INTRODUCTION

Nuwasiima Clesensio Wiston (Clese Wiston) is a physics and mathematics teacher of secondary level in all levels (O' level and A' level) and he has taught in various schools of Western Uganda.

I want to thank my parents Mr. Vitalino who managed to pay all the school requirements during the era of my study. Bravo so much Dad,

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 or individuals who are all teachers of physics in different schools all over this country Uganda, endeavor to be with the following books;

- Physics book 1 by Vision Publishing
- Physics book 1 by Baroque
- Physics book 1 by Fountain, since they are the reference books majorly used while coming up with this new **Edition of Physics book 1**

I want to thank the following teachers who contributed much to the arrangement of this book for both the teacher and the learner;

Tr. Tukundane Rogers

Tr. Twijukye Alex

Tr. Muhumuza Julius

Tr. Atwijuka Deaz

CHAPTER ONE

INTRODUCTION TO PHYSICS

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.

Question

What do you want to become in future?

Pictures on page 4 vision (a-teacher, b-an engineer, c-a medical doctor)

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

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.

ACTIVITY 1.1 Page 4 Vision Publishing

Understanding the importance of physics

RESPONSES

1. (a) use of pulleys for fetching water from underground water wells

(b) In solar panels

(c) In communication

(d) In transport

2. Medicine

Construction of buildings

Car assembling plants

Raising flags

3. Electricity

Power

Work

Energy

Expansion and contraction of materials

Machines

States of matter

ACTIVITY 1.2 page 6 vision

RESPONSES (1.a-mechanics,b-modern physics, c-light, d-waves or modern physics,2 In a, friction force is being used, In b, radiations are being used, In c, a lens camera is being used, In d, sound waves and electronics are being used.3 and 4 refer to notes)

ASSESSMENT ACTIVITY page 8 vision

Activity 1.4 Vision Page 9 mastering the laboratory rules and regulations.

APPARATUS AND THEIR USES

Metre rule: measures short length like length or width of a table, height of a person

Tape measure: measures long distances such as length of a football pitch, width of a classroom

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

Micrometer screw gauge: 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.

Pipette: it is used to transfer a measured volume of the liquid from one container to another.

Ammeter: it measures current in the electric circuit.

Voltmeter: it measures voltage between two points in the electric circuit.

Stop clock or stop watch: measures time.

Tripod stand: it is used to support and hold items during heating

Wire mesh: It is placed on top of the tripod stand to provide a flat base for the items being heated.

Measuring cylinder: Measures volume of liquids like water.

Burette: measures volume of the liquid.

Triple beam balance: it used to measure the mass of the object like stone or metre rule.

Bunsen burner: used for heating during sterilization and combustion.

Spring balance: It measures mass and weight of an object.

Laboratory thermometer: measures the temperature of the body such as temperature of water

ACTIVITY OF INTEGRATION PAGE 20 VISION PUBLISHING

CHAPTER 2

MEASUREMENTS IN PHYSICS

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

Convert the following;

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

GROUP ACTIVITY

In a group 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

Convert the following;

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

NB.one 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

Convert the following;

a. $40m^2$ to cm^2
b. $5km^2$ to Dm^2
c. $500cm^2$ to mm^2

TYPES OF AREA

- Cross sectional area
- Surface area

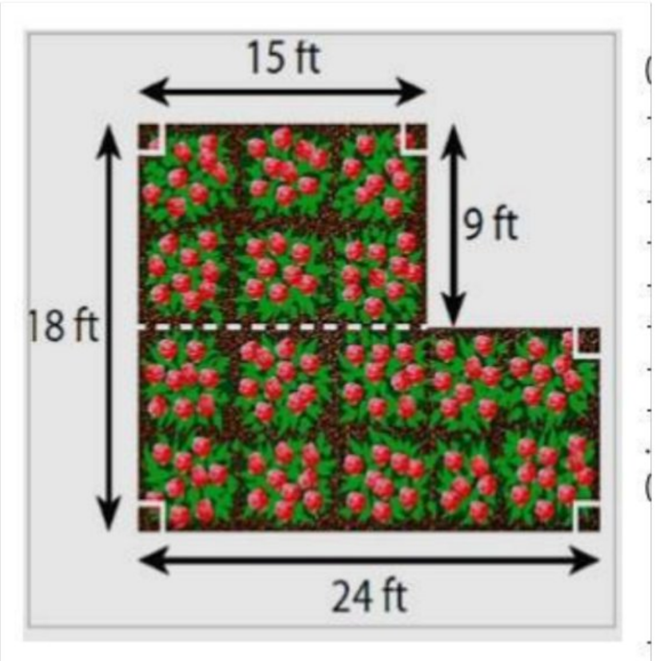
QUESTION

Distinguish between the types of area

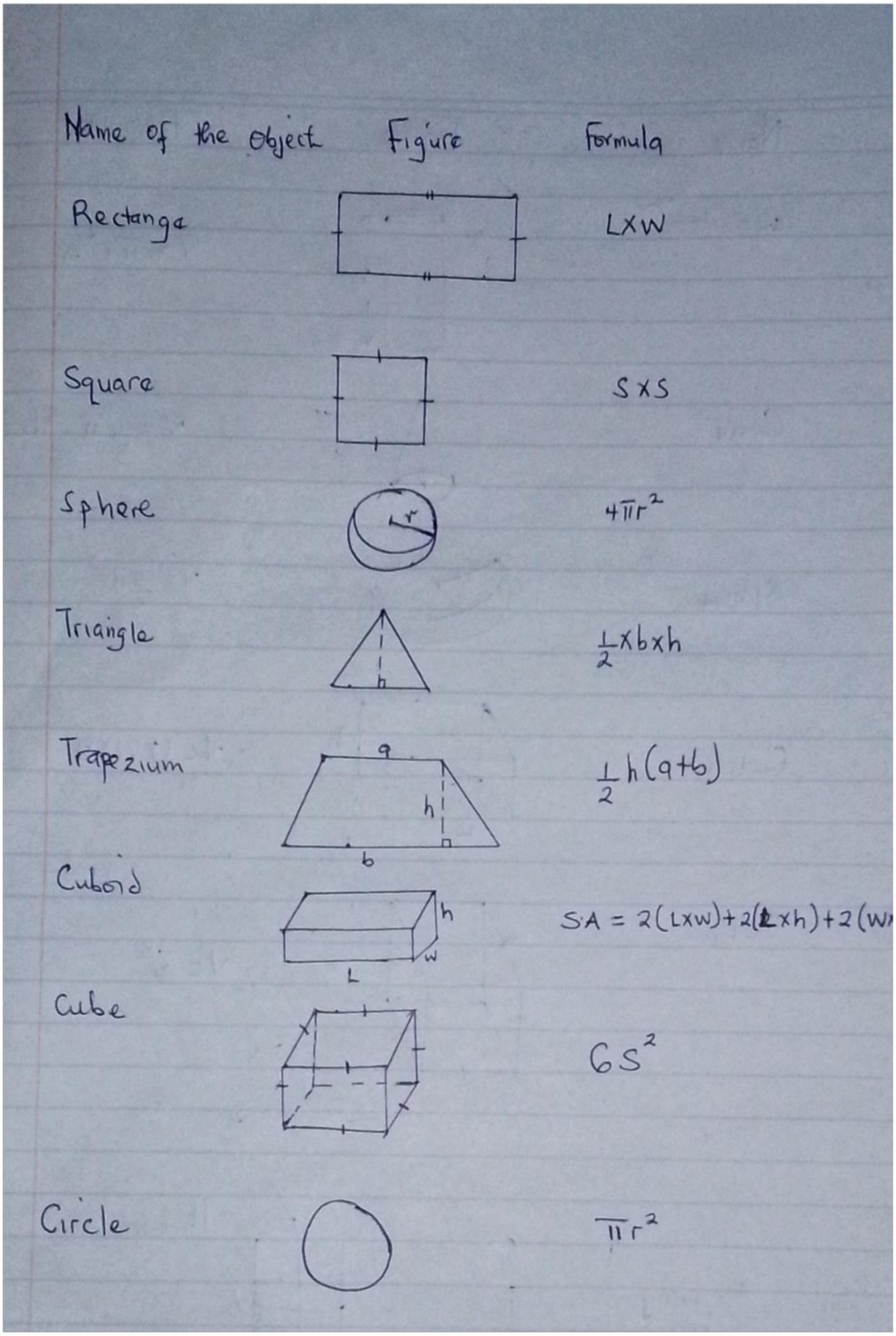
Response: cross sectional area is the area you get when you cut straight through an object while surface area is the area of the exposed surface of a particular object.

