic deformation

This is where the material regains its original shape and size when the deforming forces are **removed.**

Plastic deformation

This is where the material does not return to its original shape and size when the deforming forces are removed.

TENSILE STRESS, TENSILE STRAIN AND YOUNG'S MODULUS

Tensile stress

It is the ratio of force acting on the material to cross - sectional area OR

It is the force acting on the material per unit cross - sectional area

Tensile stress = $\frac{Force\ acting}{Cross\ sectional\ area}$

Stress $= \frac{F}{A}$

The S.I unit of stress is $\mathbf{Nm^{-2}}$ or Pascal (**Pa**)

Tensile strain

It is the extension per unit original length

Tensile strain = $\frac{extension}{original\ length}$

Strain $= \frac{e}{l_0}$

NOTE: Tensile strain has no unit because it is the ratio of similar quantities.

CALCULATIONS

1. A force of 5N acts on the material of cross sectional area $0.4m^2$. calculate the tensile stress ($12.5Nm^{-2}$)
2. when a force acts on the substance 3m long, it extends by x m, if the tensile strain is 0.4, find its extension, x (x = 1.2m)

ACTIVITY 5.1

1. The tensile stress of the material of cross section area $2000cm^2$ is $120Nm^{-2}$. calculate the force exerted on the material (240N)
2. The material 2m long is stretched by 0.5m when a force acts on it. Calculate its tensile strain. (0.25)
3. When a force acts on the material, it stretches by 2m. if the tensile strain is 0.2, calculate its original length (10m)

YOUNG'S MODULUS (E)

It is the ratio of tensile stress to tensile strain

Young's modulus = $\frac{Tensile\ stress}{Tensile\ strain}$

$$E = \frac{F}{A} \div \frac{e}{l_0}$$

$$= \frac{F}{A} X \frac{l_0}{e}$$

$$\mathbf{E = \frac{Fl_0}{Ae}}$$

The S.I unit of Young's Modulus is Nm^{-2} OR Pascal (Pa)

Examples

1. A wire of length 0.2m and cross section area $0.002m^2$ extends by 0.02m when a force of 50N acts on it. Calculate the;
   (i) stress **($25,000Nm^{-2}$)**
   (ii) strain **(0.1)**

(iii) Young's Modulus **(250,000Nm^{-2})**

2. The force of 20N acts on a lead wire of length 2m, diameter o.64mm causes an extension of 0.6mm. calculate the;
   (i) stress
   (ii) strain
   (iii) Young's Modulus

Solution

F = 20N

Lo = 2m

e = 0.6mmm

= 0.0006m

Diameter = 0.64mm

= 0.00064m

A = πr2

$= \frac{22}{7}$ X 0.00032^2

= 3.2183 x 10^{-7}m^2

(i) Stress $= \frac{F}{A}$

$= \frac{20}{3.2183 \ x \ 10^{-7}}$

= 6.2145 x 10^{-7}Nm^{-2}

(ii) Strain $= \frac{e}{l_0}$

$= \frac{0.0006}{2}$

= 0.0003

(iii) E $= \frac{stress}{strain}$

$= \frac{6.2145 \ x \ 10^{-7}}{0.0003}$

= 2.0715 x 10^{11}Nm^{-2}

ACTIVITY 5.2

A rod of 1.2m and area 1.5 x 10-4m^2 is extended by 5mm. When a stretching force of 6N is applied on it. Calculate the;

(i) Tensile stress **(40,000Nm^{-2})**
(ii) tensile strain **(4.1666 x 10^{-3})**
(iii) Young's Modulus **(9,600,153.602Nm^{-2})**

HOOKE'S LAW

Hooke's law states that the extension of an elastic material is directly proportional to the applied force provided the elastic limit is not exceeded.

Mathematically, F $\propto$ e

F = ke Finall **k =** $\frac{F}{e}$

Where k is a constant called elastic constant of a material
The S.I unit of k is newton per metre **(Nm^{-1})**

Examples

1. A force of 20N extends a wire by 2m. What is the force constant of a wire **($k = 10Nm^{-1}$)**
2. A force FN extends a wire of force constant to $2.0 \times 10^{-2}Nm^{-1}$ by 4mm. Find the value of F **(F = 0.0008N)**

NOTE: If the two efforts (forces), F_1 and F_2 act on the same material of the force constant, k, F_1 produces extension e_1 and F_2 produces extension e_2,

F = ke

$F_1 = ke_1$………….. (i)

$F_2 = ke_2$………….. (ii)

Eqn (i) ÷ Eqn (ii)

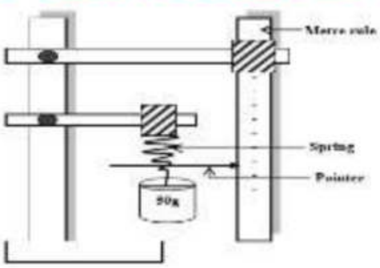
$\frac{F_1}{F_2} = \frac{ke_1}{ke_2}$

$\boldsymbol{\frac{F_1}{F_2} = \frac{e_1}{e_2}}$

Examples

1. A coiled spring is stretched 0.05m by the weight of 5N. Which weight will stretch the same spring by 0.03m? **(F_2 =3N)**
2. When the force of 12N is applied on the spring, it produces an extension of 0.08m. What mass of an object when hang on the same spring produces an extension of 0.06m? **(m = 0.9kg)**

AN EXPERIMENT TO VERIFY HOOKE'S LAW

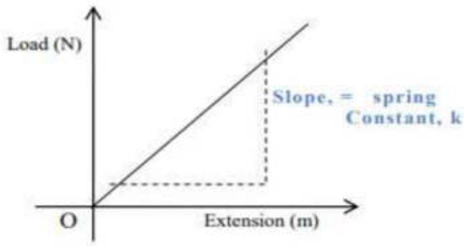


Procedures

- The setup is arranged as shown above
- The original length of the spring before any load is added is noted as l_o
- Various loads are suspended or put on the spring and the new length, l is noted
- The extension is calculated from $\mathbf{e = l - l_o}$
- The experiment is repeated using various loads and the corresponding new lengths are noted
- The results are tabulated

Load (N)	l(m)	e(m)
…………	…………	………….

