INTRODUCTION TO PHYSICS

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- **What is Physics?**

Physics is the branch of Science which deals with matter in relation to energy.

Matter is anything which occupies space and it has weight.

Energy is the capacity or ability to do work.

What is Science?

Science is the systematic study of nature.

A person who studies Physics is called a **Physicist**.

Branches of Physics

Physics is divided into various branches such as;

i) Mechanics - This is the study of motion of bodies in the frame of reference.

ii) Optics - This is the study of physical properties of light.

iii) Atomic Physics -This is the study of atoms specifically the electrons and its properties.

iv) Electromagnetism - This is the study of electrical and magnetic fields as two aspects of the same phenomenon.

v) Geophysics - This is the study of physical properties of the earth.

vi) Astronomy -This is the study of celestial bodies such as stars, galaxies, planets, e.t.c

vii) Electronics - This is the study of the flow of electrons in a circuit.

RELATION BETWEEN PHYSICS AND OTHER SUBJECTS

1. Chemistry- Devices used in studying Chemistry such as Bunsen burner and Centrifugal device are made from the application of Physics. The study of

Atomic Physics is also very useful in Chemistry.

2. Biology- Physics has simplified the study of living things. Those powerful microscopes used in studying Biology are made from the application of Physics. Different instruments for measuring blood pressure, body temperature, etc. are also made by using Physics laws.

3. Geography- Various devices used in Geography to study Weather and Climate are made from applications of Physics. Examples of these devices are Barometers, Thermometers and Wind vane. Cameras and satellites have been useful in Survey.

4. Mathematics- Physics laws are usually simplified by using Mathematical expressions. Thus, Mathematics is the language used by Physicists to simplify its information and communication.

5. History- The study of radioactivity in Physics has enabled the use of Carbon 14 to determine dates in Historical excavation.

IMPORTANCE OF STUDYING PHYSICS

1. Knowledge expansion

The study of Physics expands our knowledge. We learn about how different machines work and also understand how some natural phenomena such as earthquake, floods and winds occur.

2. Carrier development

People who study Physics may further study to be doctors, engineers, computer scientists and many other carriers which require the knowledge of Physics.

3. Basis for most modern technology

Studying Physics gives a better understanding on a modern technology. Devices such as x-ray machines, gas cookers, refrigerators are made from the principles of Physics.

APPLICATION OF PHYSICS IN DAILY LIFE

1. Communication- We use radio, television, telephone for communicating among us everyday.

2. Entertainment- We use music players, Dvd players, computer games, etc. for entertainment.

3. Transportation- We use cars, airplanes, ships for travelling from one place to another place.

4. In medicine- We use various machines in hospitals for diagnosis and treatment e.g x-ray machine, ultra sound machine, thermometers, etc

5.Agriculture- We use farm equipments such as tractors, harvester,sprinklers, etc

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THE INTRODUCTION TO LABORATORY PRACTICE

LABORATORY RULES SAFETY

Laboratory is a special room or place where equipments and chemicals are kept for the purpose of experimentation of a given matter.

Examples of Laboratory are;

- Clinical laboratory
- Physics laboratory.
- Biology laboratory.
- Chemistry laboratory.

Physics laboratory – Is a special room or place where physics equipments are kept and experiments are being conducted.

Laboratory rules - are the guidelines to be followed in the laboratory in order to reduce risks of accidents.

Physics laboratory rules;

The following are some of the physics laboratory rules.

1. Don't enter in the laboratory without permission from your teacher or laboratory assistance.
2. Don't perform any experiment in the laboratory without permission from your teacher or laboratory assistance.
3. Unnecessary movements are not allowed.
4. All exits must be clear of abstraction/ obstacle.
5. Any damages that may occur must be reported immediately to the laboratory attendant technician.
6. All damaged or broken apparatus must be well deposited to a proper place.

7. Never use free hand to hold hot objects.
8. Replace immediately the cover or stopper of the particular chemical soon after use.
9. After experiment, clean the bench and leave it dry and well arranged.
10. All connections must be checked by laboratory attendant/technician in case of electrical experiments.

THE SAFETY MEASURES IN THE PHYSICS LABORATORY

In addition to physics laboratory rules individuals working in the laboratory must be aware of safety measures for science laboratory especially physics laboratory.

These safety measures include :

1. All experiments which produce poisonous fumes must be conducted in the fume chamber
2. The laboratory floor should not be polished to avoid slippery.
3. The laboratory should have large windows and doors which should be opened outwards.
4. Ensure the fire extinguishers are fitted in an appropriate place ready to be accessed in case of fire accidents.
5. In a storage building, physics laboratory should be in the lowest floor.

FIRST AID AND FIRST AID KIT

First aid - is an immediate help given to a victim who has got an accident or injury before seeking for medicinal treatment in a hospital, medical cores or dispensaries.

First aid;
-Reduces pain
-Helps to bring hope and encouragement to accident victims.

First Aid kit - is a small box containing necessary instruments and chemicals that can be used in first Aid.

- **The following table summarizes the items which are found in the first Aid kit**

Item(s)	Uses
1. A pair of scissors	- To cut adhesive tapes, bandages and gauze.

2. Rolls of adhesive tape	- To hold firmly into wounds, bandages , gauze and cotton wool.
3. Bandages and cotton wool	- To clean and cover wounds.
4. Sterilized new razor blade	- Used in treating fresh or old wounds.
5. Sterilized gauze	- To clean and cover wounds.
6. Safety pin	- To tighten clip bandages.
7. One Jar petroleum jelly	- To apply on burns.
8. Iodine tincture	- To clean fresh cuts and bruises.
9. Soap	- To wash hand and wounds.
10. Antibiotic solution	- To clean wounds.

Causes of Accident in science Laboratory

Some of the common causes include the following.

1. Improper arrangement of laboratory instruments and chemicals.
2. Playing, fighting or quarreling in the laboratory.
3. Derailing from instruction for using chemical reagents or laboratory equipment.
4. Performing unauthorized experiment or deviating from instruction of experiment.
5. Insufficient personal protection when performing an experiment
6. Improper handling of potentially dangerous chemicals.
7. Ignoring laboratory rules.

WARNING SIGNS

Warning signs - are safety symbols used to warn a person about a possible dangers in a given area and when using the item.

- When one deals with laboratory activities he/she must take care of these Safety symbols**.**

In the laboratory safety symbols are used to warn a person and possible laboratory danger while he/she is in the laboratory and when using various chemicals.

The common safety symbols used in the laboratory are as following:

TOXIC HAZARD

Flammable materials

The following are the ways used to minimizing Accidents in the laboratory:

1. Through following laboratory rules and safety precaution.
2. By using protection wears before beginning any experiment.

Examples of protection wears are;
•**Wearing aprons or laboratory coats**- Protect people and themselves from chemicals and wearing a pair of plain plastics guards (Protects eyes from flying liquid or solid).
•**Wearing gloves**- Protects hands from corrosive chemicals

BASIC PRINCIPLES OF SCIENTIFIC INVESTIGATION

The process of scientific investigation involves the flow of five steps as follows:

1. **Problem:**
   Is a situation where there is a gap between the presence of knowledge and the knowledge one needs to have.
2. **Observation:**
   Are facts drawn by somebody using his / her sense organs (eye, nose, ear, skin, tongue).
3. **Hypothesis:**
   Is a guessed answer to a problem. It is tested by experiment and it may be accepted, modified or rejected.
4. **Experiment:**
   This is the organized way of testing the hypothesis. However experiment can be repeated several times before coming to the conclusion.
5. **Solution:**
   This is an actual and correct answer to a given problem which is obtained through experiment.

EXERCISE

1. **Define the terms.**

   a) Laboratory: Is the special room or place where equipments and chemicals are kept for the purpose of experimentation of a given matter.

   b) Physics Laboratory: Is a special room or place where the physics equipments are kept and experiments are conducted.

2. **What are laboratory rules?**
   Laboratory rules are the guidelines to be followed in the laboratory in order to reduce risks of accident

3. **Write down at least 7 rules in physical laboratory**

i. Don't enter in the laboratory without permission.
ii. Unnecessary movement is not allowed.
iii. All exits must be clear of obstruction / obstacles.
iv. Do not do perform any experiment in the laboratory without permission.
v. Never use free hand to hold hot objects.
vi. All damages that occur must be reported immediately to the laboratory attendant or technician.
vii. After experiment clean the bench and leave it dry, well arranged.

4. i) What is first aid?
Is an immediate help given to a victim who has got an accident or injury before

seeking for medicinal treatment in a hospital, medical cores or dispensaries.

ii) Why is first aid important?

a. Reduces pain
b. Gives hope to accident victims.

5. Define First aid kit?

Is a small box containing necessary instruments and chemicals that can be used in first Aid.

6. List down six components of first aid.

a. A pair of scissors
b. Rolls of adhesive tape
c. Bandage cotton wool
d. Sterilized new razor blade
e. Safety pin
f. Antibiotics

7. a) What is warning?

Are safety symbols used to warn a person about a possible dangers in a given area and when using the item

b) Draw three warning signs and its meaning

a. 

8. What is the meaning of scientific investigation?
This is the investigation done scientifically to find out the solution of a problem.

9. Mention five steps of scientific investigation

i. Problem
ii. Observation
iii. Hypothesis
iv. Experiment
v. Solution

10. State uses of :

- **Petroleum jelly** – to apply on burns
- **Gentian violet solution** – to clean wounds.
- **Methylated spirit**- to clean wounds.
- **Soap** – to wash hands and wounds.

MEASUREMENT

Measurement is the process of assigning numbers and units to a given event or observation.

Example:

- Length of a book is 25cm
- An angle of 30^o

Consider the fact that if we say the length of a pen is 25 cm " 25 gives the answer for how much" and "cm" gives the answer for "of what".

PHYSICAL QUANTITIES

In physics whatever we measure is referred as a **physical quantity**.
Physical quantity is something that we can measure in Physics.

This includes: Mass, time, length, volume, area, pressure, temperature etc

Each of these physical quantities may be measured by using one or more units. Internationally each physical quantity is assigned with its single unit which is recognized. These are the **standard international unit (SI units)** or **system of international unit**.

There are two types of physical quantities;
1. Fundamental physical quantity
2. Derived physical quantity

Fundamental physical quantities are those which can not be expressed in terms of other physical quantities namely;
1. Mass
2. Length
3. Time
4. Thermodynamic Temperature
5. Electric current
6. Luminous intensity
7. Amount of substance

Three Basic Fundamental Quantities
There are three basic fundamental quantities which are mass, length and time.

THE SI
The SI is the system of units used by Scientists worldwide. SI stands for Systemè de International.

Basic Physical quantities and their SI units

Basic physical quantities	**SI unit**	**Symbol**
Mass	Kilogram	Kg
Length	Meter	m
Time	Second	s

Standard multiplication Fracture;

Multiplication future	POWER	Prefix	Symbol
1000000000000	10^{12}	Tera	T
1000000000	10^{9}	Giga	G
1000000	10^{6}	Mega	M
1000	10^{3}	Kilo	K
100	10^{2}	Hecto	H
10	10	Deca	Da
1	-	-	-
	1	-	-
0.1	10^{-1}	Deci	D
0.01	10^{-2}	Cent	C
0.001	10^{-3}	Millis	Ml
0.000001	10^{-6}	Micro	µ
0.000000001	10^{-9}	Nano	
0.000000000001	10^{-12}	Pico	

NB: International systems of unit (SI unit) - are units which are uniform all over the world.

MEASUREMENT OF LENGTH

- **Length -** is the distance between two points. It is one of the three fundamental (basic) physical quantities used in mechanics.

The SI unit of length is the **meter (m)** Other units of length are;

- 1 kilometer (km)=1000 meter
- 1 hectometer (hm)= 100 meter
- 1 decameter (dam) = 10 meter
- 1 decimeter (dm) = 10^{-1} or 0.1 meter
- 1 centimeter (cm) = 10^{-2} or 0.01 meter
- 1 millimeters (mm) = 10^{-3} or 0.001 meter

INSTRUMENTS USED TO MEASURE LENGTH.

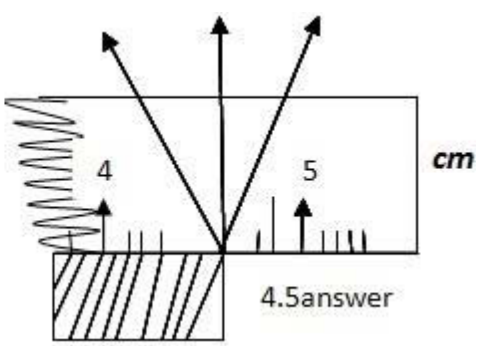
There are number of instruments used for accurate measurement of length.The choice of instrument is determined by of the object to be measured.

Examples of those instruments are;

- Meter rule
- Tape measure
- Vernier caliper
- Micrometer screw gauge

USING A METER RULE TO MEASURE LENGTH

- A meter rule measures length of the order of 100cm.
- When measuring length of unknown object, the correct way of reading is by looking straight and perpendicular to the point. Side way observation leads to very answer.



Errors

In measurement the devotion from the true reading is called **error**.

VERNIER CALIPER

A vernier caliper is used to measure short distance of the order of 10cm (the accuracy of 0.01cm).

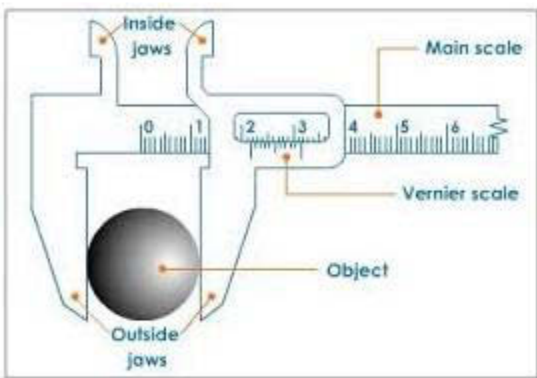
For example; diameter of pen, ball or pendulum bob.