Activity

From the figure below, find the area of the garden



AREA OF REGULAR OBJECTS



Name of the object	Figure	Formula
Rectangle		$L \times W$
Square		$S \times S$
Sphere	r	$4\pi r^2$
Triangle	h	$\frac{1}{2} \times b \times h$
Trapezium	a, h, b	$\frac{1}{2} h(a+b)$
Cuboid	h, w, L	$SA = 2(L\times W)+2(L\times h)+2(W$
Cube		$6S^2$
Circle		πr^2

ACTIVITY 2.1 page 12 vision, 2.3 page 14$15

AREA OF IRREGULAR OBJECTS

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

Find the area of the figure below

(**NOTE**: Any irregular shape)

GROUP ACTIVITY

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

NOTE: 1 litre = $1000cm^3$

$1m^3$ = 1000 litres

$1m^3$=1,000,000cm^3

1 litre = 1000ml

Activity 2.1 (d) page 15 Baroque, Activity 2.4 (e) page 30 Baroque

Convert the following;

- 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.

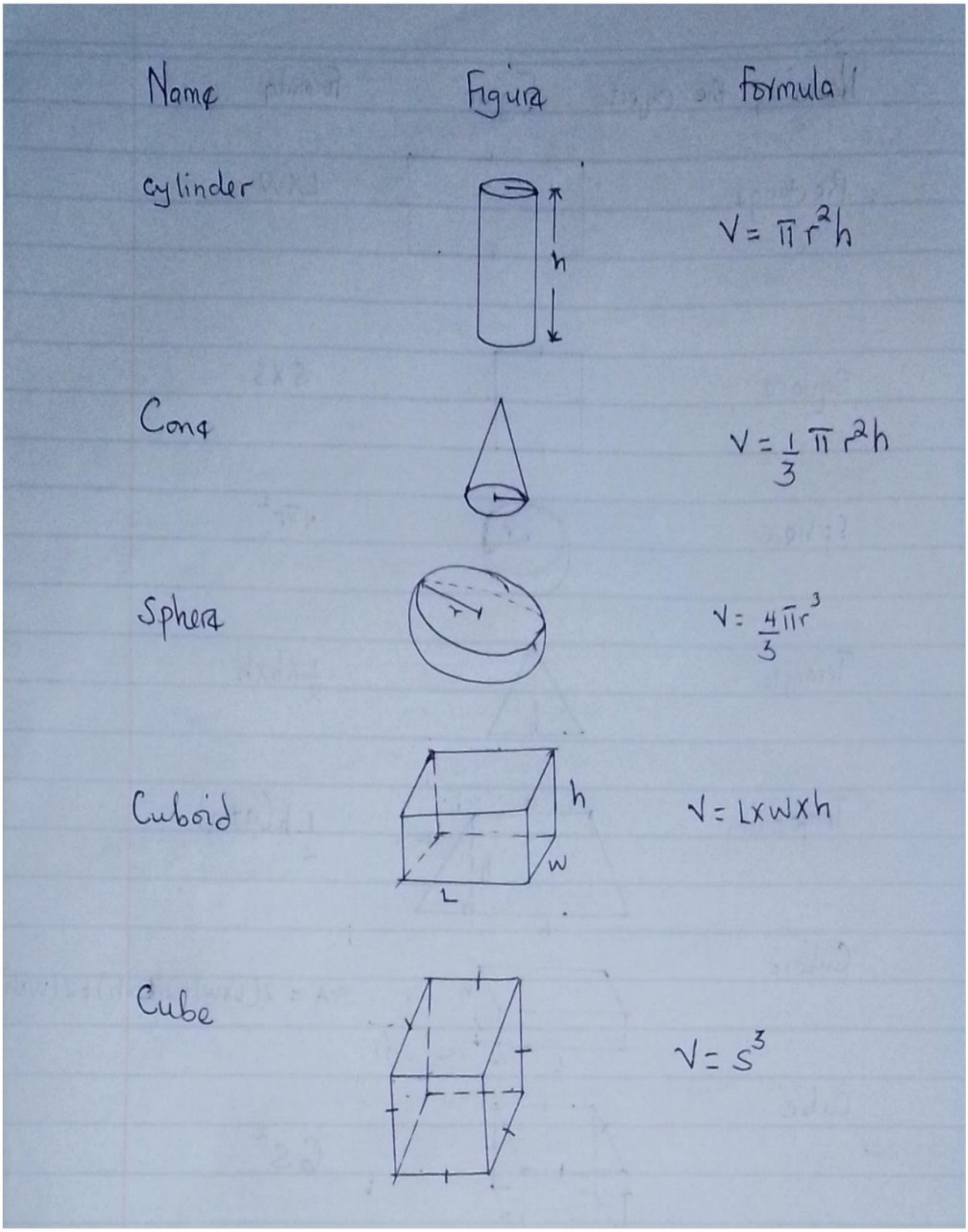
(A-dropper, B-syringe, C-pipette, D-burette, E-cup, F-conical flask, G-beaker, H-measuring cylinder, I-jerry can)

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



VOLUME OF IRREGULAR OBJECTS

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.

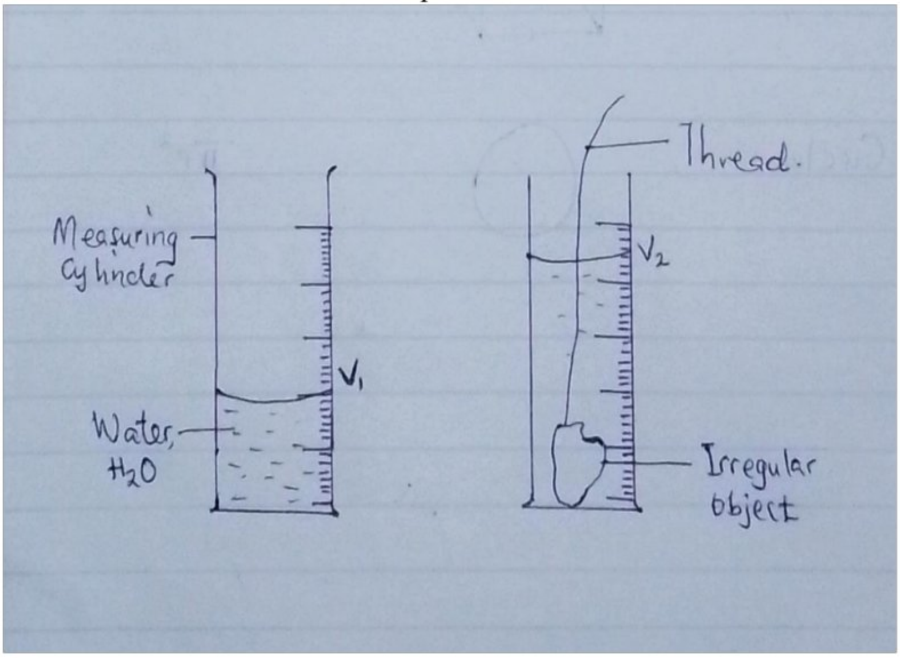
(DISPLACEMENT METHOD IS EXPECTED)