A graph of load against extension is plotted

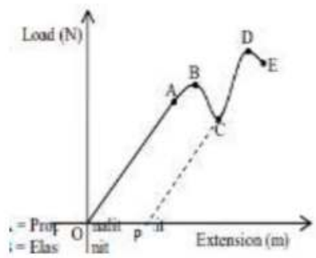


A straight line through the origin is obtained

This means that the load (force) is directly proportional to the extension. Hence verifies **Hooke's law.**

NOTE: The slope of the graph gives the spring constant, k

A graph of Load against extension of a ductile material



A – Proportional limit

B – Elastic limit

C – Yield point

D – Breaking stress (maximum stress)

E – Breaking point

- From O to A, the load is proportional to the extension. Here the material obeys Hooke's Law
- B is the elastic limit. This is appoint beyond which a material loses its elasticity.
- From O to B, the material undergoes elastic deformation i.e. it regains its original shape and size when the stretching force is removed.
- Beyond B, the material undergoes plastic deformation i.e. the material does not regain its original shape and size when the stretching force is removed.
- C – Is called the yield point (yield limit)
- Point D is the maximum stress. This is the maximum force the material can withstand
- Point E is the breaking point. It is where the material breaks

A CONCRETE

It is the mixture of sand, gravel, cement and water in the correct proportions according to the nature of the work to serve and left to harden.

A concrete is strong under compression and weak under tension since it is a brittle material.

Characteristics (properties) of a concrete that make it a desirable material

- It is strong under compression
- It is fire resistant
- It is weather resistant
- It is durable
- It is economical since it can be used for a long time.

Reinforcement

It is the addition of the material into another material in order to increase on its mechanical strength.

Reinforced concrete

It is a concrete whose mechanical strength has been increased

Types of reinforcement

Iron reinforcement

It is the addition of iron bars and wire mesh into a concrete stopping it from breaking

Fibre reinforcement

It is the addition of grass into mud before making the brick in order to increase its mechanical strength.

Lime reinforcement

It is the addition of lime into sand so that it does not develop cracks.

NOTCH

It is a crack on the surface of a material

A notch spreads more easily under tension than compression.

Application of notch

- When breaking fire wood
- When cutting glass using a glass cutter
- When cutting trees or bananas

Ways of minimizing Notch effect

- By smoothening the surface of the material
- By making sharp points of a notch blunt (by blunting the notch)
- By laminating materials using ply wood, cement or iron bars
- By making structures in a way that all parts are under compression.

STRUCTURES

Beams and Girders

A beam is a large and a long straight piece of material with a uniform cross section area.

A girder is a small piece of material used to strengthen a beam

A girder can either be a tie or a strut.
A tie is a girder under tension

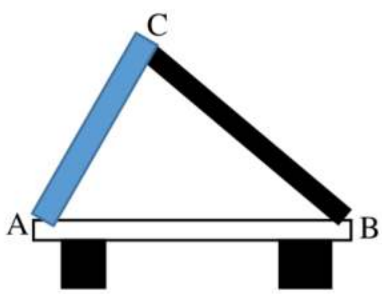
A strut is a girder under compression.

NOTE: A girder which does not experience tension or compression is called redudant

How to identify a strut or a tie
To identify a girder, remove each girder at a time and observe the effect it cusses on the structure

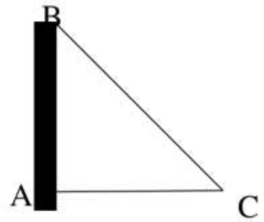
If the structure comes together, the girder is under compression and it is called a strut

If the structures tend to move away, the girder is under tension and it is called a tie
ACTIVITY 5.3
Identify ties and struts in each of the following figures



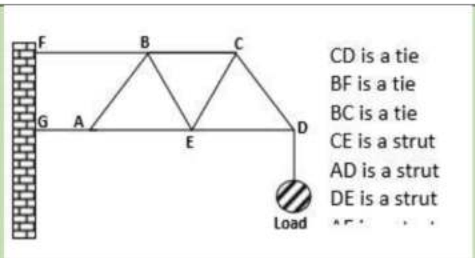
AC – strut

BC – strut
AB – Tie



AC – Strut
BC – Tie

AB – Strut



MATERIALS USED IN CONSTRUCTION

Ductile materials

<u>Characteristics (properties) of ductile materials</u>

- It should be light
- It should be resistant to chemical reactions
- It should have a good thermal conductivity

Brittle material

<u>Characteristics of brittle materials eg glass</u>

- It is transparent
- It is an insulator hence it keeps the room warm during cold days and cold during warm days
- It is quite harder
- It cannot be destroyed by pests
- It cannot decompose

Advantages and disadvantages of using the following building materials

Tiles

<u>Advantages</u>

- They are durable
- They are water proofs
- They make the structure look smart and beautiful

<u>Disadvantages</u>

- They are expensive
- They are slippery
- They are not good insulators

Grass thatched

Advantages

- They are good insulators
- They are readily available
- They are good sound absorbers
- They are good water proofs if laid properly
- They maintain cool air during hot days

Disadvantages

- It does not last for so long
- It can burn easily when set on fire
- It can provide habitant for some dangerous wild animals like snakes

Iron sheets

Advantages

- They are fairly cheap
- They are water proofs
- They last for so long

Disadvantages

- They rust easily if they are not looked after
- They make noise incase anything drops on it
- They are good conductors of heat therefore houses get hot on hot days and cool down quickly on cold days

Question 5.1

Explain why the bicycle flames are hollow in nature?

- To reduce the weight while maintaining strength.
- To increase their resistance to compression (A tube is significantly tough to bend than a rod)

CHAPTER SIX
MAGNETISM

LEARNING OUTCOMES

The learner should be able to;
a. know that a small number of materials are magnetic, but most are not
b. know how magnets can be made and destroyed
c. understand the behavior of magnets and magnetic fields
d. know that the Earth is a magnet and how a compass is used to determine direction

Magnetism is the property of a certain substance to attract or repel other substances **or** It is the force exerted by the magnetic field.
A magnet is a piece of material which attracts or repels other magnetic materials.
Magnets are classified into **two** categories;

- Ferro-magnetic substances these are substances which are strongly attracted by a magnet. They include; **iron, steel, cobalt and nickel.**
- Non- Ferro magnetic materials: these are substances which are not attracted by the magnets. They include**; plastics, wood, rubber and glass.**

Non- ferromagnetic materials are grouped into;

- Dia-magnetic materials: these are materials which show very low magnetic effects. They include copper
- Para- magnetic materials: these are materials which show partial effect to the magnetic field.

TYPES OF MAGNETS

Temporary magnets: These are magnets which can easily be magnetized and do not retain their magnetism for long.
They are used in;

- Transformers
- Electric bells

Permanent magnets: These are magnets which take long to be magnetized and once magnetized, they take long to lose their magnetism.
They are used in;

- Dynamos
- Electric motors
- Loud speakers

- Galvanometer
- Telephone ear pieces

The law of magnets

It states that like poles repel and unlike poles of a magnet attract each other.