It consists of two scales:

i. The main scale
ii. The vernier scale

• It also has the **inside jaws** and **outside jaws**.

The inside jaw is used to measure the **internal diameter** of a tube and outside jaw is for **external diameter**.



How to take readings of the vernier calipers. **There are two parts which are used in taking readings**;

a. Main scale
b. Vernier scale

1 main scale mark = 0.1 cm or 0.01 mm

1 Vernier scale mark = 0.01 cm or 0.001 mm

The reading is usually taken where the main scale mark coincides with the Vernier scale mark.

NB: When the main scale mark and Vernier scale mark do not coincide the reading may be taken with the first, second, third or fourth vernier mark.

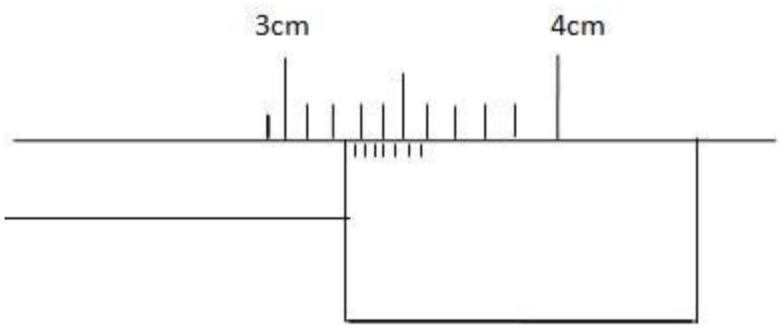
Examples;

1.Determine the reading of the following Vernier calipers.

Readings

Main scale = 6.00 cm
Vernier scale = + 0.08 cm
Reading = 6.08 cm.

2. Determine the reading of the Vernier caliper shown.



Readings:

Mean scale 3.20 cm
Vernier scale + 0.04 cm
Reading 3.24 cm

3. Determine the reading of vernier caliper shown.

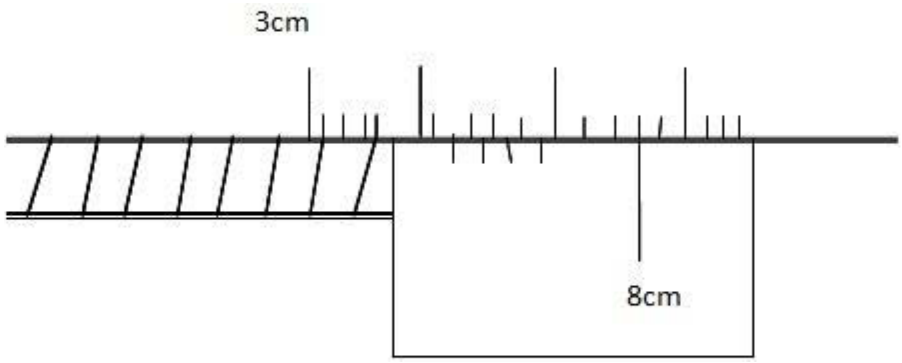
Solution:

Since No mean scale mark and vernier scale mark concedes then the reading is under;

Mean scale =	8.70	or	8.70	or	8.70	or	8.70
Vernier scale=	+0.01		+0.02		+ 0.03		+0.04
Reading =	8.71		8.72		8.73		8.74

4. Determine the reading of vernier caliper

object

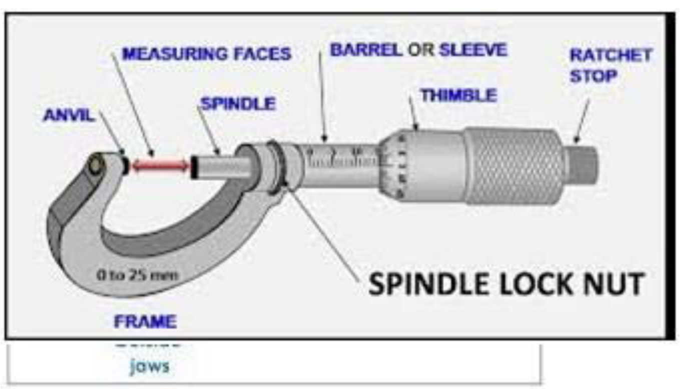


Reading Main scale = 3.40cm
Vernier scale = +0.08 cm
Reading = 3.48 cm

THE MICROMETER SCREW GAUGE

The micrometer screw gauge is an instrument used to measure a length to an accuracy of 0.001cm (or 0.01 mm).

It is used for measuring the diameter of wires and ball bearing. It is capable to measure small length up to about 2.5 cm.



It consists of;

-U-shaped frame (F)
-Anvil (A)
-Spindle (P)
-Sleeve (E)

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-Thimble (T)
-Ratchet (R)

How to take readings using micrometer screw gauge

Two principle parts are used for taking reading;

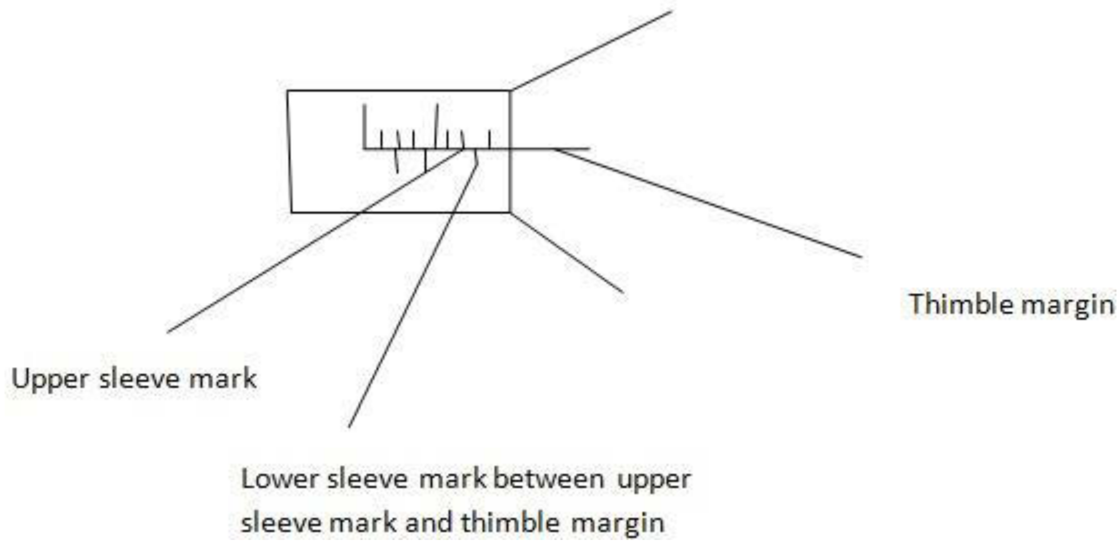
i. Sleeve **(E)**
ii. Thimble **(T)**

NOTE: 1 sleeve mark = 0.01 cm or 0.1 mm

1 Thimble mark = 0.001 cm or 0.01 mm.

1. In sleeve if the lower sleeve mark is between the thimble margin and upper sleeve mark, the lower sleeve mark is read as 0.5mm or 0.05 cm and added to the upper sleeve reading to get sleeve reading.

1. Sleeve reading



The sleeve reading;

4+0.5mm

- In contrast if the lower sleeve mark is not between the thimble margin and the upper sleeve we don’t count the lower sleeve mark to the sleeve reading.

Example:

1. What is the reading of the following micrometer screw gauge below?

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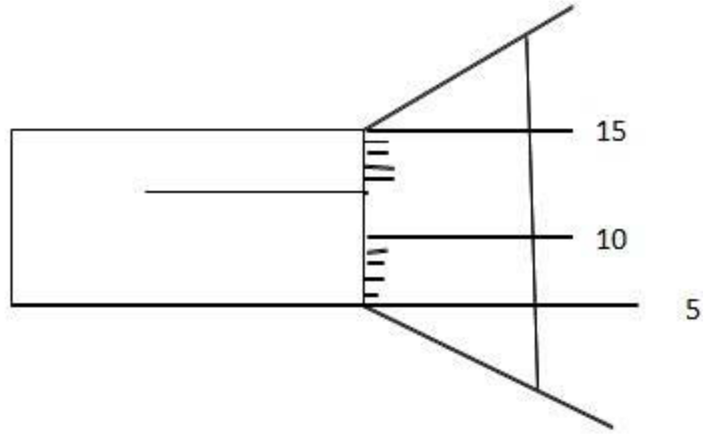
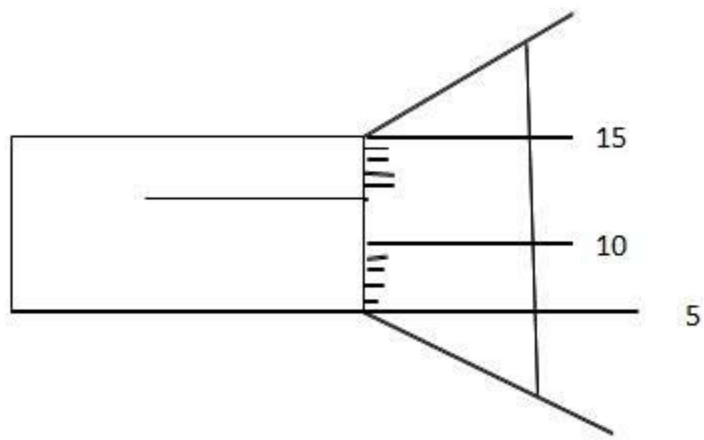


Solution:

Sleeve reading = 5.50 mm
Thimble reading = +0.12 mm
Total reading = 5.62 mm.

2. Give the reading of micrometer screw gauge below;

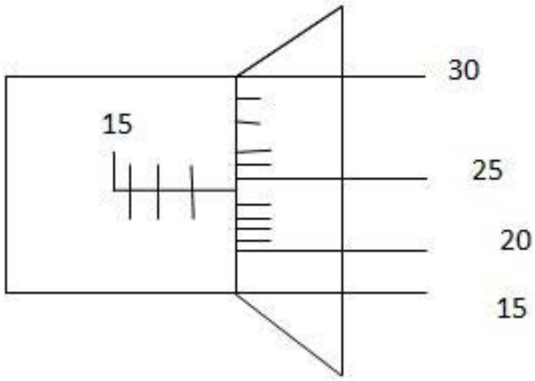


Solution:

Sleeve reading = 3.00 mm
Thimble reading = + 0.48mm
Total reading = 3.48 mm

EXERCISE

1. Determine the reading of micrometer screw gauge below;



Solution:

Sleeve reading 17.50mm
Thimble reading + 0.24 mm
Total reading = 17.74mm

MEASUREMENT OF MASS

Mass - is a quantity of matter / body it contains e.g. when we buy some flour at the shop, we buy a quantity or certain amount of flour. This is a mass of flour.

The SI unit of mass is **kilogram (kg)**.

Other units of mass include the following;

- 1 Kilogram (kg) = 1000g
- 1 Hectogram (Hg) = 100g
- 1 decagram (dag) = 10g
- 1 Decigram (dg) = 0.1g

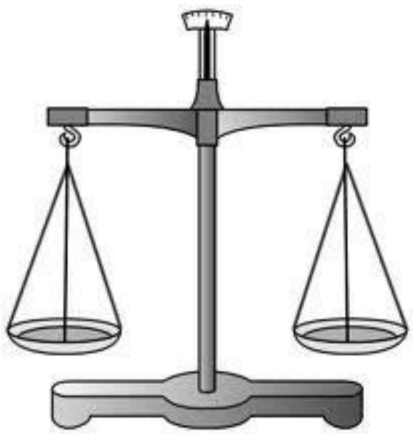
INSTRUMENTS USED TO MEASURE MASS

Mass is measured by a **beam balance.** Other instruments used to measure mass are Triple beam balance, chemical balance and digital balance.

The following are the types of beam balance;

i. Triple – beam balance
ii. Chemical beam balance
iii. Digital balance
iv. Roman steel yard beam balance

Example of beam balance:



MASS AND WEIGHT

Many people got confused of these two terms they think that mass and weight is the same but in reality they have two(2) different meaning.

MASS	WEIGHT
1. Is a quantity of matter within a body	-It is a force of attraction on bodies towards the earth center.
2. Its SI unit is kilograms (kg)	-Its SI unit is Newton (N)
3. It is measured by a beam balance	-It is measured by spring balance.
4. It does not change from one place to another	-It changes from one place to another
5. Is a scalar quantity	-It is vector quantity
6. It is a basic fundamental quantity	-It is a derived physical quantity

MEASUREMENT OF TIME

Time - Is the interval between two events used to record the duration of events taking places between them.

•The SI unit of time is **second (s)**.

•Other units of time include;

•**Minutes:** 1 minute = 60 seconds

•**Hours:** 1 hour =60 minutes also1 hour = 3600 seconds

•**Days:** 1 day = 24 hours

•**Weeks:** 1 week = 7 days

•**Months:** 1 month = 4 weeks

•**Years:** 1 year = 12 months

•**Decades:** 1 decade = 10 years

•**Century:** 1 century = 100 years

•**Millennium** - 1 millennium = 1000 years

INSTRUMENT USED TO MEASURE TIME

Time is precisely measured by using stop watch.

Stop watches are of two kinds:

1. Mechanical stop watch
2. Digital stop watch.

DERIVED PHYSICAL QUANTITIES

These are physical quantities which can be expressed in terms of other physical quantities

They include;

i. Volume
ii. Density
iii. Relative density
iv. Force
v. Velocity
vi. Acceleration
vii. Speed
viii. Work
ix. Energy
x. Power etc.