Solution

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

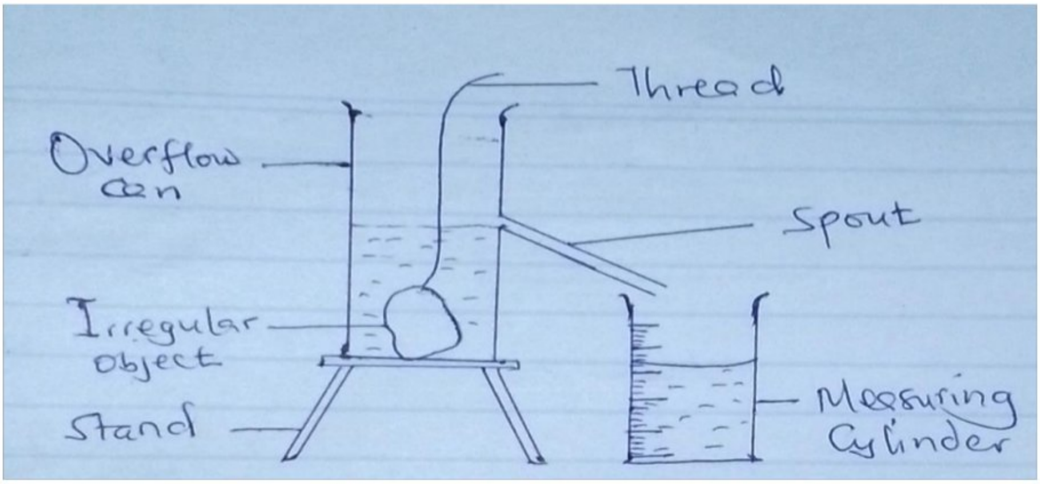
Group Assignment

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

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

ASSESSMENT ACTIVITY page 31 vision publishing

(RESPONSE No.5 (d) = 0.0495)

GROUP ACTIVITY

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 = $\frac{5}{t}$

SCIENTIFIC NOTATION

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

It is written as $m x 10^n$ where m is any number from 1 to 9 and n is an integer.

Examples

1. Write the following in standard form or scientific notation

a) 40000
b) 0.0000945
c) 2800000
d) 7.40mm
e) $\frac{1}{4}$
f) $\frac{3}{8}$

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

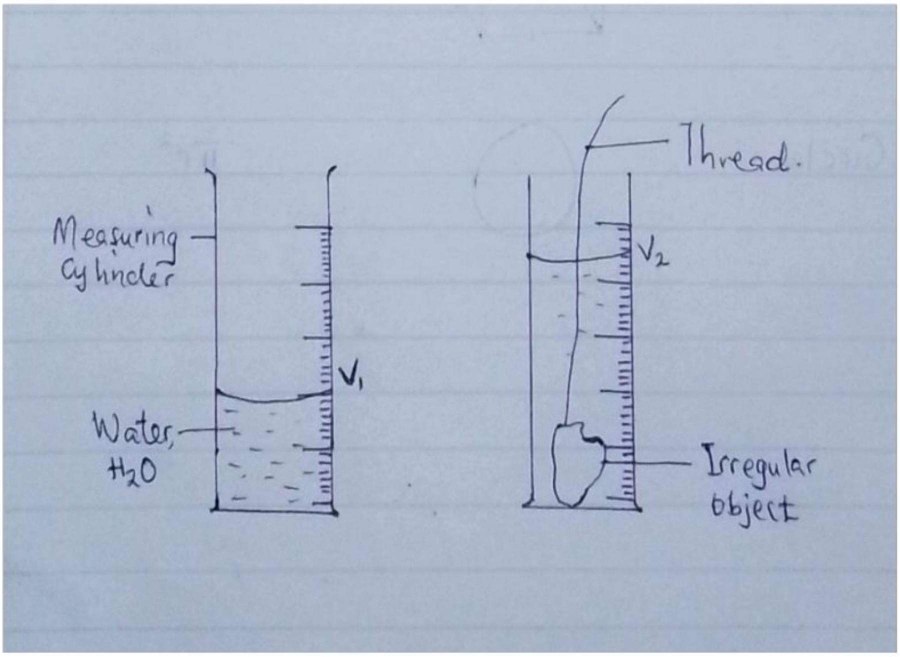
Measuring density of Liquids

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;

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

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

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-^{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

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	

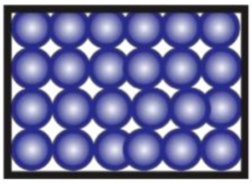
Liquids	
Gases	
Plasma	

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.

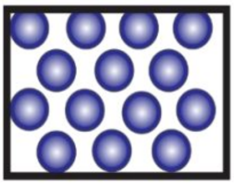


Properties of solids

- 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

<u>Liquids</u>

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

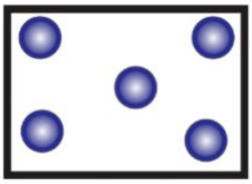


Properties of liquids

- 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

<u>Gases</u>

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



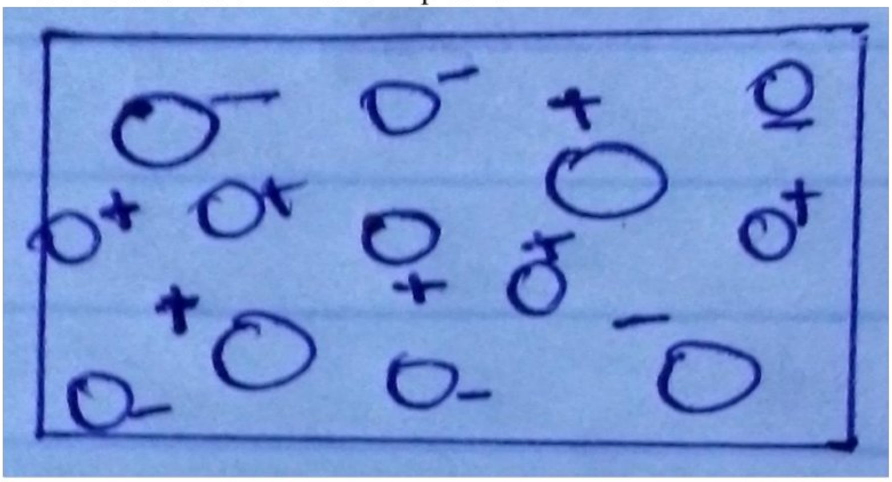
Properties of gases

- 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
4. Note: plasma is formed when a gas is exposed to very high or extremely high temperatures eg around the sun.
5. 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.

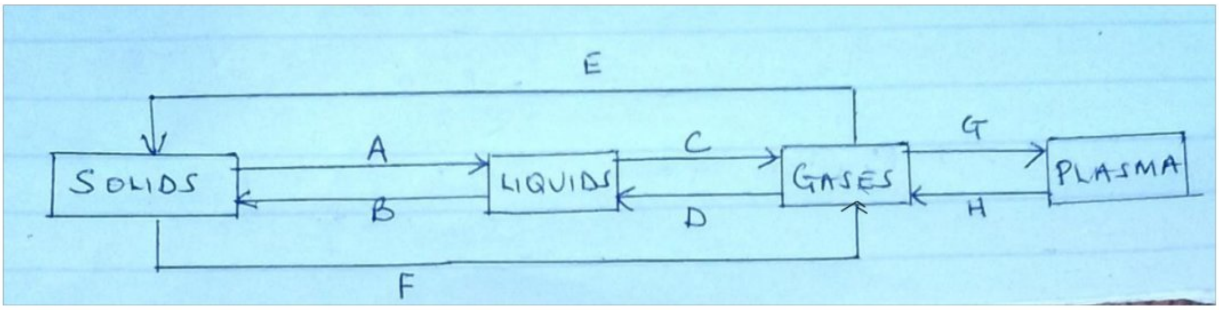
: Explain why ice melts to liquid when it is placed under sunshine.

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.

NOTE: Visit page 49 vision understand more about plasma (there are pictures)

ACTIVITY

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)

INDIVIDUAL ACTIVITY

Go to learners' book, vision book 1 page 51 and draw the diagram showing the changes of states of matter.

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 could be pushed to some distance whereas in case of water, the piston did 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

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.