Polarity of a magnet.

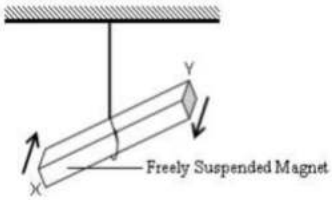
A pole of a magnet is an area on a magnet where the magnetic force is strongest i.e. North Pole and South Pole.

The two poles are found at the ends of a magnet and they occur in pairs of equal strength

PROPERTIES OF A MAGNET

- When a magnet is freely suspended, it always comes to rest in the North-South direction.

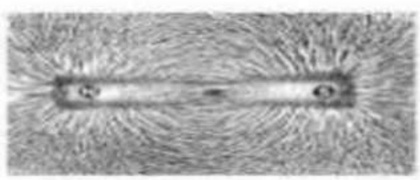
This is because the earth is a magnet and has its south pole in the Northern hemisphere and the North Pole in the Southern hemisphere.



- A magnet ha two poles found at its ends

When a magnet is dipped into iron fillings, the fillings are seen to concentrate at the ends of the magnet.

This shows that the magnetic attraction is strongest at the poles.



Testing for polarity of a magnet

- A known pole of a magnet is brought near the end of a magnet with unknown poles.
- If repulsion occurs, then that end of a magnet is a like pole.
- If attraction occurs, then that end of a magnet is unlike pole or it could be a magnetic substance.

NB: The pole of a magnet can only be tested by repulsion since attraction can either be unlike poles or a magnetic substance.

MAGNETIC FIELD

This is a region around a magnet where magnetic force is experienced or felt.

A magnetic field is represented by the magnetic field lines which start from the North Pole to the South Pole.

A magnetic field line is a path which a magnetic pole would follow if it is placed in a magnetic field.

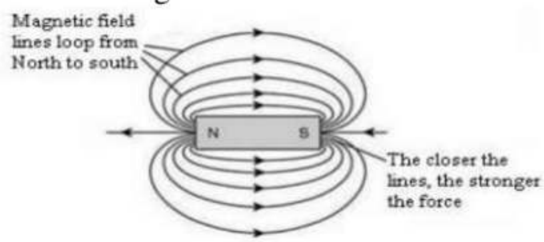
The number of magnetic field lines is called **magnetic flux**
The magnetic flux is stronger where there are many field lines which are closer to each other.

Properties of magnetic field lines

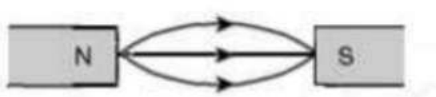
- They do not intersect or cross or touch each other.
- They flow from North Pole to South Pole
- They all have equal strength
- Their density decreases with increase in the distance from the poles.

Magnetic field patterns

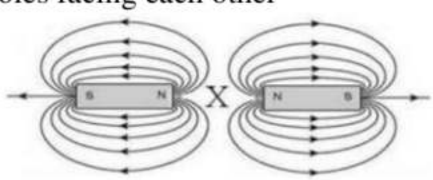
An isolated bar magnet



Two unlike poles near each other

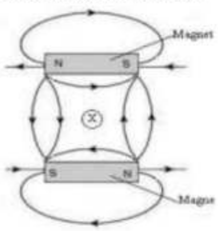


Two like poles facing each other

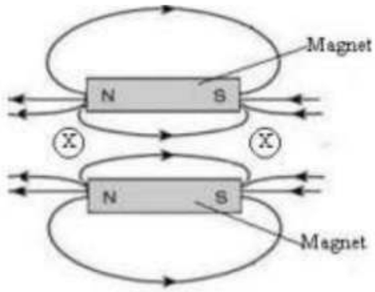


Two bar magnets lying by side

I. South-North and North South



II. North-North and South-South



Where x is the **neutral point**.

A neutral point is a region with in the magnetic field where the resultant magnetic force is zero.

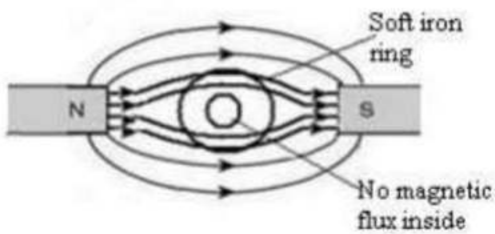
Magnetic shielding or screening

Magnetic screening or shielding refers to blocking of a magnetic field or providing a restriction. This can be achieved in two ways;

- **Using a soft iron ring**

  A soft iron is readily and strongly magnetized

  When a soft iron ring is introduced in a magnetic field, the magnetic field lines pass around the soft iron and not through it.\the inside of the ring is thus screened from the influence of the magnet



- **Using soft and hard magnetic materials**

  A soft magnetic material is that material which can easily be magnetized but loses its magnetism easily or in a short time e.g. iron

  A hard magnetic material is that material which is difficult to be magnetized but retains its magnetism for a long time e.g. steel

Properties of Iron and Steel

Iron

- It is easily magnetized and demagnetized
- It keeps its magnetism for a short time
- It is used for making temporary magnets

Steel

- It keeps its magnetism for a long time
- It is not easily demagnetized
- It is used for making permanent magnets

The domain of magnetism

It states that all the magnetic substances are composed of tiny (very small) magnets which are divided into regions called domain

Each domain has a million of tiny magnets called dipoles lined up with their north pole in one direction if the material is magnetized.

In un magnetized material, the tiny magnets point in different directions and the north pole of one is neutralized by the south pole of the other.

NOTE: Magnetic saturation is a point where a magnetic substance cannot be magnetized any more.