MEASUREMENT OF VOLUME

Volume - is the amount of space occupied by a substance.

The SI unit of volume is **meter cubic (m^3)** other unit of volume includes **liters (l), cubic centimeter (cm^3), milliliter (m)** etc.

DETERMINATION OF VOLUME OF SUBSTANCES

•A VOLUME OF SOLID

Solid have been divided into two categories;

1. **Regular solid**

   This is the solid which has both definite shape and size e.g. spheres, cylinder, squares, etc.

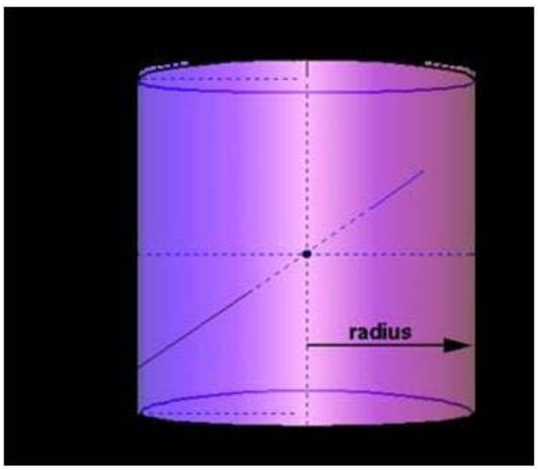
2. **Irregular solid**

   This solid which has neither definite shape nor size e.g. stones.

•VOLUME OF REGULAR SOLIDS

For example these can be found by a formula;

1. **Cylinder**



$V = \pi r^2 l$

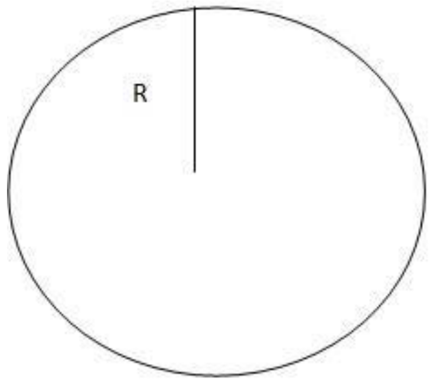
where

r=radius

=or 3.14

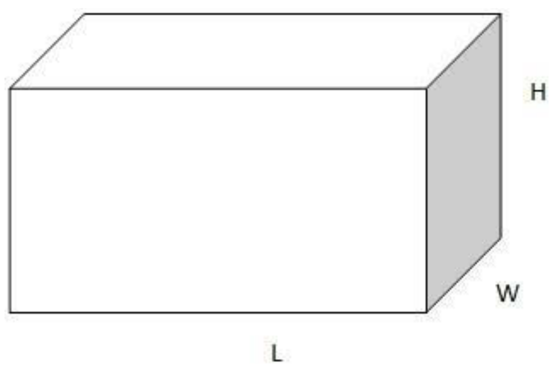
L=length

2. **Sphere**



$V=\frac{4}{3}\pi r^3$

3. Rectangular block



V= l x h x w

Where l= length

w= width

h= height

Example

1. A cylinder pipe has a radius of 7cm and is 20cm long. Calculate its volume.

Data:

R=7cm
L= 20 cm
V=?

Solution

V $=\pi l r^2$

$$= \frac{22 \times 7 \times 7 \times 20}{7}$$

V =3080 cm^3

Example 2

A spherical bob has a radius of 0. 7cm. Calculate its volume.

Data

R= 0.7cm
V=?

Solution

$$V=\frac{4}{3}\pi r^3$$

$$V=\frac{4 \times 22 \times 0.7 \times 0.7 \times 0.7}{3 \times 7}$$

Volume = 1.4373 cm^3

Example 3

Rectangular block has a length of 2cm, width of 4cm and height of 12 cm. Calculate its volume.

Data

Length = 2cm
Width = 4cm
Height = 12cm
Volume =?

Solution

$V = l \times w \times h$

$= 2\times4\times12 = 96$ cm^3

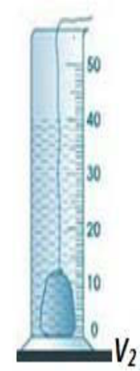
Volume = 96 cm^3

VOLUME OF IRREGULAR SOLID

The volume of these solids is obtained by using displacement method as shown.

1. Fill measuring cylinder with water and record it is volume say v_1
2. Lower a store with threads into the cylinder and record the new volume say v_2.
3. The volume of stone $v = v_2 - v_1$

Diagram



Example:

A measuring cylinder is filled with water to a volume of 20cm^3. When the stone immersed the volume raised to 38cm^3. Calculate volume of a stone.

Data:

$V_1 = 20\ cm^3$
$V_2 = 38\ cm^3$

since: $V_2 - V_1$

$\therefore 38 - 20 = 18 cm^3$

DENSITY AND RELATIVE DENSITY

Density: Is the mass of substance per unit of volume.

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

$$\rho = \frac{m}{v}$$

ρ = Symbol for density (Greek letter, rho)
M= mass
V= volume

The SI unit of density is **kilogram per cubic meter (kg/m^3)**

It's true to say;

$$\rho = \frac{m}{v}$$

And hence

$$M = \rho \times v \text{ ....(ii)} \quad \text{or}$$

$$V = \frac{m}{\rho}$$

Other unit of density is **gram per cubic centimeter (g/ cm^3)**

Example

1. Find the density of a body with mass of 200kg and volume of 10m^3

Data:

Mass (m) = 200kg
Volume (v) = 10m^3
Density =?

Solution

$$\rho = \frac{m}{v}$$

$$\rho = \frac{200}{10}$$

= 20kg m^3

Example

2. A body has a mass of 40kg and a volume of $5m^3$ calculate its density.

Data:

Mass (m) = 40kg

Volume (v) = $5m^3$

Density =?

Solution

$$\rho = \frac{m}{v}$$

$$\rho = \frac{40}{5}$$

= 8kg/m^3

Density = 8kg/m^3

Example

3. A body has a mass of 40kg and volume of $0.4m^3$. Calculate its density.

Data:

Mass (m) = 40 kg
Volume (v) =$0.4m^3$

Formula:

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

$$\text{Density} = \frac{40 \text{ kg}}{0.4\text{m}^3}$$

Density=100kg/m^3

Exercise

1. A block of wood of volume 60cm^3 has a mass of 45g. Find the density of wood.

Data:
Mass (m) = 45g
Volume (v) = 60cm^3
Density =?

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

$\text{Density} = \frac{45g}{60cm^3}$

Density=0.75g/cm^3

2. The density of mercury is 13.6g/cm^3. Find the volume if the mass of mercury is 204 gram.

Data:
Mass (m) = 204g
Volume (v) = ?
Density = 13.6g/cm^3

Formula: $V = \frac{\text{mass}}{\text{density}}$

$V = \frac{204}{13.6}$

V= 15cm^3

3. A body has a density of 0.9g/cm^3 if the volume of that body is 6cm^3. Find its mass.

Data:

Mass (m) =?
Volume (v) = 6cm^3
Density = 0.9g/cm^3

Solution: m= 0.9g/cm^3 × 6cm^3

= 0.54g/cm^3

mass =0. 54cm^3

DETERMINATION OF DENSITY OF LIQUID

Procedure

Find the mass of an empty dry beaker then pour it into a known volume of liquid by using a pipette.Find the mass of beaker of liquid.

Result:

Mass of empty beaker = (m_1)

Mass of beaker and liquid = m_2

Volume of liquid = v

Mass of liquid = $m_2 – m_1$

Density of liquid = ($m_2 — m_1$) g /cm^3 or kg /m^3

Example:
1. A Clean beaker has a mass of 100g. A volume of 100cm^3 of liquid is poured into the beaker with the help of a pipette. The mass of beaker and its contents is 140g. Calculate the density of liquid.

Data:

Mass of empty beaker (m_1) = 100g
Mass of beaker and liquid (m_2) = 140g
Volume of liquid = 100cm^3
Density of liquid = ?

Solution:

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

But mass = $m_2 - m_1$

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$$\rho = \frac{(140-100)g}{100cm^3}$$

Density of liquid = 0.4g/cm^3

Example 2:

A clean beaker has a mass of 500g. A volume of 25cm^3 of liquid is poured into the beaker with the help of pipette. The mass of beaker and its contents is 600g. Calculate the density of liquid.

Mass of empty beaker (m_1) = 500g
Mass beaker and liquid (m_2) = 600g
Volume liquid = 25cm_3
Density of liquid = ?

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

But mass = $m_2 - m_1$

$$\text{Density of liquid} = \frac{(600-500)g}{25cm^3}$$

Density of liquid = 4 g/cm^3

RELATIVE DENSINTY (RD)

Definition:

Relative density is the ratio of a density of a substance to the density of liquid.

OR

Relative density is the ratio of mass of substance to the mass of equal volume of liquid.

- Since the density of water is 1g/cm^3 or 1000kg /m^3 .It is common to compare density of substance to that of water.
- This comparison is what we call **relative density (RD)**. Relative density **has no unit** because it is the ratio of two equal quantities.

mathematically;

$$\text{Relative density (RD)} = \frac{\text{density of substance}}{\text{density of water}}$$

$$\frac{kg/m^3}{kg/m^3} = 1 \quad \text{or} \quad \frac{g/cm^3}{g/cm^3} = 1$$

$$\text{Also relative density (RD)} = \frac{\text{mass of substance}}{\text{mass of equal volume of water}}$$

$$= \frac{kg}{kg} \quad \text{or} \quad \frac{g}{g}$$

Example

1. The iron metal has a density of 2700kg/m^3. Find its relative density if the density of water is 1000kg/m^3.

Data:
Density of iron = 2700kg/m^3
Density of water = 1000kg/m^3
Relative density (Rd) =?

Solution

$$\text{Relative density} = \frac{\text{density of iron}}{\text{density of water}}$$

$$= \frac{2700}{1000}$$

$$= 2.7$$

2. If the mass of copper is 3600kg and mass of water is 2500kg. Find the relative density of copper.

Solution:

Mass of copper = 3600kg
Mass of water = 2500kg
Relative density = ?

$$\text{Relative density} = \frac{\text{mass of copper}}{\text{mass of water}}$$

$$RD = \frac{3600}{2500}$$

RD= 1.44

3. An object has a mass of 50g and a volume of 20cm3. Find the relative density of object

Data:
Density of mass = 50g
Density of volume = 20cm3
Relative density (RD) =?

Solution:

$$\text{But density of an object} = \frac{\text{mass}}{\text{volume}}$$

$$= \frac{50}{20} = 2.5g/cm^3$$

$$\text{Relative density} = \frac{\text{density of substance}}{\text{density of water}}$$

$$= \frac{2.5}{1}$$

=2.5

RELATIVES DENSITY OF LIQUID

The relative density of liquid can be easily determined by using a relative density bottle.

Procedure:

- Find the mass of an empty dry of density bottle - m_1
- Fill the bottle with liquid then record its mass -m_2
- Empty the bottle and raise its water.
- Fill the bottle with water and find its mass after drying with a blotting paper m_3.

Results:

- Mass of liquid = $m_2 - m_1$
- Mass of water = $m_3 - m_1$

Example.

1. A relative density bottle has a mass of 29.2g when dry and empty. Its mass is 116.2 g when full of liquid (diesel) and when full of water its mass is 129.2g. Calculate the relative e density of diesel.

Data:

Mass of empty bottle (m_1) = 29.2 g
Mass of diesel (m_2) = 116.2 g
Mass of water (m_3) = 129.2g

Solution:

$$\text{Relative density of a liquid (RD)} = \frac{m_2 - m_1}{m_3 - m_1}$$

$$= \frac{116.2-29.2}{129.2-29.2}$$

$$= \frac{87}{100} = 0.87$$

The relative density of diesel is 0.87

APPLICATIONS OF DENSITY IN DAILY LIFE
1.Design of sheep and planes
2. Relative density is used to determine density of unknown substance
3. To identify gemstones
4. Density is considered in designing of swimming equipments

FORCE

Definition:
Force is a pull or push of a body.

Force can cause a moving body to stop.
Force can cause a body at rest to start moving.
Force can change the size and shape of an object.
Force can affect direction and the speed of a moving body.

The SI unit of force is the **Newton (N)**

TYPES OF FORCES

There are four types of fundamental forces which are;

1. Gravitational forces- Is the force of attraction between bodies in the universe. An example is the earth's gravity which pulls objects towards earth's centre.
2. Strong forces- These are forces responsible for binding nuclei of an atom. They hold the nucleus together (neutron and proton)
3. Weak forces - Is the force responsible for various trends of radioactive decay. The decay of fundamental particles such as Beta particles.
4. Electromagnetic forces- Is the force which cause magnetic and electrical effect.

QUESTIONS

1. Define the term force and state its SI unit.
2. What can force do?
3. List four types of force
4. Distinguish between stretching force and restoring force. Give one example of each force
5. What do you understand by the weight of a body?

EFFECTS OF FORCES

Effect of forces include;

1. Stretching and restoring

2.Compressional and restoring

3. Attraction

4. Repulsion

5. Torsion

6.Friction

7. Viscosity

8. Air resistance

Stretching and Restoring

Stretching occurs when an object increases its length when the force is applied to it. For some objects there is a tendency to return to their original shape and size. This is called restoring force.

Compressional and Restoring

Compressional force is the force when applied to an object results in decrease in its volume. If the body returns to its original shape and size it is called restoring force.

Attraction
Is the force by which one object attracts another for example a magnetic exerts an attractive force on a piece of metal.

Repulsive
This is the force of separation that a body or particle exerts on another. Example when the like poles of two magnets are brought near each other.

Viscosity
Viscosity is the force which resist flow of fluid we may call it the liquid friction.