Importance of the changes of state of matter

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 due 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 its 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

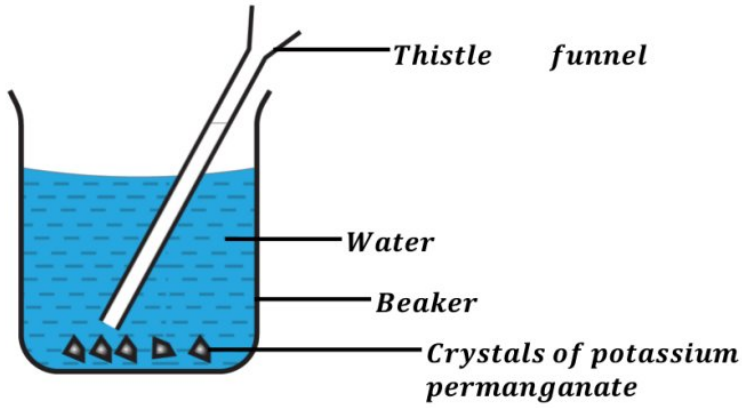
- Copper II sulphate crystals (blue in color)

- 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 glass trough

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.

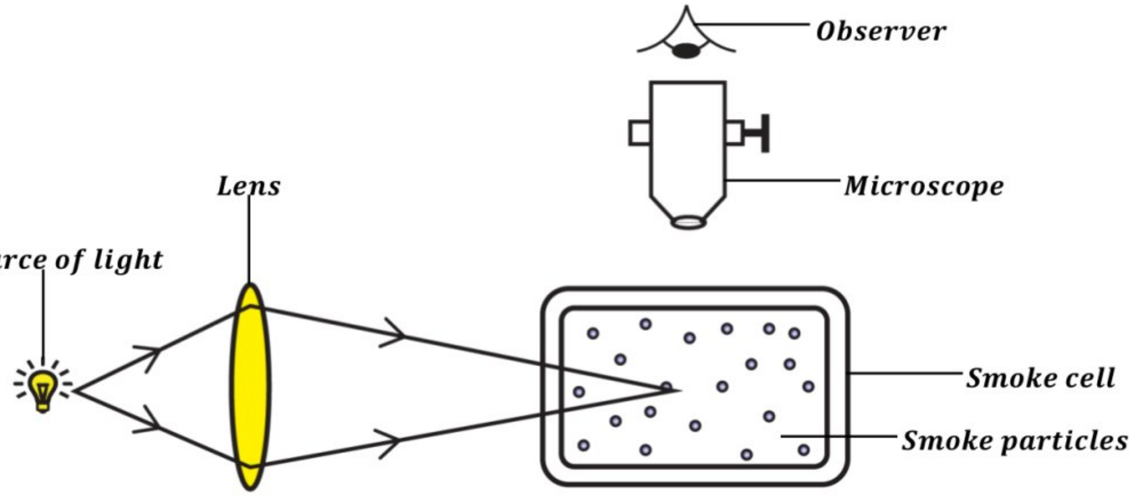
Brownian motion

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 FOUR

EFFECTS OF FORCES

What is a force?

Activity

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?

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.

(Soln: a smooth mass has a low friction while a block has a high friction. The length of the rubber band increases in length, the length of the rubber band decreases in length, 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)

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.

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

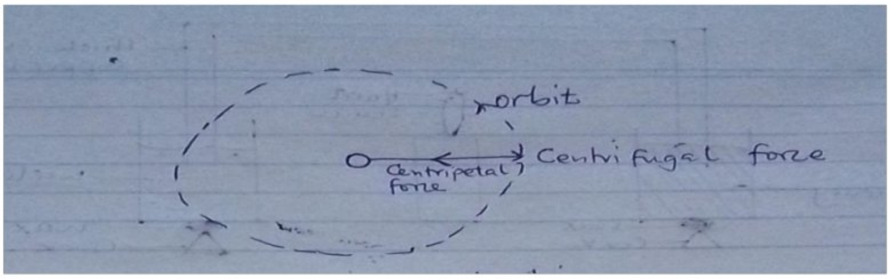
Frictional force (friction): This is the force that opposes the relative motion between two bodies in contact.

Application

- 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.

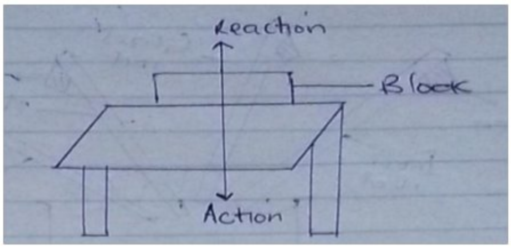
Centrifugal force: This is the force that is felt by an object moving in a circular path.



Application

- 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

- 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

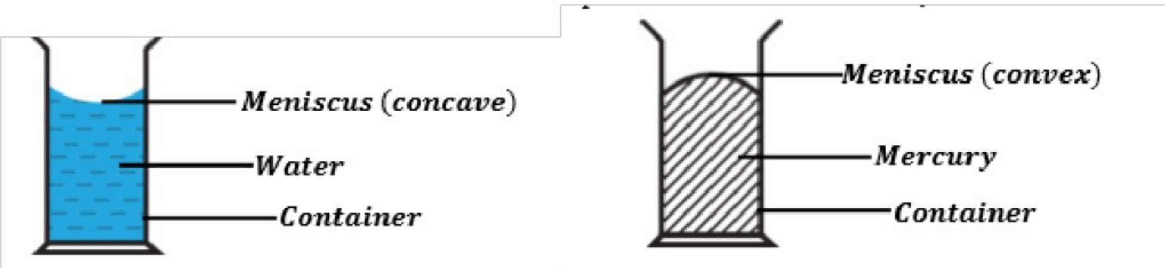
Cohesive forces cause tendency in liquids to resist separation of its particles

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? (**Note:** The above explanation is the solution)

CAPILLARITY (CAPILLARY ACTION)

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

Application of capillarity.

Activity

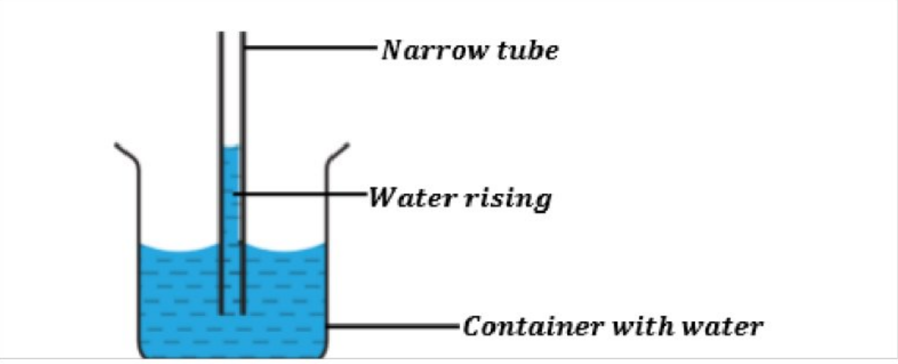
Study the pictures and state the application of capillarity formed (vision book 1 page 68)

Soln (Pict A-Absorption of paraffin by the wick of the stove, Pic B-Absorption of minerals and water by rots of a plant, Pict C-Use of dry towel to dry ourselves after bathing, Pict D-Cleaning of glass materials using water.)