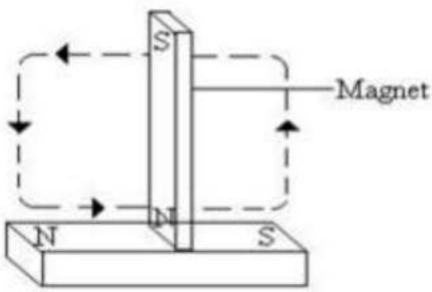
MAGNETISATION

This is the process of making a magnet from a ferro magnetic material

Methods used for magnetization

1. **Stroking method**

- Single touch method

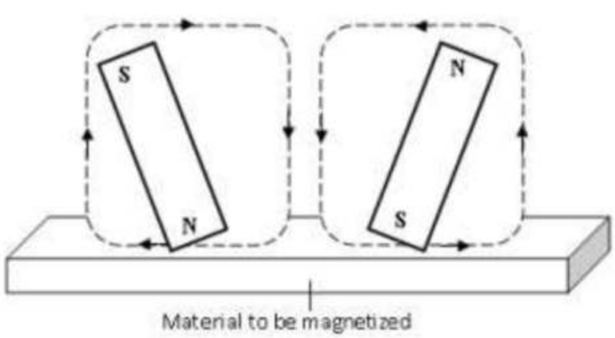


A- North pole

B- South pole

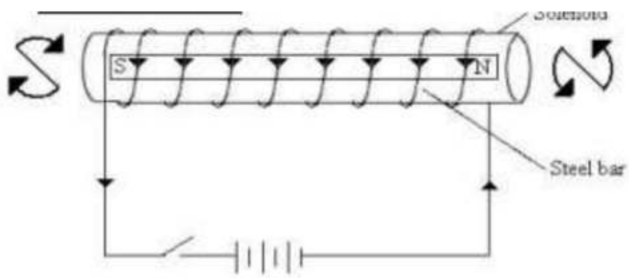
- A steel bar is placed on the table and one pole of a magnet is dragged along the surface of the steel bar from one end to another and then lifted away.
- The procedure is repeated several times using the same pole.
- The end of the magnet where stroking stops acquires the opposite pole to that used in the stroking.

- **Double touch method**



- Two opposite poles of two bar magnets are used to stroke a steel bar starting from the middle going to the opposite directions.
- The procedure is repeated and each time the magnets are lifted away.
- The end of the steel bar where the magnet finishes stroking acquires an opposite pole to that of the stroking magnet.

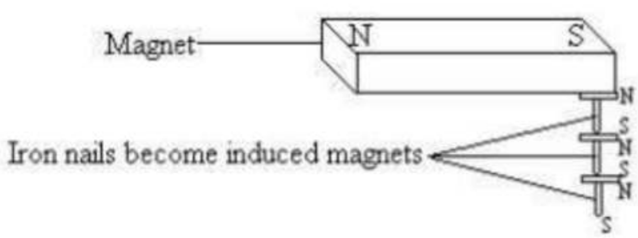
2. **Electrical method**



- A steel bar is placed in a solenoid connected to the direct current (DC)
- The current is switched on for some time and then off.
- The steel bar will be magnetized and the polarity of a magnet depends on the direction of current.

NOTE: On viewing the bar, if current flows in the clockwise direction, that end will be the South Pole and if current flows in the anti-clockwise direction, that end will be the North Pole.

3. **Induction method (induced magnetism)**



- A piece of un magnetized material is placed in contact with the pole of a permanent magnet.
- This material gets magnetized by induction and it can attract other pieces of iron.
- This type of magnetism acquired is called induced magnetism.
- Each nail added to the chain gets magnetized and magnetizes the next one by induction.

DEMAGNETIZATION

This is a process by which a magnet loses its magnetism.
The following methods are used to demagnetize a magnet.

1. **Using ac (alternating current)**

A magnet is placed in a solenoid connected to an ac supply
The current is switched on and off.

On testing, the magnet has lost its magnetism.

2. **Heating**

A magnet is heated until it becomes red hot and on cooling, it will have lost its magnetism

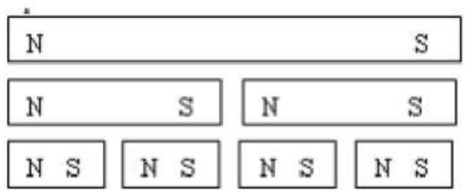
3. **Hammering/ dropping/ throwing**

When a magnet is hammered, or dropped or thrown for many times, it loses its magnetism.

4. Keeping the like poles together for a long time.
5. Boiling the bar magnet in hot water.
6. leaving a magnet to rust

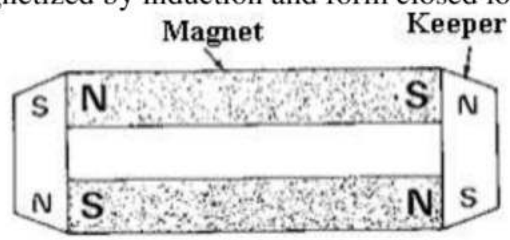
BREAKING A MAGNET

Every molecule in a magnet is itself a permanent magnet and when a magnet is broken into portions, both will have two unlike poles which appear at opposite ends of each piece.
The cutting of a magnet does not separate two poles of a magnet no matter how many times the magnet is broken



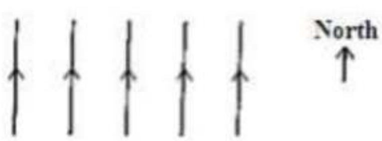
STORING MAGNETS

Magnets tend to become weaker with time due to self-demagnetization
This is caused by the poles at the end repelling each other and disorganizing the alignment of a domain inside the magnet.
To prevent this, magnets are stored in pairs with unlike poles adjacent to one another and with small pieces of soft iron bars called **keepers** placed at their ends.
The keepers are magnetized by induction and form closed loops with no free poles.



The earth's magnetic field.

The earth contains the south pole with in the Northern hemisphere (Geographic north) and the North Pole in the southern hemisphere (Geographical south)
The field lines of the earth are parallel and point towards the North.



Uses of magnets

- Electro magnets are used in electric bells
- Magnets are used in hospitals to pick iron bits from patients eyes, ears and nose
- They are used in separating magnetic and non-magnetic metals
- They are used in loud speakers
- They are used in industries to hold metals
- They are used in doors of refrigerators and freezers to keep them closed.
- They are used in the kitchen to hold utensils
- They are used by mechanics to hold small magnetic materials
- They are used in screw drivers at their tips.
- bar magnets are used in laboratories for study purposes
- They are used to make hydro power generators
- A compass is a magnetized pointer and it is used in showing direction.

ASSESSMENT ACTIVITY

1. The public is complaining that beans supplied by a certain trader contain magnetic metals. This claim has raised serious concerns on the health of customers. The Uganda national bureau of standards (UNBS) is investigating this concern. As a technical officer, design a system to screen the bean to prove or disprove the claim that there are metal impurities in beams. Write a report to resolve this claim

2. A certain maize milling company produces maize flour. People suspect that its maize flour contains some metallic pieces of grinding machines because they assume that the machines are too old to process the maize. Investigations were carried out by the authorities to check whether these allegations are true by obtaining a sample of about 1kg. Assuming that you were on the authority team, using the following materials;

- 6 inch iron nail
- Insulated copper wire
- Dry cells

Make a simple circuit and use it to prove whether the allegations are right or wrong.