Torsional force
This is produced when a solid object is twisted, if this object return to its original shape then it is called restoring force.

Air Resistance
Is the force which resists the movement of an object through air.

Friction Force
Is the force which opposes motion of a moving body whenever one object slides over another object, friction tries to stop the movement.

Weight
The weight of a body is the attractive force towards the earth's centre exerted by the earth on the body.

Formula for weight
Weight=Mass × Gravitation Acceleration
W=m.g

ARCHMEDES PRINCIPLE AND LAW OF FLOATATION

1.ARCHIMEDES PRINCIPLE
An apparent weight:

Is the weight of body when it’s partially or totally immersed in liquid.

Up thrust - is upward force exerted by the fluid on the body.

Fluid - is a liquid or gas.

EXPERIMENT

- Tie a solid with a string and suspend it from a spring.
- Find the weight of a body in air, call it W_1.
- Find the weight of a body when it is partially immersed in water contained in a beaker, call it W_2.
- Find the weight of a body when it's totally immersed in water, call it W_3.
- Remove a body from the water, dry it and find its weight, call it W_4.
- It will be observed that $W_1 > W_2 > W_3$.

Also $W_1 = W_4$

- This shows that the weight of a body when immersed in water is equal to its weight after it has been removed in water.
- This result shows that there is apparent loss of weight of body when it partially or totally immersed in water.
- That loss of weight is not a real loss.
- An apparent loss = weight of a body – apparent weight of a body in liquid.

From that experiment

An apparent loss = $W_1 - W_2$

A liquid exerts an upward force in a body when it is partially or totally immersed in it.

Up thrust = an apparent loss in weight = $W_1 - W_2$

Example:

1. A body weights 3.0N in air. When it is totally (completely) immersed in liquid it weights 2.2N. Find the upthrust experienced by the body.

Data:

Weight in air (w_1) = 3.N
Weight in water (W_2) = 2.2N

Upthrust = ?

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Solution

Up thrust = weight in air– apparent weight

$= w_1 - w_2$

= 3.0N - 2.2 N

=0.8N

Example

2. A body weight 4.6 N in air and 3.1 N when immersed in water. Find the up thrust exerted on the body by the water.

Data:

Weight in air (W_1) = 4.6N
Weight in water (W_2) = 3.1 N

Upthrust=?

Solution:

Upthrust= weight in air- apparent weight

$= W_1 - W_2$

= 4.6 – 3.1 = 1.5N

Example:

3. A body which is totally immersed in liquid weights 3.2N. It weights 6.8N in air. Calculate the up thrust of body.

Data:

Weight in air (W_1) = 6.8N
Weight in water (W_2) = 3.2N

Upthrust =?

Solution:

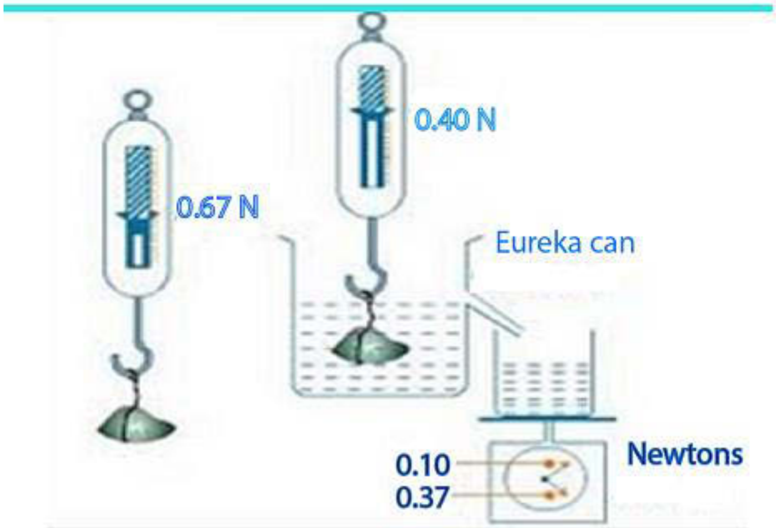
Upthrust= weight in = apparent weight

$= W_1 — W_2$

= 6.8 – 3.2 = 3.6N

Up thrust = 3.6N

DEMONSTRATION OF APPARENT LOSS IN WEIGHT



Experiment:

- Find the weight of a body in air by using a spring balance.
- Pour water into eureka can up to its spout.
- Take any dry beaker, weight it and place it under the spout of eureka can.
- Find the weight of the body when is totally immersed in water.
- The water displaced by the body over flows through spout into the weighted beaker.
- Remove the beaker and weight.

The results are as follows;

- Weight of the body in air -W_1
- Weight of the body in water - W_2
- Weight of the empty beaker - W_3
- Weight of the beaker and displaced water -W_4

The upthrust = $W_1 — W_2$ and the weight of displace water = $W_4 — W_3$.

- It will be observed that the upthrust is equal to the weight of displaced water.
- This result is known as **Archimedes principle** which states that "When a body is partially or totally immersed in a fluid it experiences an upthrust which is equal to the weight of the fluid displaced"

EXAMPLE

1. A body weights 6.0N in air and when totally immersed water it weights 4.2N. Find the upthrust experienced by the body.

Data:

Weight of a body in air (W_1) = 6.0N
Apparent weight (W_2) = 4.2N
Upthrust =?

Solution

Upthrust = weight in air (w_1) - apparent weight (W_2)

= 6.0N — 4.2N

Upthrust = 1.8N

RELATIVE DENSITY BY ARCHIMEDES PRINCIPLE

Relative density by Archimedes principle can be obtained by taking the **weight of a body in air** divide by **apparent loss in weight of the body**.

RD = weight in air — apparent weight

$$= \frac{\text{weight in air}}{\text{upthrust}}$$

$$= \frac{w_1}{w_1 - w_2}$$

Example

1. A body weights 5N in air and when totally immersed in water it weights 3N. Find its RD.

Data:

Weight in air (W_1) = 5N
Weight in water (W_2) = 3N

RD =?

Solution

$$= \frac{\text{weight in air}}{\text{upthrust}}$$

$$= \frac{w_1}{w_1 - w_2}$$

$$= \frac{5}{5-3} = 2.5$$

RD = 2.5

2. Find the relative density of a body which weights 7.5N in air and 6.0N when in immersed in water.

Data:

Weight in air (W_1) = 7.5N
Weight in water (W_2) = 6.0N

RD =?

Solution

$$= \frac{\text{weight in air}}{\text{upthrust}}$$

$$= \frac{w_1}{w_1 - w_2}$$

$$\frac{7.5}{7.5-6.0} = 5$$

RD = 5

EXERCISE

1. A body weights 0.8 N in air and 0.5N when completely immersed in water, Calculate;

i. Upthrust
ii. Relative density of a body.

Data:

Weight in air (W_1) = 0.8
Weight in water (W_2) = 0.5

RD =?

Solution

$$RD = \frac{\text{weight in air}}{\text{upthrust}}$$

$$= \frac{w_1}{w_1 - w_2}$$

$$\frac{0.8}{0.8-0.5}$$

RD = 2 .66

2. THE LAW OF FLOATATION

FLOATATION:

A body will float in a fluid if up thrust is equal to its weight. We can conclude by saying that;

i. A body floats if

   Up thrust = its weight

   U = W

ii. A body will sink if

   Up thrust is less than its weight i.e. **U < W**

iii. A body will rise if the up thrust is greater than weight i.e. **U> W**

STATEMENT OF THE LAW OF FLOATATION

The law of floatation states that:"The floating body displaces its own weight of liquid in which it floats".

APPLICATIONS OF THE LAW OF FLOATATION

The laws of floatation are applied in different situations in our daily life. The following are some of the situations.

i. Ships
ii. Submarine
iii. Balloons
iv. Hydrometer

FLOATING OF SHIPS

A common question one may ask is "why a coin sinks in water while a ship made of steel floats".The answer to this common question is that, A ship floats because it is very large and hollow, the structure of which enables most of its volume to be filled with air which makes the ship to become less dense than water.

The average density of the ship becomes less than the density of water. When cargo is loaded in a ship the mass of the ship increases thus increasing its density, The ship there after sinks until when the weight of water displaced is equal to the weight of the ship and cargo, the ship then floats.

NB. A limited weight of cargo is allowed in a ship or else there will be a danger of over loading and making it to sink completely.

BALLOONS

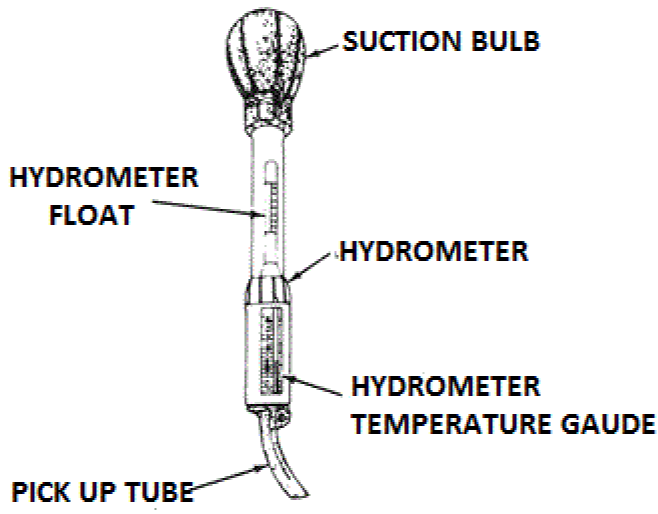
A balloon is a light bag filled with hydrogen or helium gas. These gases are less dense than air. An air ship is a large balloon with a motor to make it and fin to steer it. The downward force in a balloon is equal to the weight of the bag plus the weight of a gas in it.

Note that: The balloon rises if the upthrust is greater than the down ward force.

HYDROMETER

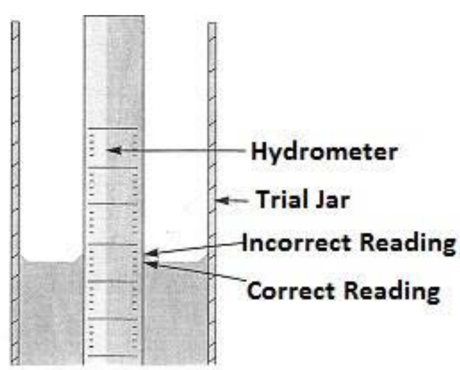
A hydrometer is a floating instrument used for measuring the densities of liquid. E.g. Milk, beer, Wines, acids in car butteries etc.

The measuring is done by noting how far its sinks in them. A hydrometer consists of a long glass tube with a bulb at the bottom, mercury or lead shots is in the bulb so that the hydrometer floats upright, the stem is thin and graduate. It can sink in different liquid even if having the same position.



HOW TO USE THE HYDROMETER

When a hydrometer is gently lowered into a volume of liquid and allowed to settle, it may float deeper or shallow in the liquid. It floats deeper in a less dense liquid or shallow in dense liquid.



Examples

1. The density of ice is 920 kg/m^3 and the density of sea water is $1030 kg/m^3$. What is the volume of an iceberg is exposed?

Solution

Given:
Density of sea water = 1030kg/m^3
Density of ice = 920kg/m^3
Weight of a body = Weight of fluid displaced
Weight of ice = Weight of sea water displaced

$V_{ice} \times \rho_{ice} \times g = \rho_{water} \times V_{water\ displaced} \times g$

$V_{ice} \times 920 = 1030 \times V_{water\ displaced}$

$$\frac{1030V\ \text{water displaced}}{1030} = \frac{920V\ \text{ice}}{1030}$$

$$\text{Volume of water displaced} = \frac{920}{1030} V\ \text{ice}$$

$$\text{Fraction Volume submerged} = \frac{920V\ \text{ice}}{1030V\ \text{ice}}$$

$$= \frac{92}{103}$$

Fraction volume exposed = 1–Fractional submerged

$$= 1 - \frac{92}{103}$$

$$= \frac{11}{103}$$

$$\text{Fraction Volume exposed} = \frac{11}{103}$$

2. If a block is 50kg and i submerged 40% in the liquid bromo form (890kg/m3), the what is the density of the block in g/cm3 ?.

Solution

Weight of block = Weight of fluid displaced
Mass of block = Mass of fluid displaced

$$V\text{block} \times \rho\text{block} = V\text{liquid displaced} \times \rho\text{liquid}$$

$$\rho\text{ block} = \frac{V\text{ liquid displaced} \times \rho\text{ liquid}}{V\text{ block}}$$

$$\text{But, Volume of liquid displaced} = \frac{40}{100}\text{volume of block}$$

$$= 0.4\text{ volume of block}$$

$$= \frac{\text{Mass of liquid} \times 0.4\text{ volume of block}}{\text{volume of block}}$$

$= 890 \times 0.4$

$= 356\ g/cm^3$

STRUCTURE AND PROPERTIES OF MATTER

The meaning of Matter

Matter is anything which occupies space and has weight or mass.

Example: water, chair, stone oxygen etc.

STATES OF MATTER

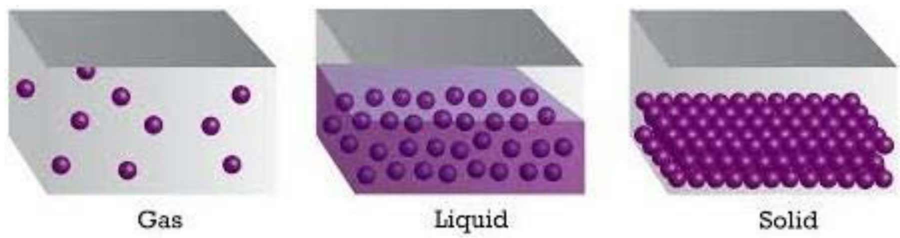
There are three states of matter which are;

1. Solid
2. Liquid

3. Gases

NOTE:
Matter is made up of tiny (small) particles which are known as **atoms** or **molecules**.