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

Capillary action depends on cohesion and adhesion

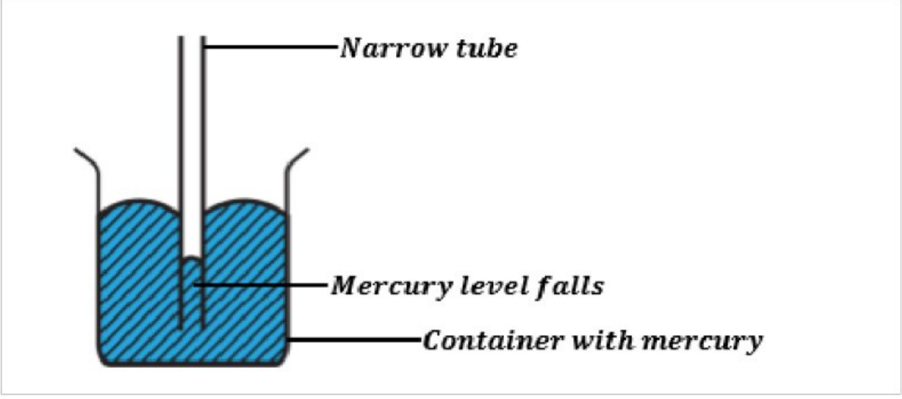
When adhesion is greater than cohesion



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

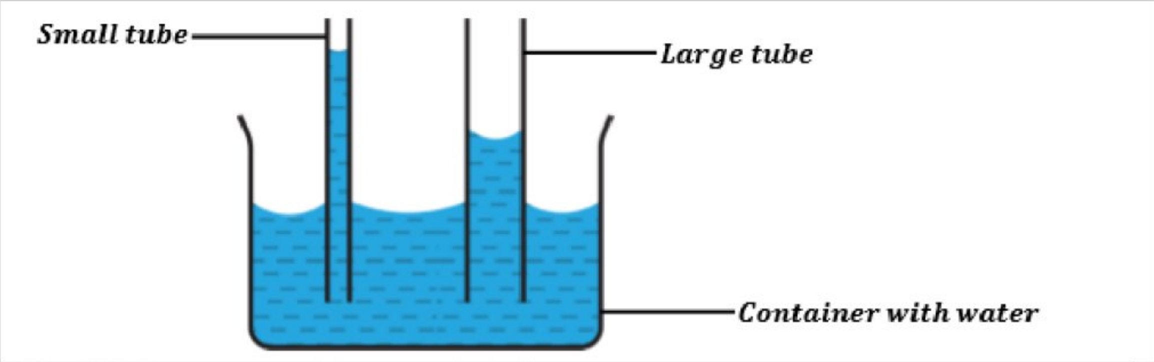
The meniscus curves downwards (convex)

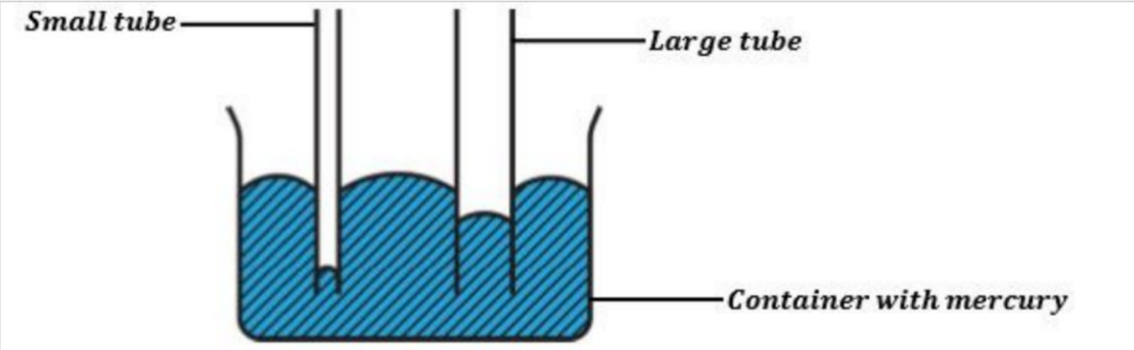
The liquid does not wet the glass

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 diameter.





Surface tension

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

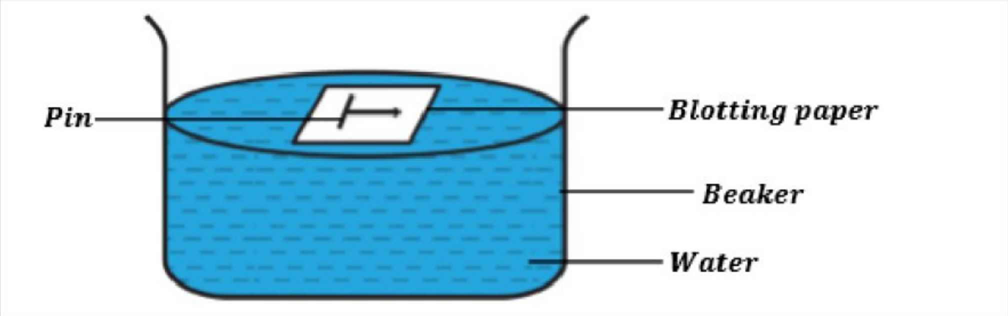
- ✓ Filter or bloating paper
- ✓ Basin/bucket
- ✓ Clean water

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 glass trough 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

i. Some birds and insects can walk on the surface of water
ii. A steel needle or razorblade floats on water when carefully placed on top of water

iii. 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

i. Design steps you can follow to investigate factors that affect surface tension.
ii. Carry out the experiment using the above steps
iii. 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

Mas is the quantity of mater in a body

Weight is the pull of gravity on the body

Mas 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

Calculations

i. A boy has a mas 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.**

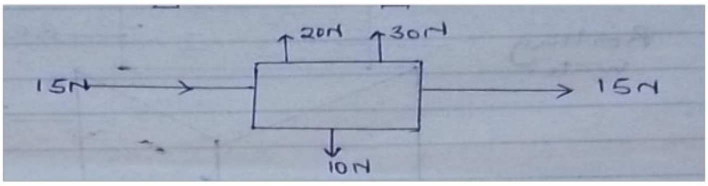
NOTE: suppose one team was pulling with a greater force than the other, in which direction would the cloth move? What name is given to such forces?

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

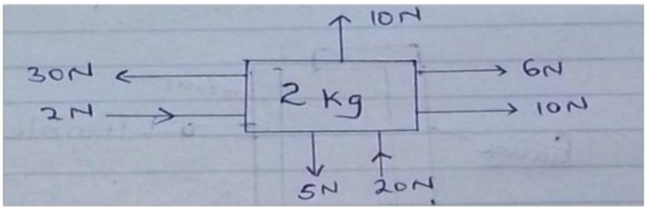
NOTE: Resultant force is the force which has the same effect as individual forces acting on the body.

Examples

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

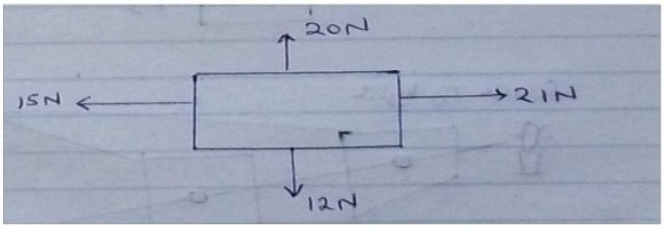


- Find the resultant force acting on the body of 2Kg and hence calculate the acceleration of the body



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

CHAPTER FIVE

TEMPERATURE MEASUMENT

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?

Soln

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?

Soln

- 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?

Soln: 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?

Soln: 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?

Soln: 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

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

Example

Convert the following as required

1. 37^0c to kelvin

   $K = {}^0C + 273$

   $K = 37 + 273$

$37^0c = 310K$

2. 273K to Celsius scale

$K = {}^0c + 273$

$273 = {}^0c + 273$

$273K = 0^0c$

Activity

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

Group activity

In a weather forecast, UBCTV 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 ^0F (98.6^0F)
- 87^0F to ^0c (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

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

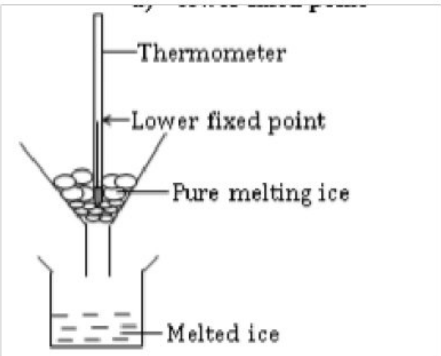
Is the temperature at which pure water boils under normal atmospheric pressure

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.



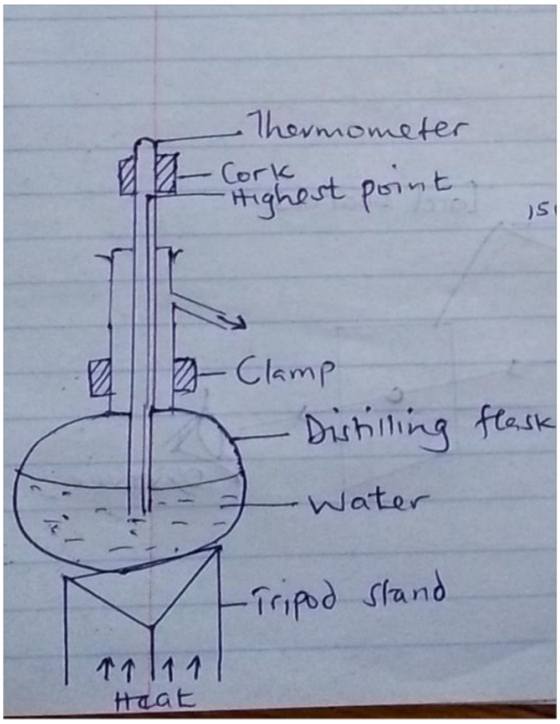
- Fill the filter funnel with ice cubes
- Insert the un calibrated thermometer in the ice cubes
- Place the beaker below the filter funnel to collect the melted ice
- Give the set up some time until you observe that the mercury thread is steady (constant)
- Mark the level of mercury on the glass of the 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

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.