CHAPTER SEVEN
ELECTROSTATICS

LEARNING OUTCOMES

The learner should be able to:

a. understand everyday effects of static electricity and explain them in terms of the build-up and transfer of electrical charge

apply knowledge of electrostatic charge to explain the operation of devices like lightening conductors

This is the study of electric charges at rest**. OR** It is the study of charges between two stationary charged bodies. When a nylon piece of cloth is taken off from the body, it often cracks. This implies that it has been charged by static electricity.

The cracks are caused by tiny electric sparks which can be seen in darkness

When a bic pen or a ruler is rubbed against a dry object like hair, it attracts small pieces of papers when brought near to them

The Fundamental Law of Electrostatics

It states that like charges repel while unlike charges attract each other.

Charges flow if there is a force between the nucleus and the shell.

Electrons are in the outermost shell (**energy level**) and have negligible force of attraction and they are called **free electrons** (mobile electrons)

These electrons are responsible for the conduction of electricity. In an insulator, there are no free electrons, therefore it does not conduct electricity

Conductors and insulators

A conductor is a material which allows charges to pass through it easily. OR it is a substance which has free electrons and loosely bonded to the atoms which can move from one point of a conductor to another.

Examples of conductors include;

- Metals such as zinc, copper, Aluminium and mercury
- Water

Insulators

It is a material which does not allow charges to pass through it easily **OR**

It is a substance which has electrons tightly bonded to the atoms.

Examples of insulators include;

- Glass
- Wood
- Plastics
- Rubber
- Polythene

Differences between conductors and insulators

Conductors	**Insulators**
Electrons are free to move from one point to another	Electrons are not free to move from one point to another
Electrons are loosely packed	Electrons are tightly packed
Charge acquired is not fixed	Charge acquired is fixed

Methods of Charging Bodies

Charging the body (object) by friction

When a glass rod is rubbed with a silk cloth, glass atoms tend to loose electrons faster than the atoms of silk.

The electrons lost by the atoms of glass are acquired by the atoms of silk. This makes the glass to be positively charged and silk negatively charged.

Question

Explain how Ebonite rubbed against fur can be charged by friction.

Charging the body by conduction

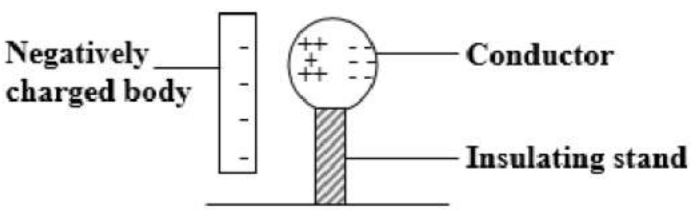
When uncharged body is brought into contact with a charged body, the charges divide themselves equally and the same sign of charge is acquired by the other body

Changing the body by induction

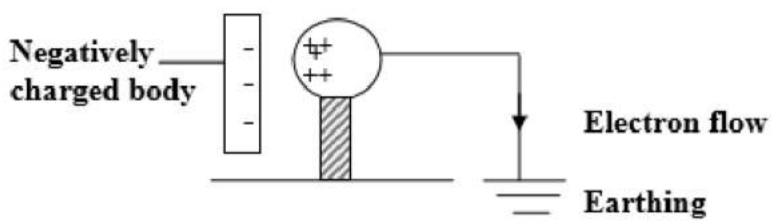
This is the process of changing a boy by bringing another charged body near to it but not in contact with it.

Charging a Body Positively By Induction

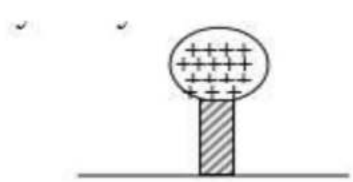
- The body to be charged is put on an insulator.
- A negatively charged rod is brought near to one side of the body
- Positive charges are attracted to the side nearer to the charged rod while negative charges are repelled to the opposite far end of the body.



- Side B of the body is earthed using the earth wire.
- Negative charges (electrons) move to the earth.

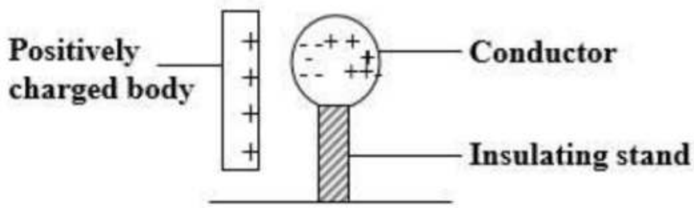


- Keeping the negatively charged rod in its position, the earth wire is broken.
- The negatively charged rod is removed. Positive charges distribute themselves throughout the body hence the body becomes positively charged.

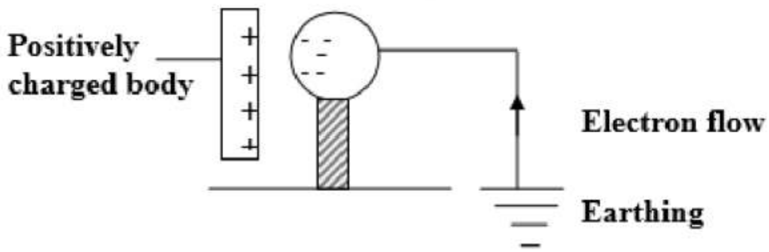


Changing a Body Negatively By Induction

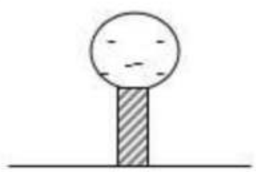
- ✓ The body to be charged is put on an insulator.
- ✓ A positively charged rod is brought nearer to the body but not in contact with it.
- ✓ Negative charges are attracted nearer to the side of the charged rod while positive charges are repelled to the opposite side



- ✓ Side B of the body is earthed using the earth wire. Negative charges move from the earth to the body and neutralize positive charges on the body.



- ✓ Keeping the positively charged rod in its position, the earth wire is broken and the charged rod is removed.
- ✓ Negative charges distribute themselves throughout the body hence the body becomes negatively charged.

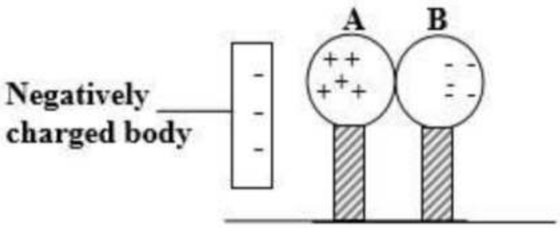


Charging two conductors (bodies) positively and simultaneously by induction

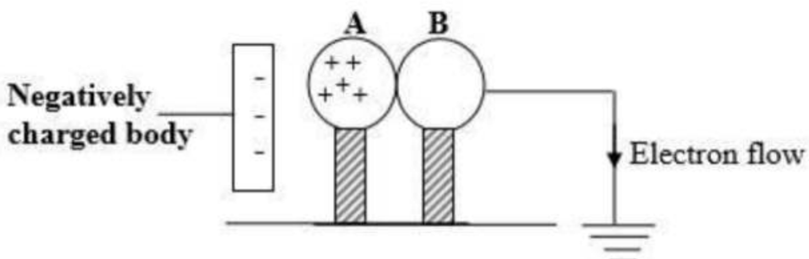
The two conductors to be charged are put on insulators and brought into contact

A negatively charged rod is brought near one body, A

Positive charges are attracted to body A while positive charges are repelled to the far end of body B.