Arrangement of molecules in solid, liquid and gases respectively:



In gases- Molecules are further apart and free to move, they move very fast.
In liquids- Molecules are slightly further apart.
In solids- in the solid structure particles are compacted together.

PARTICULATE NATURE OF MATTER
The concept of Brownian movement

Robert Brownian was a botanist who investigated the motion of molecules in liquid and gases.

They did an experiment on smoking in air. The result brought about is what is known as **Brownian motion** which states that, “The molecules of fluid (liquid and gases) are in a continuous random motion”.

Molecular properties of matter include the following;

1. Elasticity
2. Adhesion and cohesion
3. Surface tension
4. Capillarity
5. Osmosis
6. Diffusion

1. Elasticity

This is the ability of a substance to recover (regain) its shape and size after deformation.

Application of elasticity

Elasticity has a variety of applications in homes. In homes elasticity is present in;

- Rubber
- Clothing
- Spring in a furniture etc.

2. Adhesion and cohesion.

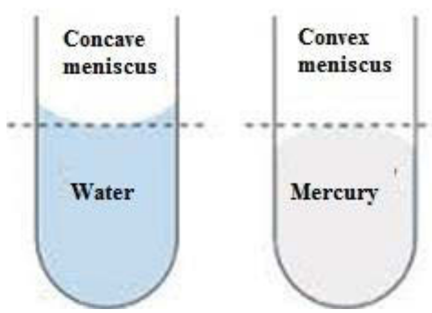
These are intermolecular forces of attraction.

Adhesion is the force of attraction between molecules of different substances.

Cohesion is the force of attraction between molecules of the same substance.

MENISCUS

This is the bending or curving of liquid a when kept in a container.



Application of adhesive and cohesive force

•To stick two different objects together e.g. Using of a glue or tapes.

3. SURFACE TENSION

Is the ability of the surface of a liquid to behave like a full stretched elastic skin. This is the ability of the surface liquid to be elastic.

Application of surface tension

•In extraction of impurities during laboratory process.

4. CAPILLARITY

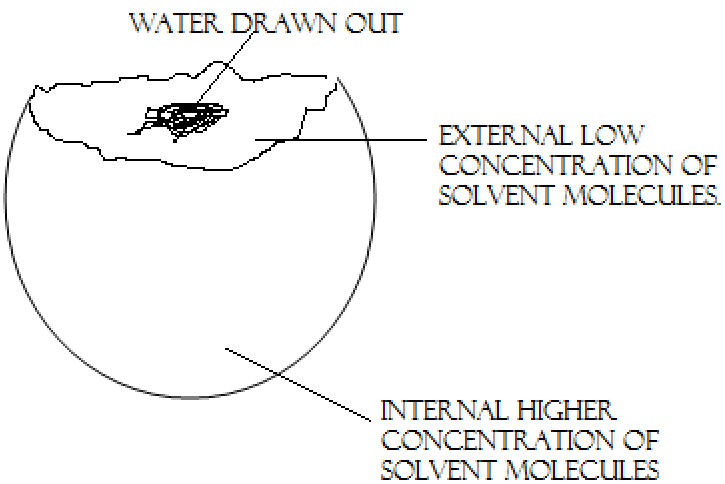
This is the ability of liquid to rise or fall in a narrow tube.

5. OSMOSIS

If two solutions of different concentration are separated by a semi-permeable membrane which is permeable to the smaller solvent molecules but not to the larger solute molecules, then the solvent will tend to diffuse across the membrane from the less concentrated to the more concentrated solution. This process is called osmosis.

Osmosis is of great importance in biological processes where the solvent is water. The transport of water and other molecules across biological membrane essential to many processes in living organisms. The energy which drives the process is usually discussed in terms of osmotic pressure.

Example; A fractional peeling of potato give a result of water to come out due to low concentration.



6. DIFFUSION

Is the movement of particles from a region of high concentration to one of low concentration.

Diffusion refers to the process by which molecules intermingle as a result of their kinetic energy of random motion. Consider two containers of gas A and B separated by a partition. The molecules of both gases are in constant motion and make numerous collisions with the partition. If the partition is removed as in the lower illustration, the gases will mix because of the random velocities of their molecules. In time a uniform mixture of A and B molecule will be produced in the container.

The tendency toward diffusion is very strong even at room temperature because of the high molecular velocities associated with the thermal energy of the particles.

APPLICATION OF MOLECULAR PROPERTIES OF MATTER

1. Kerosine lamp capillarity draws the kerosine up into the wick where it can be burnt.
2. Capillarity promotes movement of ground water.
3. Diffusion balances the concentration of water and nutrients in and out of the cells of living organisms.
4. Diffusion is applied in sprays and air fresheners.
5. Osmosis is used in filtration process.
6. Osmosis controls the movement of water and nutrients in and out of the cells.

EXTENSION

Hooke's Law

Hooke's Law states that if a spring is not stretched beyond its elastic limit, the force that acts on it is directly proportional to the extension of the spring.

Elastic Limit

The elastic limit of a spring is defined as the maximum force that can be applied to a spring such that the spring will be able to be restored to its original length when the force is removed.

Equation derived from Hooke's Law

From Hook's Law, we can derived that

Spring Constant

Spring constant is defined as the ratio of the force applied on a spring to the extension of the spring.

It is a measure of the stiffness of a spring or elastic object.

Graph of Streching Force - Extension

Gradient = Spring constant

Area below the graph = Work done

F-x graph and spring constant

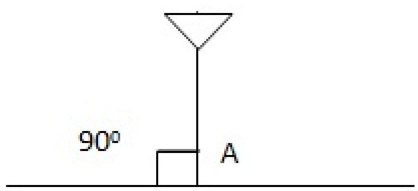
The higher the gradient, the greater the spring constant and the harder (stiffer) spring.

For example, the stiffness of spring A is greater than spring B.

PRESSURE

Pressure is the force (**f**) acting normally per unit area (**A**).

i.e The word normally means perpendicular.



Mathematically;

The SI units of pressure are **N/m²** or **Pascal.**

Example.
1. Find the pressure exerted when a force of 640N acts in the area of $16m^2$

Data:

Force (f) = 640N
Area (A) =16m^2
Pressure (p) =?

Solution:

Pressure=40 Pascal

2. A pressure of 75N/m^2 is resulted from a certain force acting on an area of 0.8m^2. Calculate its force acting on it.

Data:

Pressure = 75 N/m^2
Area = 0.8m^2
Force =?

Solution

F = PA

: F = 75N/m^2×0.8 m^2

= 60N

3.Find the pressure exerted when a force of 3600N act on the area of 36m^2

Data:

F = 3600N
A = 36m^2
P =?
P = 100N/m^2

Maximum and minimum pressure

Maximum pressure is the value of high pressure and it is determined when a force acts perpendicular.

Example
1. A body of area 0.5m^2 and 20m^2 acts on a force of 4000N. Calculate the maximum and minimum pressure.

Data:

Area minimum (A1) = $0.5m^2$
Area maximum (A2) = $20m^2$
Force F = 4000N
Maximum pressure =?
Minimum pressure =?
Maximum pressure = $8000N/m^2$

Minimum pressure = $200N/m^2$

2. A body of area $0.024m^2$ and $15m^2$ acts on a force of 3600N.Find the minimum and maximum pressure given:

Force = 3600N
Area 1 = $0.024m^2$
Area 2 = $15m^2$
Maximum pressure =?
Minimum pressure =?

The maximum pressure = 150,000Pascal

The minimum pressure = 240 Pascal

1. The body which weights 500N covers an area of $250m^2$. Find the pressure which is exerted on the flour.

Given data

Force F=500N
Area A=$250m^2$

$$\text{Pressure } [P] = \frac{\text{force } [f]}{\text{area } [A]}$$

$$\text{From } P = \frac{F}{A}$$

$$= \frac{500}{250}$$

= $2N/m^2$ or 2 Pascal

CONDITIONS FOR PRESSURE

Pressure depends upon the area. **I.e**.: The smaller the surface area the greater the pressure and the vice verse. **For example** it is easy to cut meat with a sharp knife than with a blunt one, this is because in the sharp the area is small than in the blunt one.

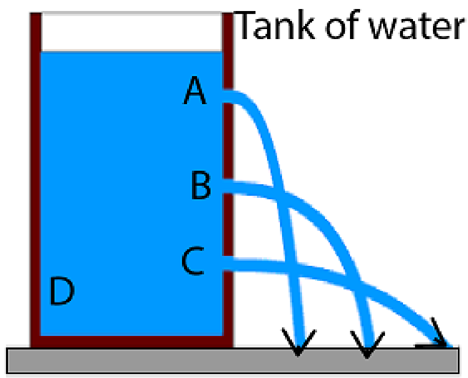
APPLICATION OF PRESSURE

a) Solids

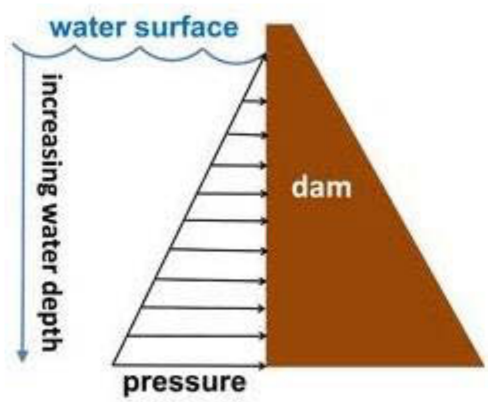
- Broad tire of a tractor.
- Potters with a heavy load on the back in order to reduce pressure.
- The use of different edges of knives.

b) Liquids

- Variation of pressure with depth.
- Liquid pressure varies with depth. **For example**; the higher the depth the greater the pressure.



Water is pushed through the holes of different speed. The speed at A is higher than the speed at B and C. The speed at C is very less as compared to the speed at B and A. **For example** pressure in a liquid increases with the increase in depth.



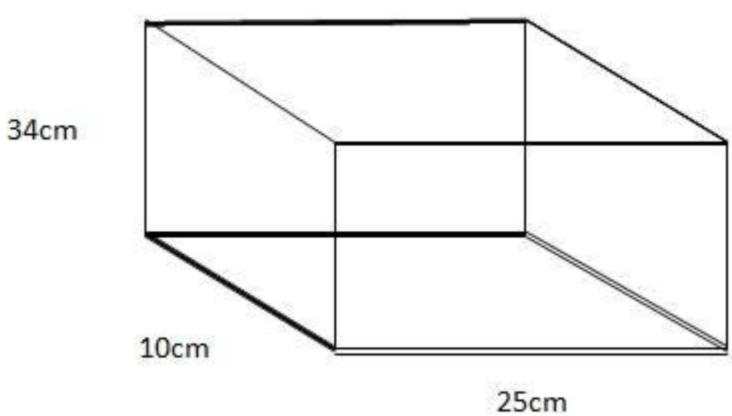
The wall of the dam is made thicker at the bottom because pressure is greater at the bottom.

Example 2

A rectangular block weighing 250N has dimensions 34cm, 25cm by 10cm what is the greatest pressure and the least pressure it can exert on the ground

Solution

a) The greatest pressure the block can provide when it is resting on a horizontal flour occurs when it rests on its smallest face i.e. the smaller the area the larger the pressure

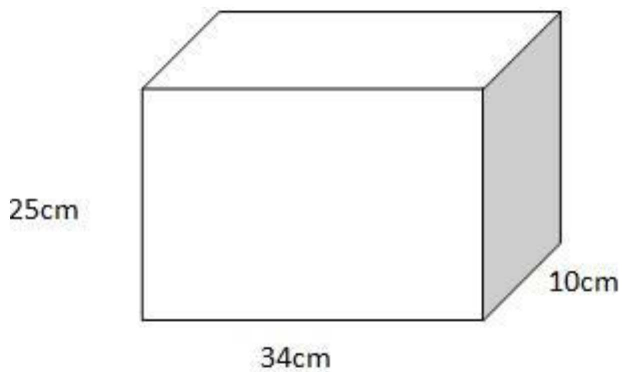


The smallest surface area is 0.25m x 0.1m=0.25m²

There for the greatest pressure is = $\frac{250}{0.25}$

= 1000 Pascal

b) The least pressure that the block can produce when resting on a horizontal floor occurs when it rests on its largest face i.e. The larger the area corresponds to its least pressure



Largest surface area 0.34m x0.25m=0.085m²

There for the smallest pressure is = $\frac{250}{0.085}$

= 2941.18

PRESSURE IN LIQUIDS

The pressure under width, The higher , the depth, the higher the pressure and the low the depth, the lower the pressure.

EXPERIMENT

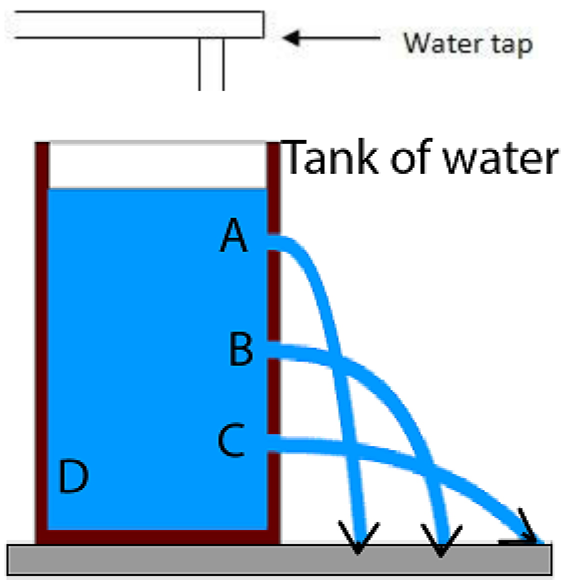
AIM

To demonstrate the increase of pressure with depth.