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

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

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_o =3cm

Length of mercury in water bath $l\theta$ =12cm

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

Determine the temperature of his water bath.

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

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

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

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.

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

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

$\theta = 20^0\text{c}$

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?

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

$\theta = -20^0\text{C}$

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.

Chapter six

Heat transfer

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?

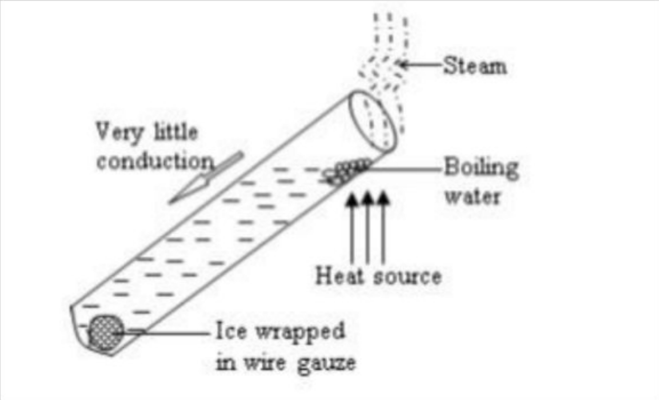
How does heat reach your fingers?

Soln: Heat reaches the fingers and warmth is felt.

Soln: 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;

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

Bad conductors of heat (insulators)

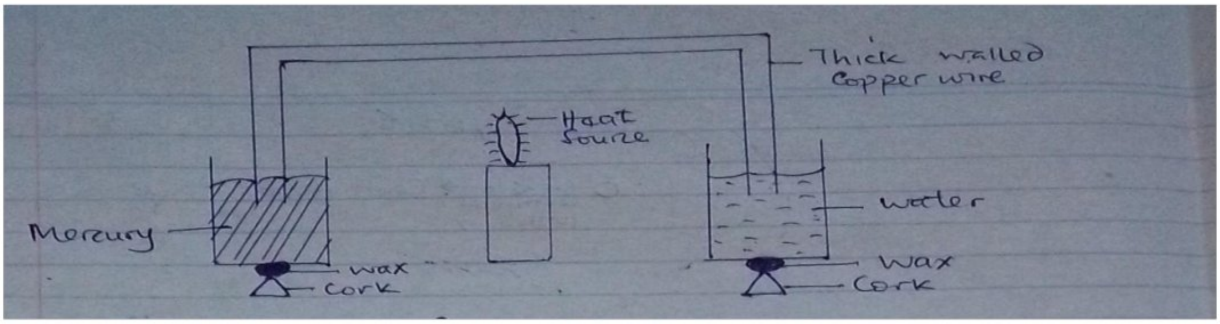
These are materials that do not allow heat to move from one point to another easily.

Examples include;

- Plastics
- Rubber
- Wood
- Cork
- Cotton
- 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

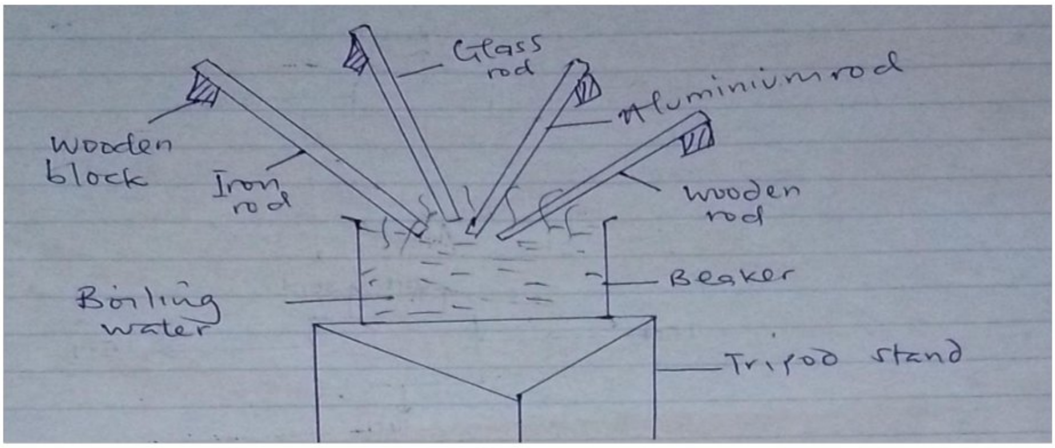
Rates of conduction in different materials

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)

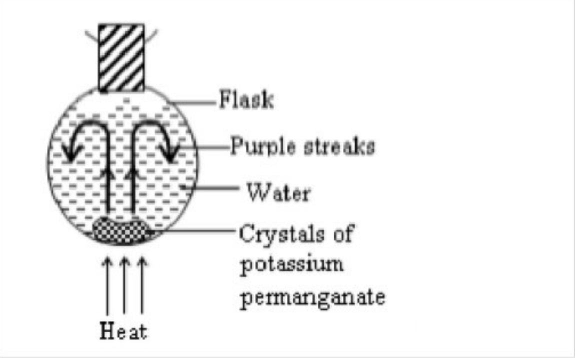
Convection

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.

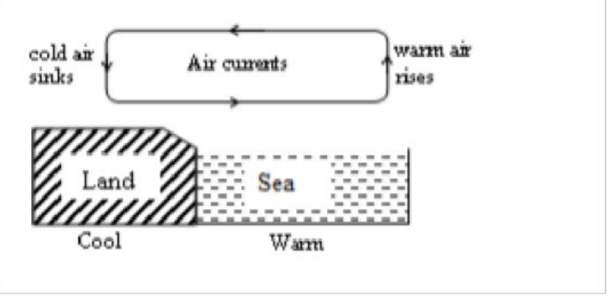
The upward movement of hot water and downward movement of cold water is called convectional current.

Application of convectional currents

It is applied in;

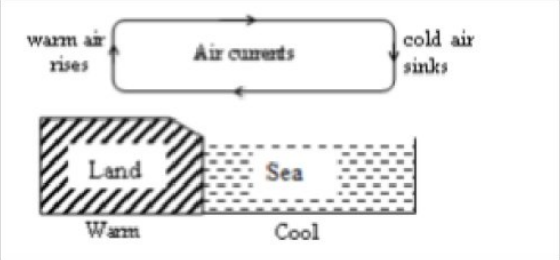
- Sea breeze
- Land breeze
- Ventilation

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

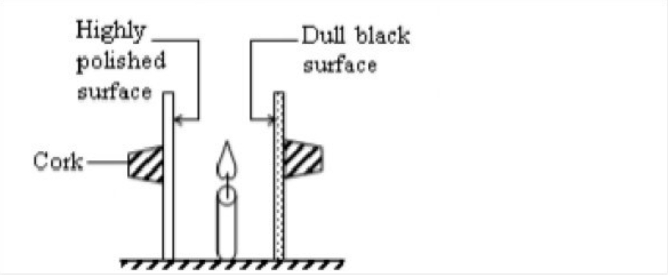
Radiation.