Body B is earthed using the earth wire. During earthling, negative charges move to the earth.



Keeping the negatively charged rod in its position, the earth wire is broken and then the negatively charged rod is removed.

Positive charges distribute themselves throughout the two bodies.

The two bodies are separated and each is positively charged

Group activity

Explain how two bodies can be charged negatively and simultaneously by induction

Guiding questions

1. Explain why when charging a conductor, the conductor is put on an insulator?
   - ➢ To avoid the back flow of electrons from the soil to the conductor or from the conductor to the soil
2. Explain why the earth wire is removed when the charged rod is still in it position?
   - ➢ To avoid flowing of electrons back into the conductor which results into neutralization

GOLD LEAF ELECTROSCOPE (GLE)

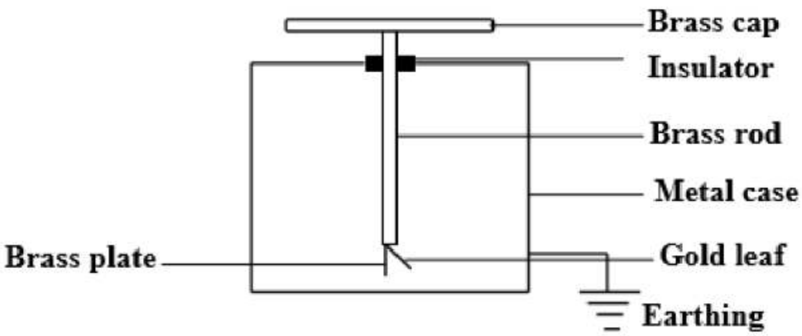
Research work

Make notes on the structure of the GLE and its uses.

A GLE is a device used to;

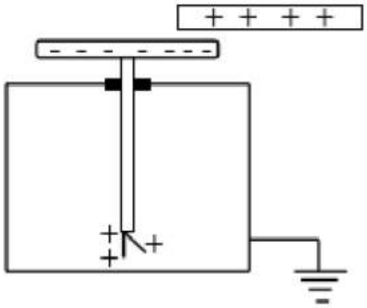
- Determine the presence of charge
- Determine the nature of charge
- Determine the magnitude of charge
- Determine the insulating property of a substance

The structure of the GLE

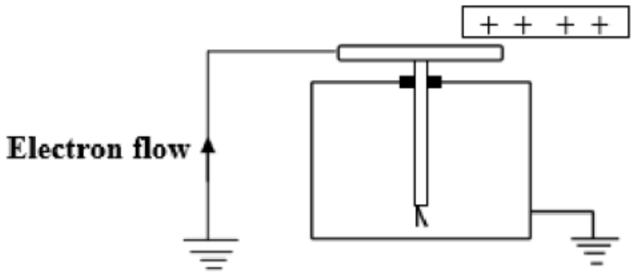


Charging the GLE negatively by induction

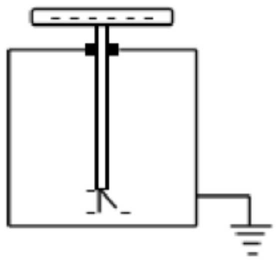
- A positively charged rod is brought near the metal cap of the GLE. Negative charges are attracted to the metal cap and positive charges are left around the metal plate and gold leaf
- This makes the gold leaf to diverge (rise)



- The metal cap is earthed using the earth wire. During earthling, electrons move from the earth to the metal cap and through the metal rod and then neutralize the positive charges on the metal plate and gold leaf
- This makes the gold leaf to fall



- Keeping the positively charged rod in its position, the earth wire is removed.
- The positively charged rod is also removed and negative charges distribute on the metal plate and gold leaf which makes the gold leaf to rise again.
- Therefore, the GLE becomes negatively charged by induction



Question

Explain how a GLE can be charged positively by induction.

How does the GLE determine the presence of charge?

- The body under test is brought near the metal cap of the uncharged GLE
- If the gold leaf rises, the body is charged
- If the gold leaf does not rise, the body is not charged.

How does the GLE determine the nature (type) of charge?

- The body under test is brought near the metal cap of the charged GLE
- If the leaf diverges or rises more, the body has the same charges like those of the GLE
- If the leaf collapses (falls), the body has opposite charges like those of the GLE

How does the GLE determine the magnitude of the GLE?

- The body under test is brought near the metal cap of the charged GLE
- If the leaf rises or falls more, the body has many charges
- If the leaf rises or falls less, the body has few charges.

How does the GLE test the insulating property of a substance?

- The GLE is first charged

- Different materials are brought to the metal cap of the GLE one after the other.
- If the leaf falls or rises rapidly, the body is conductor.
- If the leaf falls or rises slowly, the body is an insulator

Care while handling the GLE

- The conditions should be dry
- The conditions should be free from strong heat
- The conditions should be ion free

Limitations of the GLE

- It does not work when the atmosphere has moisture. This is because moisture contains water which is a good conductor of electricity and therefore static charges build up on the gold leaf can quickly be taken away by moisture and the divergence of the leaf will not occur.

ELECTRIC FIELD

It is an area where electric force is experienced **OR**

It is an area where electrostatic force is experienced.

Electric force may be repulsive or attraction. It is represented by the electric field lines with direction

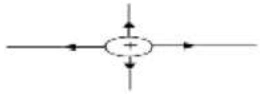
The electric field lines are always originating from positive charge and ending from negative charge.

The electric field lines are close if the electric field is strong and electric filed lines are apart if the electric field is weak.

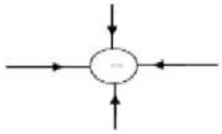
All conductors carrying electricity have electric field around them.