MATERIALS

The apparatus to be used and they include the following;

a. A tall vessel
b. Water tap



PROCEDURE

i. Take the vessel
ii. Make three holes on its side
iii. Fill the vessel with tap water

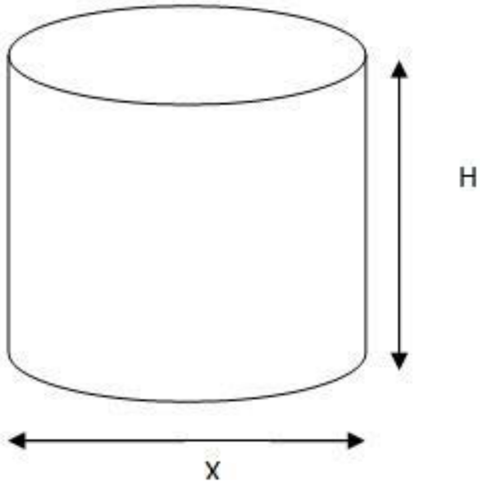
OBSERVATION

i. Water is pushed through the holes at different speeds.

ii. The pressure at the hole A is greater than that at hole **C** because of the difference in height.

PRESSURE FORMULA

Consider a liquid columns standing on an area **X** at a depth "**h**" with liquid of density **"D"**.



The pressure P exerted by this column of liquid is given by;

$$\text{Pressure } [P] = \frac{\text{force } [f]}{\text{area } [A]}$$

But force = Mass x Acceleration due to gravity,

Mass = Density X volume,

Volume = Area x height,

Volume = A.h, then mass = A.h

Force weight = A.h x g

$$\text{Pressure } [P] = \frac{\text{force } [f]}{\text{area } [A]}$$

Therefore

Pressure in liquids = Density X Acceleration due to gravity X height

Example:

1. If the cube of the height 4m contains water of density 1000kg/m^3. Calculate the pressure exerted by taking g = 9.8N/kg

Solution

Data given

(h) Height = 4m

(D) Density = 1000kg/m^3

(g) Gravity = 9.8N/kg

$$\text{Pressure [P]} = \frac{\text{force [f]}}{\text{area [A]}}$$

P = density x height x gravity

P = 1000 x 4 x 9.8

P = 39 200N/m^3

2. The pressure at the base of the cube is 98,000N/m^2. Find the height of the cube if the density of water is 1000kg/m^3 and g = 9.8N/kg.

Solution

Data given

P = 98000N/m^2

D = 1000kg/m^3

g =9.8N/kg

But pressure is given by P=h.g

h =?

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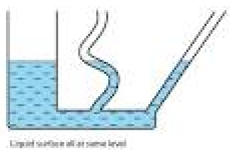
But height $h = \frac{P}{\rho \times g}$

$= \frac{98000}{1000 \times 9.8}$

$=$ 10 Pascal

LIQUID FINDS ITS OWN LEVEL

When water is poured into a communicating tube, even if each part has different cross section area and shape, the water will be at the same level.



The principle of the spirit level

A spirit level is an instrument used by masons to test whether the surface is level.

When the surface is horizontal the spirit level in both limbs A and B is the same.

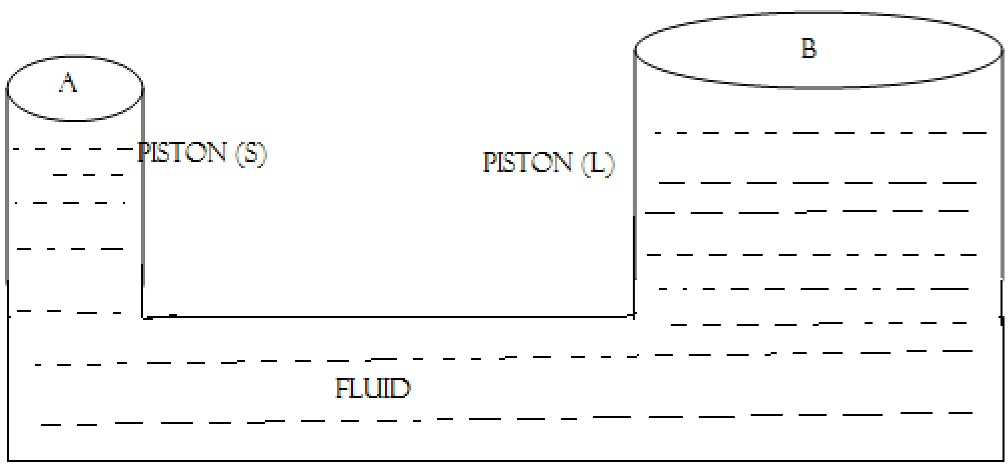
ACTION OF PRESSURE IN LIQUIDS

To a non-viscous liquid in an enclosed vessel **e.g.** a ball

If it is compressed the pressure is transmitted equally in all directions.

When the ball is squeezed, water will come out equally in all directions.

PRINCIPLE OF HYDRAULIC PRESS
Paschal's principle
If a liquid is filled precisely in vessel and pressure is exerted at one part of it, the effect of pressure will be transmitted equally throughout of total volume.



Pressure at piston (s)= $\frac{f}{a}$

The effect to piston (L)

P (L) = $\frac{F}{A}$

But F=?

F is the thrust due to P(s)

$$F = \frac{f}{a} \times A$$

Hence therefore

$$\frac{F}{A} = \frac{f}{a}$$

Example;
In the hydraulic system a body of 150kg need to be raised up at a thick column of 615.44cm² cross-sectional area. If a narrow column has a 38.465cm² find a minimum force should be applied.

Solution
Data
Mass= 150kg
Area (A)=615.4cm²
Small area (s)=38.465cm²
Minimum force =?
From

$$\frac{F}{A} = \frac{f}{a}$$

$$f = \frac{F}{A} \times a \text{......................................(i)}$$

but F=Mg

$$f = \frac{Mg \times a}{A}$$

$$f = \frac{150\text{kg} \times 10\frac{\text{N}}{\text{kg}}}{615.4\text{cm}^2} \times 38.615cm^2$$

f=93.7N
Therefore, a force 93.7N should be used.
Application of Pascal's principle is applied mainly in:

1. Hydraulic press
2. Hydraulic brakes

MODES OF OPERATION

When a smallforce **(f)** is applied at **S**, the piston at area **(d)** produced some pressure.

The pressure **(p)** produced is transmitted through the liquid to the large piston at b.

A heavy load is raised by the force **(f)** by the pressure extended by small piston given by;

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

These pressures then produce a big force (f);

$$\text{i.e.} \frac{F}{A} = \frac{f}{a}$$

EXAMPLE

1. In a hydraulic press they area of a piston to which the effort applied is $5m^2$. If the press can raise a weight of 5KN of 2KN when and effort of 400N is applied. What is the area of the piston under the load?

Given data

a = $5m^2$
F = 2KN
f = 400N
A =?

From $\frac{F}{A} = \frac{f}{a}$

$$\frac{400N}{5m^2} = \frac{2000N}{A}$$

$$A = \frac{5 \times 2000}{400}$$

$$A = 25m^2$$

APPLICATION OF HYDRAULIC PRESS

Hydraulic pressure is applied (used) in many area in our daily life.

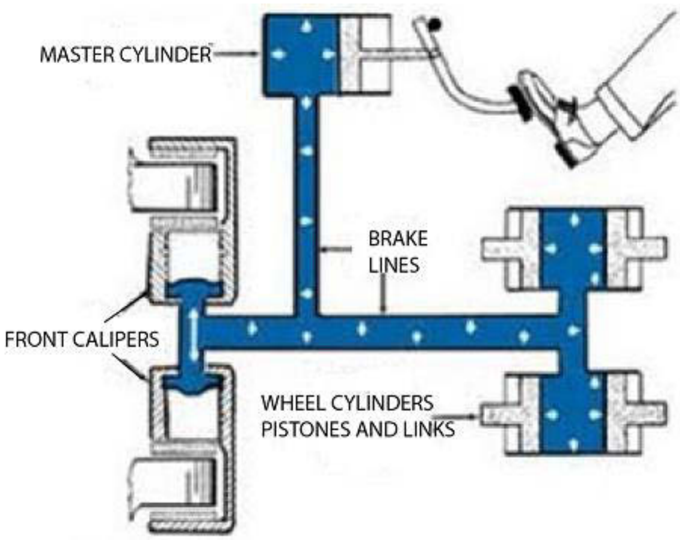
Example;

- In lifting heavy load i.e. in a crane.
- In pressing cotton bale.
- Shaping bodies of motor car.
- Braking system of car.

HYDRAULIC BRAKE

In modern cars there is braking system which slow each wheel equally. The system reduce the dangers of skidding off of the car. When the brake pedal is pressed, the pressure is transmitted through the liquid (oil) to the brake shoe where they are forced apart.

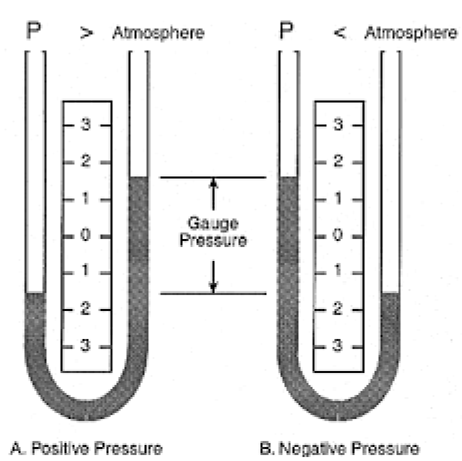
BRAKE SYSTEM



ATMOSPHERIC PRESSURE

- Air is matter and hence has weight
- Air contains Oxygen, Hydrogen, carbon dioxide, helium etc.
- Air exerts (pits) its weight onto the surface of the Earth.

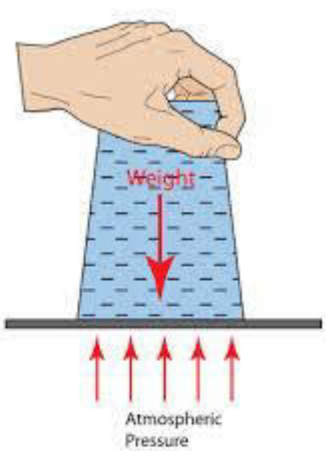
Therefore **atmospheric pressure** is the weight which the layer rest on the earth surface.



Atmospheric pressure can be observed in several areas.
Example: -

- In a glass tumbler
- In a crashing can

In a glass tumbler when a glass is filled with water and covered with a card.



If the card and glass are turned upside down, the card holds in place, Because the upward force in air pressure is greater than the downward pressure.

CRUSHING CAN

Little water is put and boiled in an opened can, so that it drives off the air steam.

crushed cans

When heat is removed and the can is tightly, closed cold water is then poured into the can. The can is observed to collapse. When cold water is poured onto the can, the little steam inside condenses leaving vacuum. The outside pressure presses the can.

INSTRUMENT

Atmospheric pressure is measured by **Barometer**

TYPES

There are three main types of barometer;

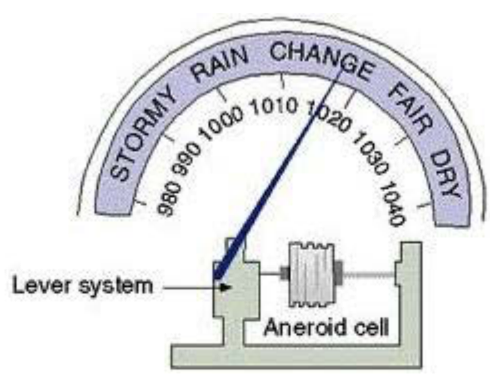
1. Simple Mercury barometer
2. Aneroid barometer
3. Fortin's barometer

Advantages of barometer to another barometer (Aneroid)

- It is used in confined space.
- It is intact and portable.
- It is used in aircraft i.e. it shows height where the plane is flying.

  ANEROID BAROMETER

-

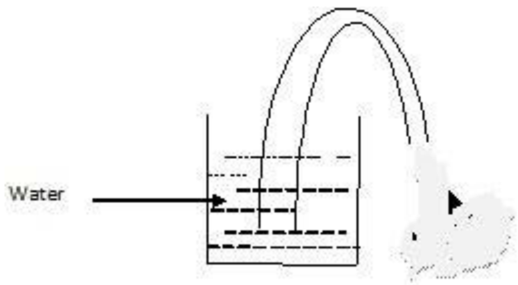


FORTIN'S BAROMETER

- It is heavy barometer.
- It is not portable.
- It is very expensive (this is because it uses mercury in a liquid).

DEVICES WHICH WORK UNDER ATMOSPHERIC PRESSURE

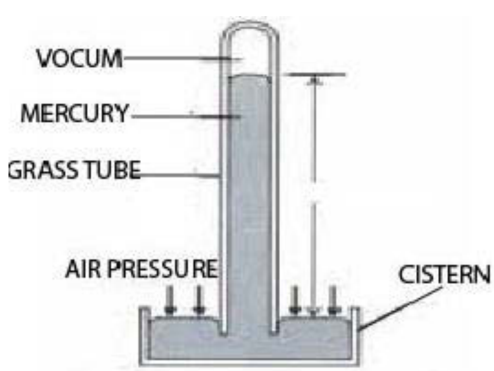
They all work under the principal of siphon.



E.g.

- Automatic flashing
- Chain and bull flashing tank
- Lift pump
- Bicycle pump
- Syringe

MERCURY BAROMETER



WORK, ENERGY AND POWER

WORK

Work is said to be done when the applied force produces a distance.

This work is the product of **force (f)** and **distance (d)** in the direction of force.