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

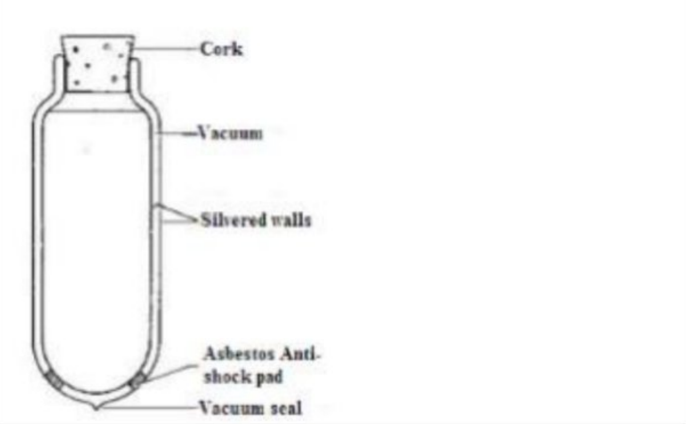
After some time, the wax on the dull black surface melts and the cork falls off faster than that of the highly polished surface.

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.

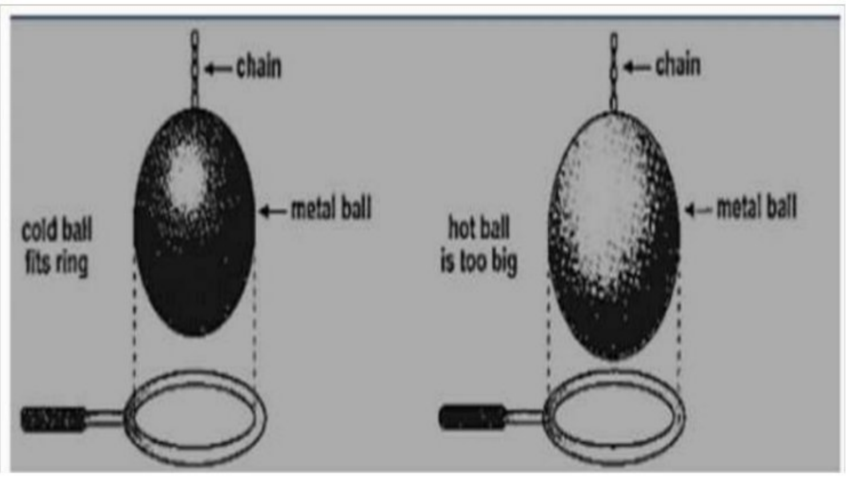
Chapter seven

EXPANSION OF SOLIDS, LIQUIDS AND GASES

(Thermal expansion of matter)

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

Expansion of solids



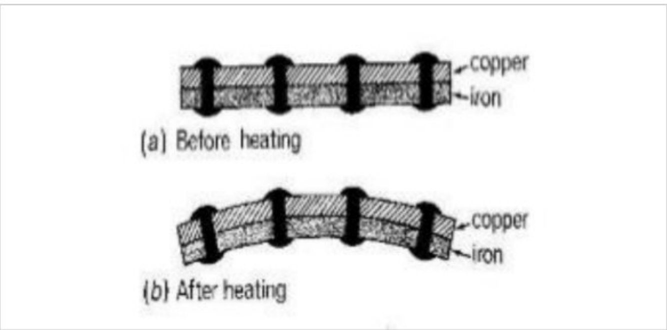
The metal ball passes through the ring when it is cold but when it is heated, it does not pass through the ring.

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

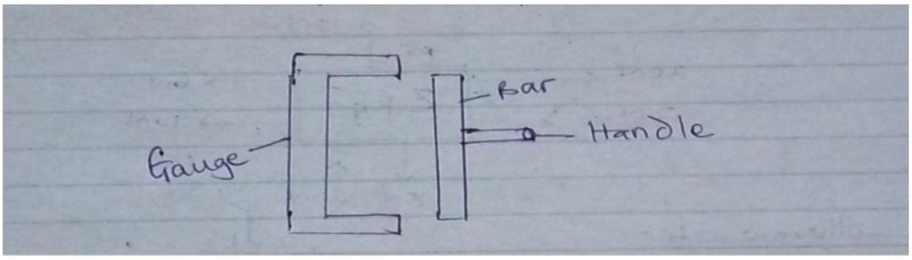
BI-METALLIC STRIP

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



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.

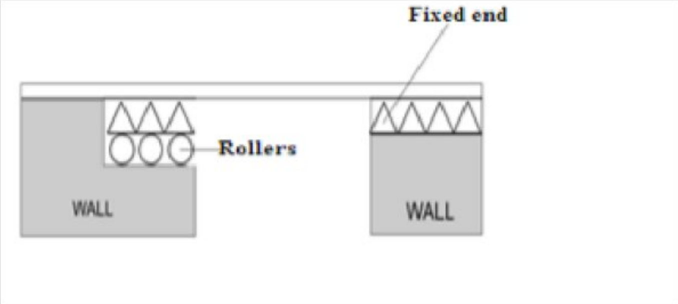
Conclusion

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.



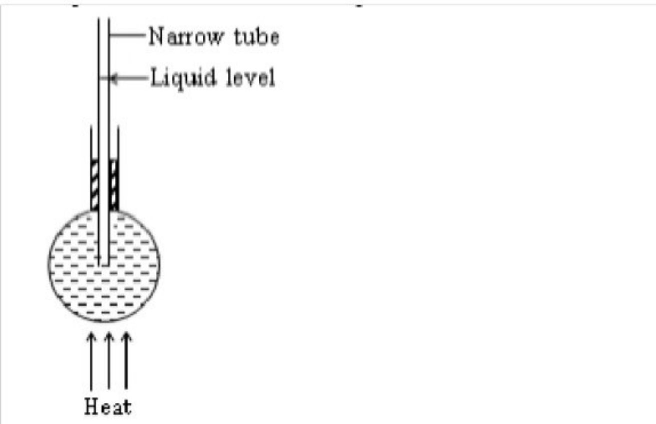
Railway lines

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

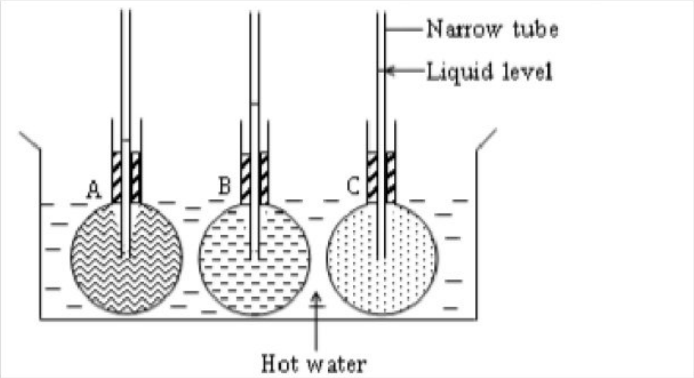
Observation

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

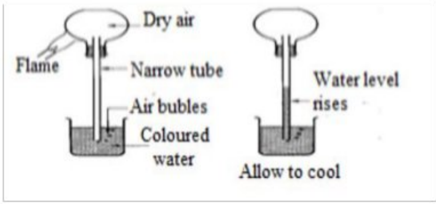
This shows that liquids expand differently when heated at the same temperature

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

LINEAR EXPANSIVITY

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

Linear expansivity, ($\propto$) = $\frac{linear\ expansion}{original\ length X temperature\ change}$

$$\propto = \frac{(l2 - l1)}{l1(\theta 2 - \theta 1)}$$

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

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

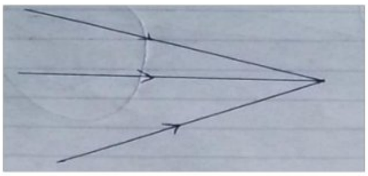
RAYS AND BEAMS

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

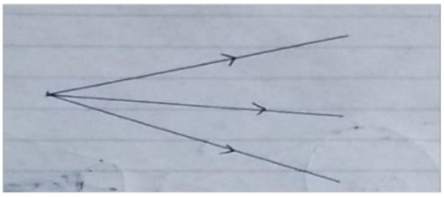
A beam is the collection of light rays. A beam maybe parallel, divergent or convergent.