Electric field pattern

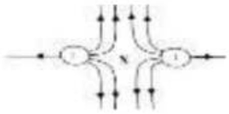
Isolated positive charge



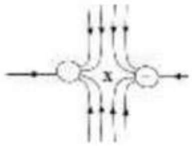
Isolated negative charge



Two similar positive charges



Two similar negative charges



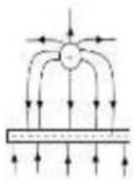
X is the neutral point

A neutral point is the region where the resultant electric field is zero **OR**

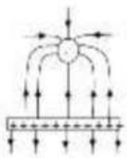
It is a region where the electric force is not experienced

Electric field lines between charged points and plates

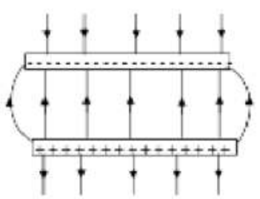
Positively charged point and negatively charged plate



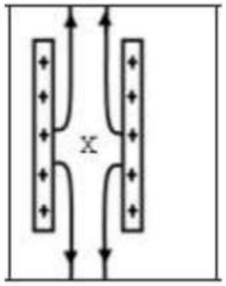
Negatively charged point and positively charged plate



Positively charged point and positively charged plate

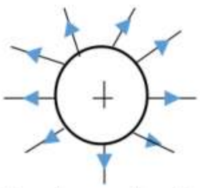


Two similar charged plates

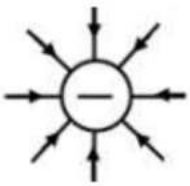


Charged sphere

Positively charged sphere

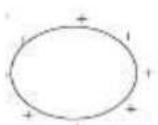


Negatively charged sphere

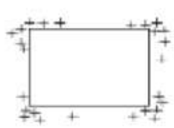


Charge distribution on conductors

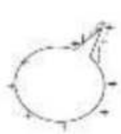
Spherical conductor



Cylindrical conductor



Pointed (spear shaped) conductor



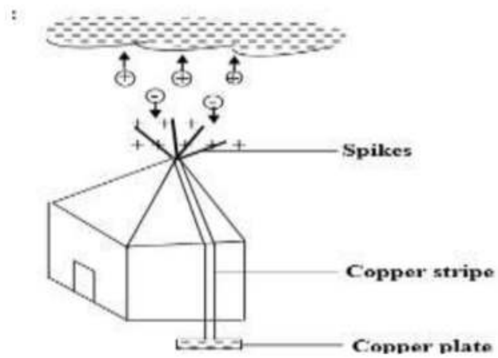
LIGHTNING AND THUNDER STORM

Lightning is a huge spark that discharges in the sky or between the sky and the ground

Protection against lightning strike

- Avoid standing near or under a tall tree or electric pole
- In order to protect a tall building, a lightning conductor is used
- Avoid holding umbrella so high when it is raining

How a lightning conductor protects a tall building from being destroyed by lightning



- When a negatively charged cloud passes above the spikes of the lightning conductor, it induces positive charges on the spikes and negative charges on the earthed copper plate.
- Negative charges immediately move to the soil and point action occurs at the spikes
- Negative charges formed are attracted to the spikes and neutralize the positive charges while the opposite charges are repelled to form the space charge that neutralizes negative charges in the cloud.
- In case the negative charges in the cloud are left un neutralized, any discharge is conducted harmlessly to the soil through the lightning conductor since it has a low resistance thus protecting the building from being destroyed by lightning

Formation of thunderstorm

- During a rain storm, clouds become charged by friction.
- The positively charged clouds attract the negatively charged clouds and causes discharge
- This discharge causes the air to vibrate with a lot of energy producing sound waves which are heard as thunder

SAMPLE ACTIVITY

During an evening down pour, a sharp flash occupied with loud sound were witnessed. As a result the whole village experienced a total blackout. Later it was discovered that a transformer had been damaged by the sharp flash. The village organized a meeting to solicit funds to purchase a new transformer. In attendance was the area Member of Parliament who promised the members that he was to purchase a device which can safeguard the transformer against other damages from such a flash. People wondered how the device can protect a transformer. After two weeks the funds were realized and a committee was selected to go to town and buy the new transformer

Support

Task

Using knowledge of physics, sensitize the community on how the device would safeguard the transformer against such destruction

CHAPTER EIGHT

THE SOLAR SYSTEM

LEARNING OUTCOMES

The learner should be able to;

a. know the relative sizes, positions, and motions of the earth, sun and moon
b. understand how day and night occur and demonstrate the phases of the moon
c. understand the roles of the sun, earth and moon in explaining time, seasons, eclipses, and ocean tides
d. know the components of the solar system and their positions
e. know the main characteristics of the inner and outer planets in the solar system

understand the various views about the origin and structure of the universe

The solar system is a gravitationally bound system of the sun and all objects that orbit it. The objects include planets, moon and small bodies in the form of asteroids, meteoroids and comets (A celestial body consisting of mainly ice, dust and gas)

Every day you wake up in the morning, you see the sun rising from East and in the evening, you see the sun setting in the west.
You might be asking yourself whether it is the same sun that rises up and sets down or different.
You have also observed that in some nights there is no moon and in other nights there is moon appearing in different sizes i.e. a crescent or a full moon.
Relative sizes, positions and motion of the earth, moon and sun
Life on earth is greatly influenced by two bodies in the universe ie sun and moon. These two bodies are actually very big but you see them appearing small because they are very far from the earth.
The sun, moon and earth are all spherical with the following diameters;
The diameter of the moon is approximately 3,500Km
The diameter of the sun is approximately 140,000Km
The diameter of the earth is approximately 12,800Km
The distance between the earth and the moon is approximately 400,000Km
The distance between the earth and the sun is approximately 1,500,000Km
Note: The sun is very far from the earth compared to the moon.

THE SUN

The sun is a ball of hot glowing gases. It is much hotter than any of the nine planets and the outer most layer is about **$5{,}600^0$c**

The sun is the most important part of our solar system and it is the major source of energy inform of heat and light.

Without the sun, the earth would be very cold and there would be no life on earth.
The sun is a star. There are other stars some of which are bigger, smaller, hotter and cooler than the sun.

During the day, we see only the sun because it is so bright that we cannot see others
At night, we see many stars in the dark sky and they appear like tiny points of light because they are very far away

The earth's rotation

The earth is ever in motion. It is constantly rotating or spinning in an anti-clockwise direction about an axis which passes from the North Pole to the South Pole.
The earth takes one day **(24 days)** to make one complete rotation about its axis.
As the earth rotates about its axis, some part of the earth receives light from the sun while the other part does not receive sunlight.
The part of the earth which receives sunlight is called day while the other part which does not receive sunlight is called night.
This explains why the day is always bright while the night is always dark indicating the absence of light

Revolution of the earth around the sun

As the earth spins (rotates) about its axis rotation, it also revolves around the sun in circular path called an orbit. The earth takes 365.25 days to revolve in its orbit around the sun. Therefore, during ordinary years, it is assumed that the earth takes 365 days to revolve around the sun.
However, after 4 years, the fractional days **(0.25x4 = 1 day)** add one more day to the revolution of the earth and such years are called leap years
Note: In a leap year, the earth takes 366 days to revolve around the sun.