Therefore work is given by;

W = F.d

Where

F = force

d = distance

SI – UNIT OF WORK

The SI unit of work is given by;

W = F.d

F = Newton

d = Meter

SI- UNIT of work is **Newton meter (Nm)** or **joule (J)**

NB: 1 Joule of work is done when the force of one Newton (1N) is applied and moves a distance of one meter (1m)

Example

1. A sack of maize which weights 800N is lifted to a height of 2m. What is the work done?

Data

F = 800N
d = 2m
W =?

From

W = F.d

=800N x 2m

= 1600Nm

= 1600 Joule

ENERGY

Energy is the ability to do work.

SI – UNIT

The unit measure of energy is **Joule (J)**.

THERE ARE VARIOUS FORMS OF ENERGY

e.g;

i. Heat energy
ii. Sound energy
iii. Solar energy
iv. Nuclear energy
v. Electrical energy
vi. Light energy
vii. Mechanical energy

There are two types of mechanical energy;

1. Kinetic energy (K.E)
2. Potential energy (P.E)

1. **KINETIC ENERGY**

Is the energy possessed by a body due to its motion.

The kinetic energy is given by;

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

where m= mass

$$V = velocity = \left(\frac{distance}{time}\right)$$

Areas where kinetic energy can be observed;

- Moving cars
- Walking people
- People running
- A moving train
- A flying airplane
- A moving ship
- A jumping lion
- A moving bicycle etc.

2. **POTENTIAL ENERGY**

This is the energy possessed by a body due to its state or position.

The potential energy is given by;

PE =m.g.h

Where

m = mass

g = gravity

h = height

The PE can be observed into the following areas;

- A boy sitting on a bench
- A pen put on the table
- A man sleeping on a bed
- A book placed onto a table
- A ruler put on the table
- A man standing on a bus stop
- A brick put on the ground etc.

TRANSFORMATION OF ENERGY

The process whereby one form of energy is changed into another form of energy is called **transformation**.

- The source of all energies is the sun therefore all energy is a result of the transformation of solar energy

Transducer - Is a device which is used to transform one energy to another

E.g;

i. **Generator**

It transforms mechanical energy to electrical energy.

ii. **Microphone**

It transforms electric energy to sound energy.

iii. **Bulb**

It transforms electrical energy to light energy.

The **principle of conservation of energy** it states that: - "Energy can neither be created nor destroyed but it can be transformed from one form to another".

Example

1. A ball of mass 0.5kg is kicked vertically upwards and raised to a height of 5m. Find the potential energy required by the ball.

Solution:-

Given data

Mass=0.5kg
Height (h) =5m
P=m.g.h

P=0.5 x 9.8 x 5

=24.5 joules

POWER (P)

Power is defined as the rate of doing work.

Power (P) is given by;

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

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

Therefore SI- UNIT of power is **Watt**

Example:

A boy lifted a box of 200N through the height of 3m in 5 seconds. Calculate the power.

Data

F= 200N

S= 3m

t=5s

P=?

$$P = \frac{W.d}{t}$$

W.d= F×s

P= F×s/t

= 200N×3m/5

=120 Watt

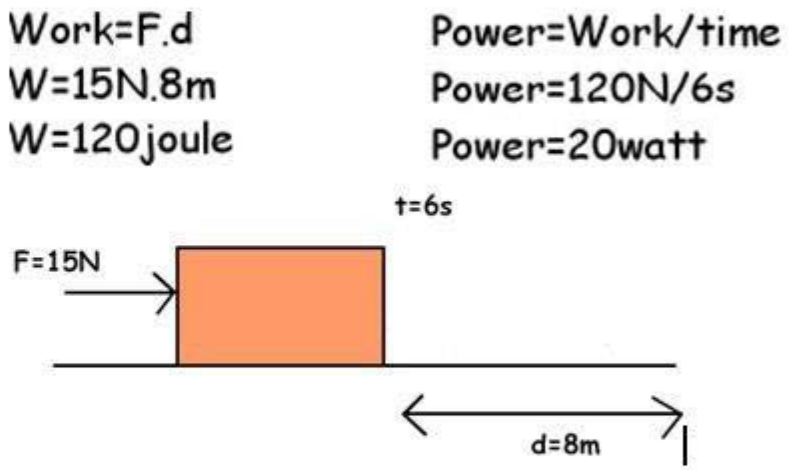
POWER

Power is the rate of work done in a unit of time. It can be misunderstood by most of the students. They think that more power full machine does more work. However, power just shows us the time that the work requires. For example, same work is done by two different people with different time. Say one of them does the work in 5 seconds and the other does in 8 seconds. Thus, the man doing same work in 5 seconds is more power full. The shorter the time the more power full the man. Let's represent it mathematically;

The unit of the power from the equation given above, ***joule/s***, however, we generally use the unit of power as ***watt***.

1joule/s=1watt

Example: Find the power of the man who pushes the box 8m with a force of 15N in a 6seconds.



The power of the man is 20 watt. In other words he does 20 joule work in 6 seconds.

LIGHT

Definition

Light - is the form of energy which stimulates the sensation of vision or seeing.

The sun is one of the source of light energy.

Generally, the source of light is grouped (divided) into two main parts;

i. **Natural sources**

   These are objects which produce their own light.

   -Sun, stars, lightning

ii. **Artificial sources**

   These are objects which do not produce their own light.

-Electric lump, florescent tubes etc.

Concerning light there are two types of objects which provide light;

i. **Luminous objects**

These are objects which produce their own light**.**

E.g. Sun, stars

ii. **Non -Luminous objects**

These are objects which do not produce their own light**.**

E.g. Moon and planets.

iii. **Incandescent and Fluorescent**

iv. These are artificial objects which release their own light due to effect of electricity or chemical reaction e.g -candle , Filament bulb, A gas filled tube light, A gas filled coil bulb.

PROPAGATION OF LIGHT

•Light travels in a straight line in a form of an arrow called **a ray**

A ray

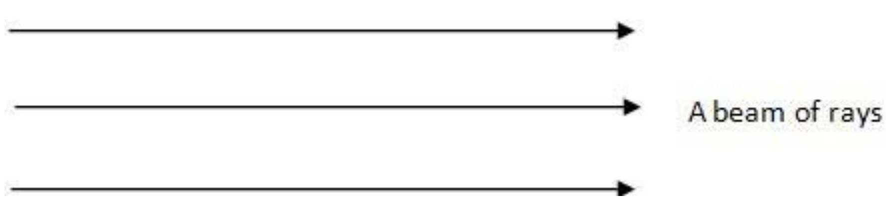
A ray is the path taken by light.

Beam

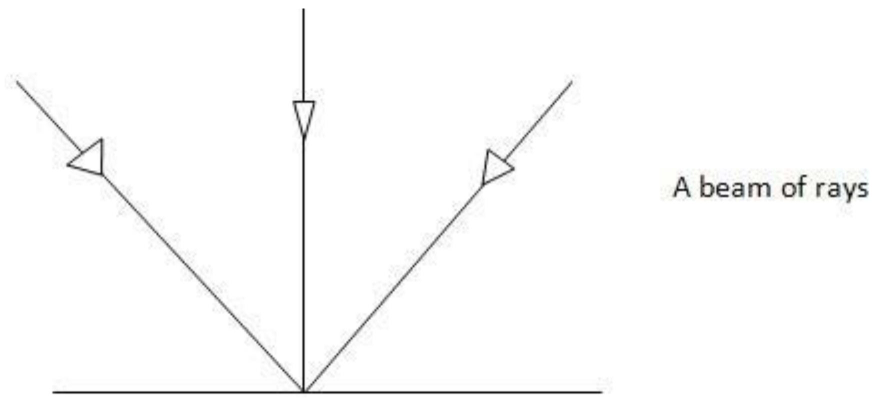
A beam is a collection of rays.

There are three types of beam;

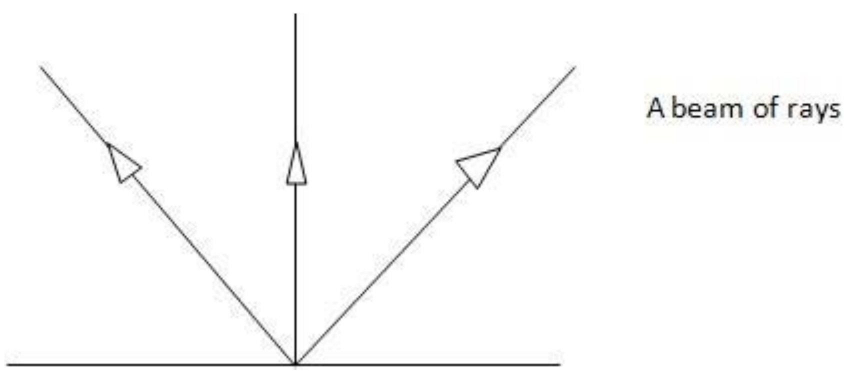
(I) Parallel beams/rays



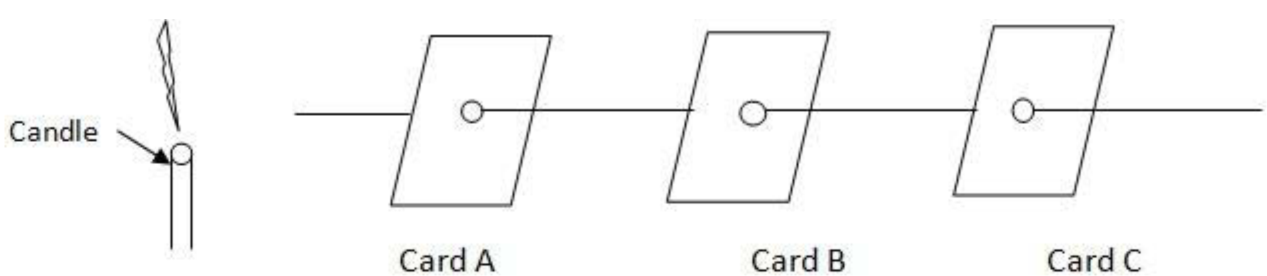
(Ii)Converging rays



(Iii)Diverging rays



- **To verify that light travels in a straight line.**



In the diagram

From card C we can see the candle;

- If card B is put aside, the candle is not seen from C
- This proves that light travels in a straight line.

TRANSMISSION OF LIGHT

This refers to the passage of light through objects.

Mainly there are three types of objects;

1. **Transparent objects**

   Materials which allow the total amount of light to pass

   E.g. Glass, air, pore, water etc

2. **Translucent object**

   Materials which allow little amount of light to pass

   E.g. Paper, tinted glass, plastics

3. **Opaque materials**

   Materials which do not allow the passage of light

   E.g. Stones, walls, wood, book etc

Usually opaque materials results to the formation of shadow.

SHADOW

A shadow is a part of surface which obstructed to receive light rays. Shadow gives the shape of a concerning objects.

Example;

When you walk in the open space during sunshine, you have to see a shadow shape like yourself is walking together for every step.

There are two types of shadows;

1. Umbra

Is a shadow of definite shape.

2. Penumbra

Is a shadow of indefinite shape.

ECLIPSE OF THE MOON AND SUN

Eclipses that take place in these celestial objects as witnessed from the earth are caused or result of falling shadow at a particular surface.

1.SOLAR ECLIPSE

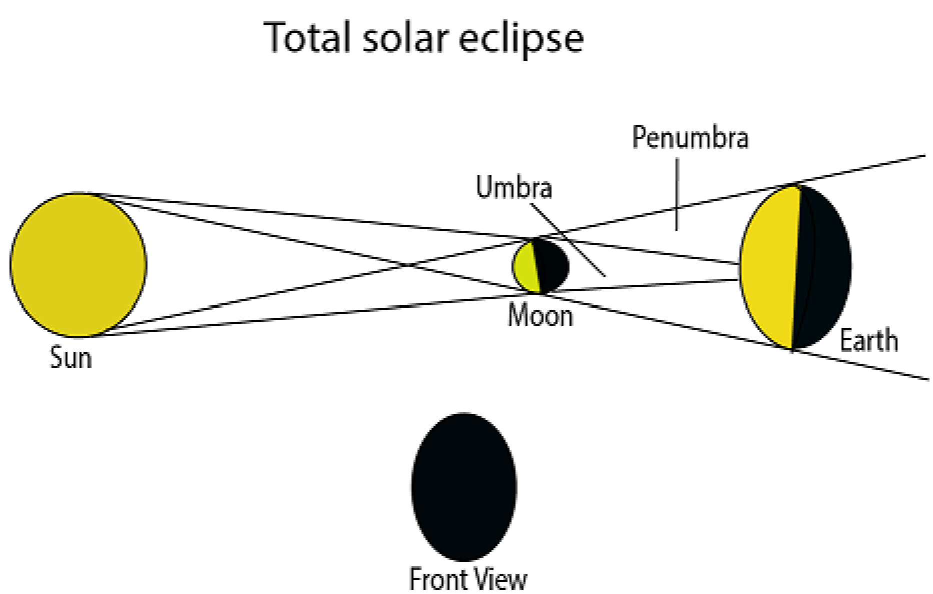
This occurs when the moon comes between the earth and the sun. When the moon aligns between the sun and Earth, its shadow fall on the earth's surface. The observation of sun become abnormal; hence therefore we say eclipse of the sun. In so doing there is total eclipse of the sun and partial eclipse of the sun.

Partial eclipse of the sun

This is eclipse after falling of penumbra of the moon on the earth's surface.

Total eclipse of the sun

Is an eclipse which happen after falling of umbra of the moon on the earth's surface.