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



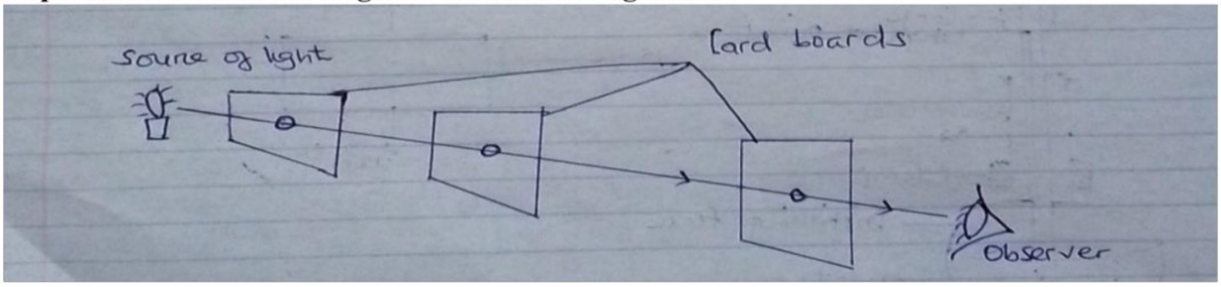
Properties of light

- ❖ Light can be reflected
- ❖ Light can be reflected
- ❖ 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

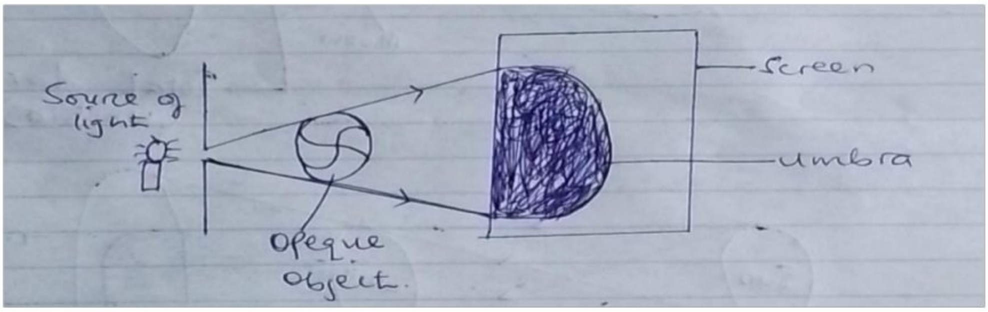
A shadow is an area formed when an opaque object obstructs the source of light.

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.

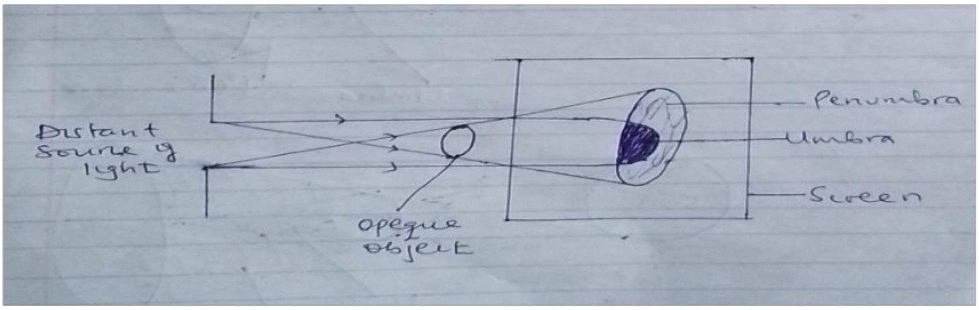
A shadow from a point source of light

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

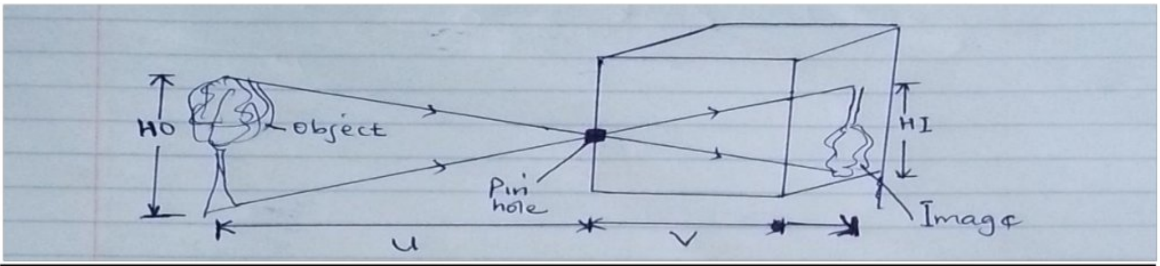
An eclipse is formed when the sun, moon and the earth align themselves in a straight line.

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



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 = $\frac{image\ height}{object\ height}$

$$M = \frac{HI}{HO}$$

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.

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

Soln

HO=5cm

U=20cm

HI=1.25cm

M=?

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

Soln

HO=1.6m

U=4m

V=20cm

HI=?

M=?

Reflection of light

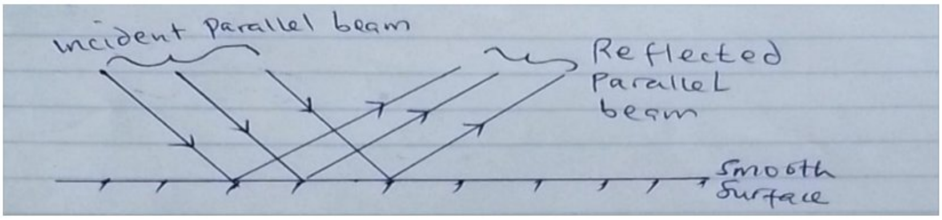
Reflection is the bouncing off of light rays after meeting a shiny surface.

Types of reflection

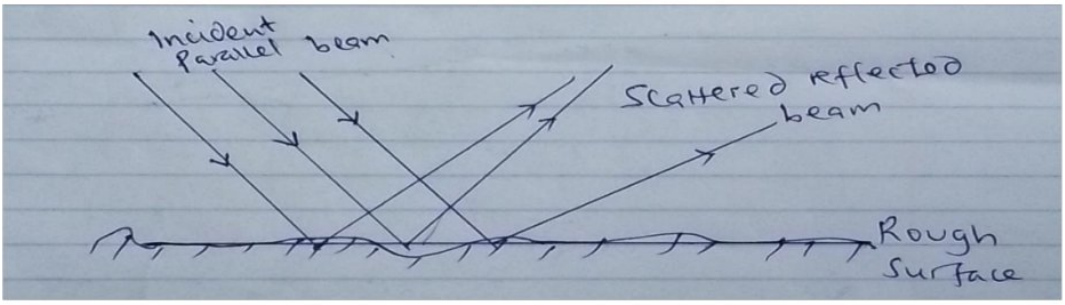
Regular reflection

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;

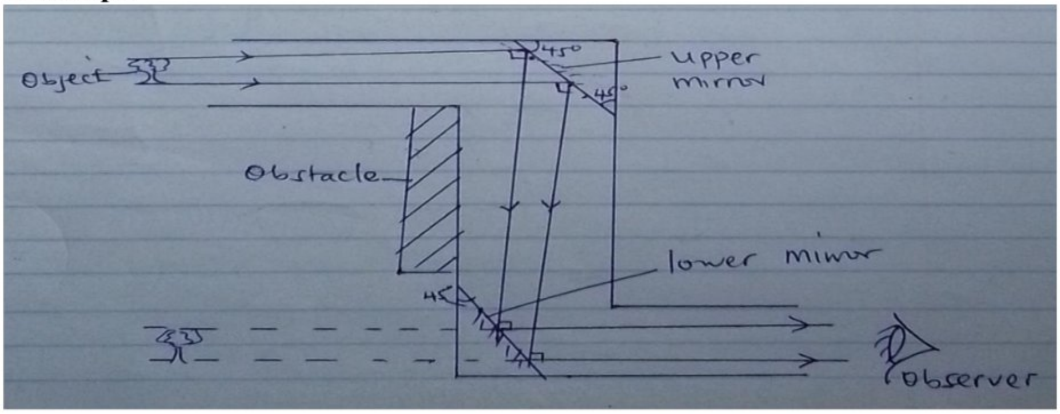
a. 30^0
b. 36^0
c. 90^0
d. 60^0

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

Diagram is in the book of Baroque learners' book at the last page.

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 P1 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, N1 and B_2, N_2.
xi. Measure angles l_1 and r_1 and angle l_2 and r_2