Rotation of the moon around the earth

Just as the earth rotates around the sun, the moon also rotates around the earth. The time the moon takes to make one complete revolution around the earth is approximately 27 days and 7 hours.
During this rotation, we can only see the part of the moon which receives and reflects sunlight to us on earth. This explains why we see different shapes of the moon every day and these shapes are called phases of the moon. The phases repeat themselves after every 29 days and 12 hours
Note: The new moon occurs when the moon is on the same side of the earth as the sun. Full moon occurs when the moon is on the opposite side of the earth relative to the sun.

Questions

1. Explain why you cannot see the new moon?

It is because it is not reflecting any light from the sun.

2. Why are the waxing or waning crescents less bright compared to the full moon?

This is because during waxing or waning crescents, the surface of the moon which reflects sunlight is small compared to the full moon.

Note: Waxing means growing. It is used to describe the moon as it grows from the new moon to the full moon.

Waning means shrinking. It is used to describe the moon as it gets smaller from the full moon to the new moon.

3. Why don't the eclipses occur every month?

For any eclipse to occur, the moon, earth and sun must be in a straight line. However, in some cases, this alignment is not realized because the path of the moon and the earth are not always in the same plane.

OCCURANCE OF OCEAN TIDES

Tides are periodic rise and fall in the level of large bodies of water like oceans and seas.

Tides are caused by attraction between the masses of the earth and the moon. This attraction is commonly known as gravitational attraction.

The gravitational attraction between the earth and the moon causes the oceans to bulge (rise) out from the surface of the earth in the direction of the moon.

Another bulge occurs in the opposite side since the earth is also being pulled towards the moon. Since the earth is rotating while this is happening, two tides occur each day.

Exercise 8.1

1. What are the economic importance of ocean tides to the people living along the coastal lines?
2. Search on the internet about the dangerous impact of ocean tides.

Solution

No. 1

- They help in generating electricity
- They provide renewable sources of energy for coastal people
- They help in controlling the depth and flow of water to help ships navigate easily near the shores
- They move floating animals and plants to and fro breeding area

No. 2

Dangers of ocean tides

- They cause accidents to swimmers entering the sea
- Flooding spring tides can sometimes danger buildings and people near the shores

COMPONENTS OF THE SOLAR SYSTEM

The solar system is the system of objects that orbit the sun either directly or under the influence of sun's gravitational pull.

The sun is at the centre of our solar system. It is the largest body in our solar system.

Moons, asteroids and meteoroids are also part of the solar system.

Moons orbit planets while the asteroids, comets and meteoroids orbit the sun.

The people who study the universe including the solar system are called **Astronomers**
They discovered that our solar system is extremely very large in size and the distance between the planets and the sun is very long.

As a result, the Astronomers introduced a new unit to measure the distance between planets and from the sun called **astronomical unit** (AU)

1AU= 150,000,000Km

This unit provides an easier way to compute the distances between the planets and from the sun.

ACTIVITY 8.2

1. Research on the internet about the relative sizes of the planets in our solar system and complete the table below

Planet	*Diameter (Km)*
Mercury	………………
Venus	………………
Earth	12,800
Mars	………………
Jupiter	……………….
Saturn	………………
Uranus	51,200
Neptune	………………
Pluto	2,400

2. Determine how many earths can fit in each of the planets.

Note: All planets are spherical in shape.

Solution

Volume of the earth $= \frac{4}{3}\pi r^3$

$= \frac{4}{3x8}\pi d^3$

$= \mathbf{1.0985 \times 10^{12} Km^3}$

Volume of Uranus = 7.0305 x 10^{13}Km^3

No. of earths that fit in one Uranus = $\frac{volume\ of\ uranus}{volume\ of\ the\ earth}$

$= \mathbf{64}$

PHASES OF THE MOON

The part of the moon that we see is the part the sun is shining on.

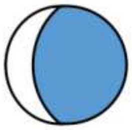
Phases

1. **New moon (0 days).**

This occurs when the moon is between the sun and the earth. It is not visible because the sun is not shinning on the side facing the earth.

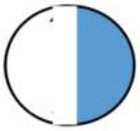
2. **The crescent (3 days).**

This happens when a thin sliver of the moon is visible. It rises in the day time and sets before mid-night.



3. **Quarter (first quarter moon or half-moon) (7 days).**

From the earth, we can see half of the moon s face which is a quarter of the entire moon.



4. **The Gibbous moon (11 days).**

This is less than the full moon but more than a half a moon.

5. **The full moon (14 days).**

This is when all the moons face is visible from the earth. This happens when the earth, moon and sun are in line. The moon is more lit up than in any other planet. it lights up the night sky making things more visible at night on earth

SAMPLE ACTIVITY

One of the most misunderstood branches of physics for many years has been space physics (Astronomy). Some of the examples of such misunderstandings include the following. The Catholic Church at one time thought that other heavenly bodies, including the sun, orbited around the earth, rather than the earth. This was the problem that Catholic hierarchy had with Galileo. For example, the Church tried and arrested Galileo Galilei for supporting Sun-centered view of the universe.
While watching the world cup which took place in Brazil in 2014 at 9pm East African time, the football fans watching the game in East Africa realized that it was still daytime in Brazil, some of them were puzzled by this?
While it snows (winter) in most European countries in December around Christmas season, the people in East Africa have never seen any snow fall in East Africa and some of them wondered why it is this way?

Task

As a learner of physics,
Write a report to the community on enlightenment about these astronomical events in order to promote deeper understanding of physics in the school and community at large.

ABOUT THE AUTHOR

Mr. Clesensio Wiston is a physics and mathematics teacher of secondary school in all levels (O' level and A' level) and he has taught in various schools of Uganda.

I want to thank my parents who managed to pay all the school requirements during the era of my study. Bravo so much.

I also thank Mr. Kaziba Steven who made me love the teaching profession especially during COVID-19 period as he came up with a new innovation of having online lessons with learners under HeLp program and continuous workshops he always organizes that equip and instill more techniques and skills of teaching especially in this New curriculum.

Note to the user

As you use this book which was intensively internalized by different persons who are all teachers of physics in different schools all over this country Uganda, endeavor to be with the smart phone or computer with internet connection for more interpretation and understanding of Physics content.

Note: For hard copies, reach the author through;

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