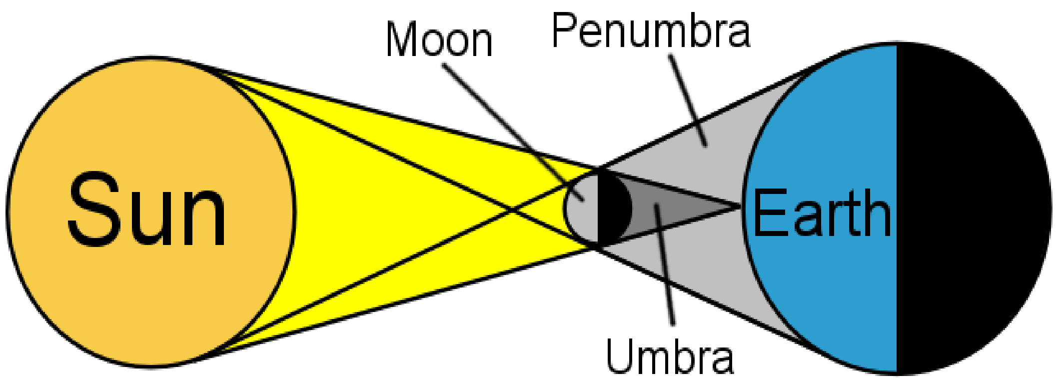
2.LUNAR ECLIPSE

This occurs when the earth comes between the sun and the moon. Lunar eclipse happen when umbra or penumbra of the earth of on moon surface. In so doing, there is total lunar eclipse and partial lunar eclipse.

Partial lunar eclipse

Is an eclipse happen when penumbra of the earth fall on moon surface. The moon is observed in orange colour.

Total lunar eclipse
Is an eclipse happen when an umbra of the Earth fall on moon surface. The moon appear in red colour such that wet in the blood.

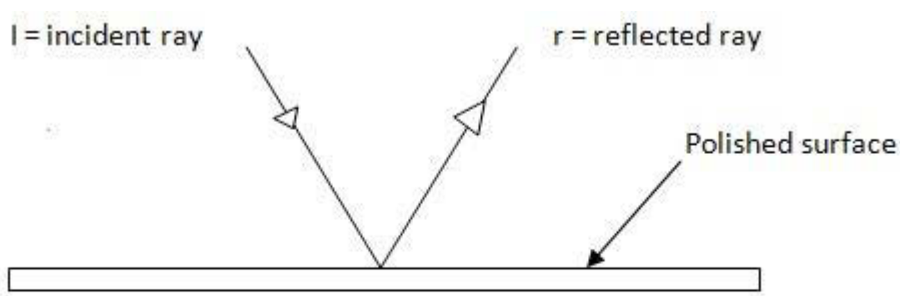


REFLECTION OF LIGHT

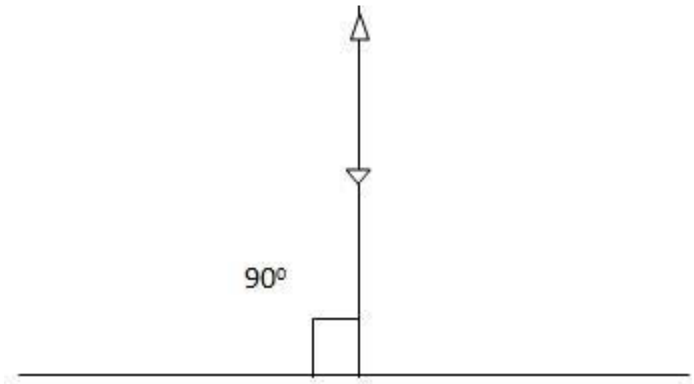
Definition: -

This is the bouncing back of light ray after reaching onto a smooth polished surface.

E.g. the surface of a metal, iron, copper, gold, mirror etc

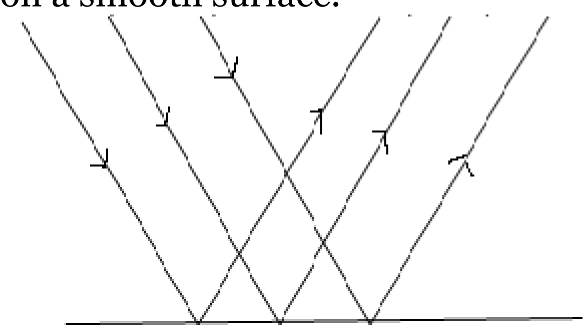


If a ray of light falls at 90° it will be thrown back in the same path.



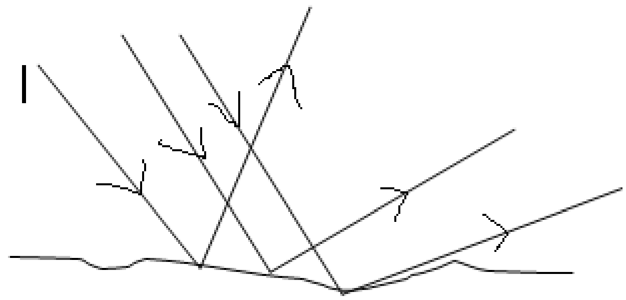
There are two types of reflection;
i) Regular reflection
ii) Diffuse reflection

Regular reflection
Is the type of reflection where all rays are reflected in one direction. The reflected rays are also parallel to each other. It occurs when light is reflected on a smooth surface.



Regular reflection

Diffuse reflection (Irregular reflection)
Is the type of reflection where the reflected rays are not parallel. They are scattered. The image formed is distorted and this kind of reflection usually occurs on rough surfaces.



Diffuse reflection/Irregular reflection

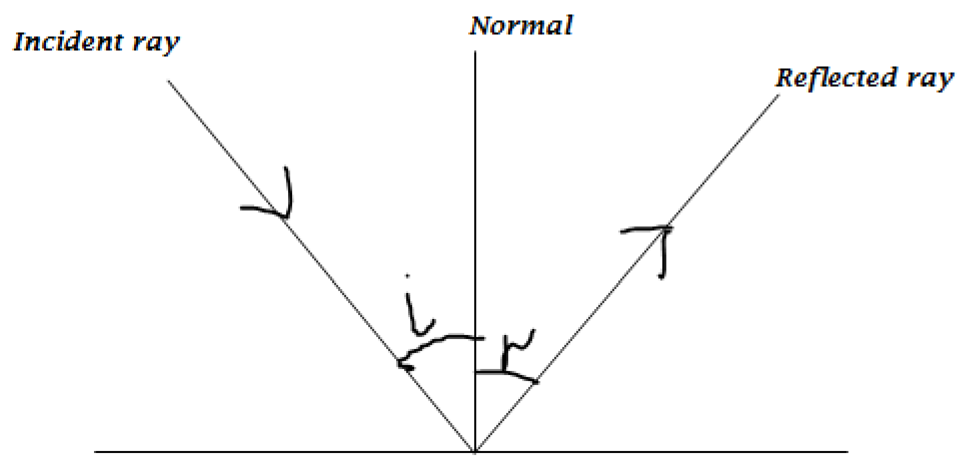
LAWS OF REFLECTION

First law

"The incident ray, reflected ray and the normal all lie on the same plane".

Second law

"The angle of incidence and the angle of reflection are equal".



CHARACTERISTICS OF IMAGE BY A PLANE MIRROR

1. Image is virtual.
2. Image has the same size as that of the object .
3. The image has the same distance behind the mirror as the object is in front the mirror.
4. Image is laterally inverted.
5. The image is upright (erect).
6. Laterally inverted

Laterally inverted

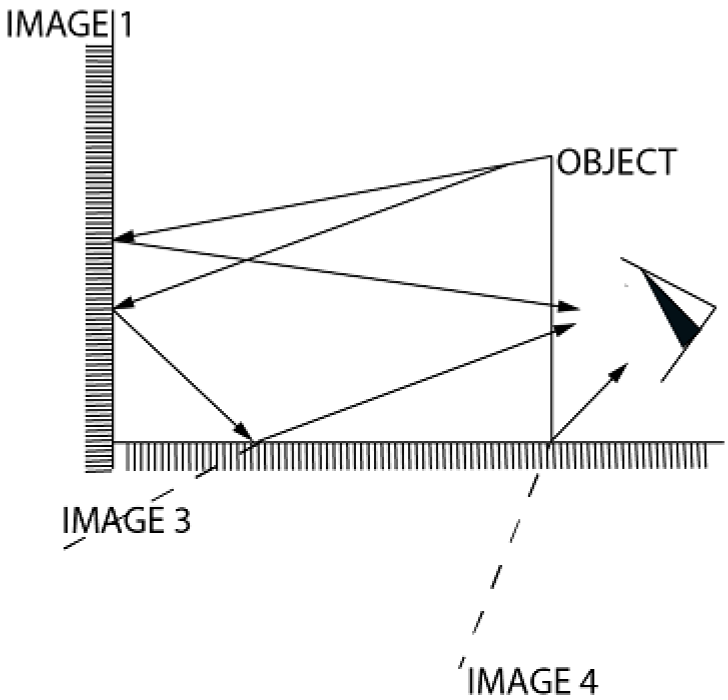
<u>Magnification</u>

$$Magnification = \frac{\text{Image distance from the mirror}}{\text{Object distance from the mirror}}$$

$$Magnification = \frac{\text{Image size}}{\text{Object size}}$$

REFLECTION ON THE TWO MIRRORS AT AN ANGLE

If the two mirrors are placed at an angle of 90°, the observer will see three images.



Multiple angles in in right angle mirrors
Generally, the number of images produced by two mirrors placed at an angle θ, is given by;

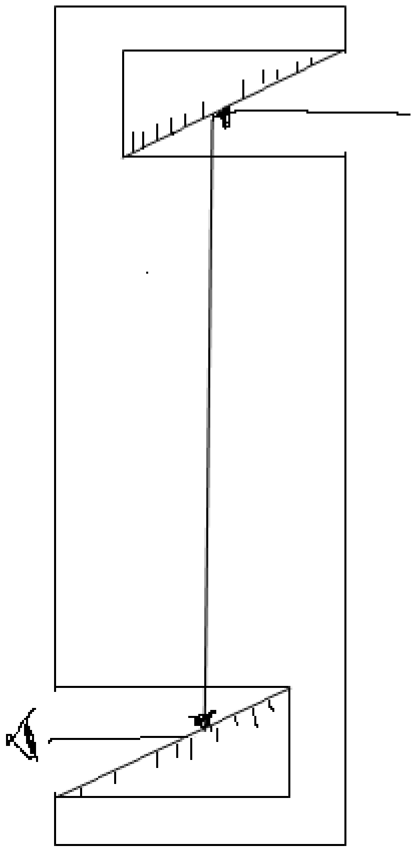
$$n = \frac{360^{\circ}}{\emptyset} - 1$$

n= number of images
θ = angle between the mirror
However, if the angle between is 0°, the number of images will be infinity.

APPLICATION OF REFLECTION

1. Driving mirrors
2. Dressing mirrors
3. Mirrors in saloons
4. Periscope

A periscope is an instrument used to see over an obstacle from concealed position. The mirrors are placed at an angle of 45 as shown in the diagram below;



Simple periscope

DENSITY AND RELATIVE DENSITY

Density and Relative density are quantities used by scientist to examine substances and their differences.

1: DENSITY

Is a ratio of Volume and Mass of a particular substance.

Therefore we say;

Mass in variation to Volume

M : V

For any material a ratio is constant for any varying traces.

$$\frac{M_1}{V_1} = \frac{M_2}{V_2} = \frac{M_3}{V_3} = \text{Constant}$$

The Constant density symbolized by Greek letter ρ

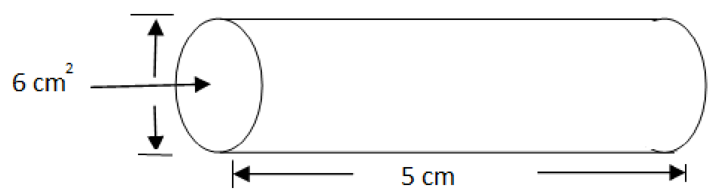
There fore;

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

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

Example:-

Musa had a piece of wire of Aluminum .The mass measured was 81g. He decided to find density after articulate dimensions



Solution

Length of wire = 5cm

Cross-sectional area = $6cm^2$

Mass = 81g

$$\rho = \frac{M}{V} \quad \text{..................(i)}$$

but

V = A x L …………….(ii)

V = $6cm^2$ x 5cm

V = 30 cm^3

Therefore

$$\rho = 81g/30cm^3 = 2.7\ g/cm^3$$

A density of Aluminum = 2.7g/ cm^3

The SI unit of Density that negotiated by scientist is g/cm^3 or kg/m^3.

Due to this a mixture, alloys and pure substance may found their densities .

Any substance of definite or undefinite shape may found their densities.

Example:-

-A mixture of sand and impurities, water and Alcohol e.t.c

-An alloys of Brass and solder e.t.c

-A pure substance like water, Paraffin,copper ,iron ,Aluminum e.t.c

EXPERIMENT FOR REINFORCEMENT

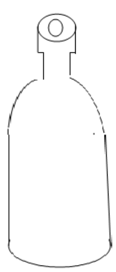
Aim:-

To determine densities of sand and water.

Sand:-

How to measure Mass of sand and Volume of sand?

The Mass of sand and Volume of sand can be found by using empty bottle.



Procedure:-

(1) Pour water into the bottle at the top; and spill into the measuring cylinder. Then record the Volume of water.

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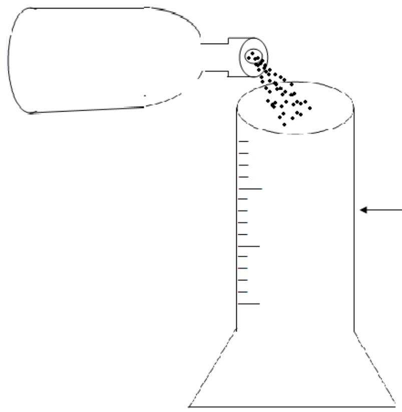

The volume of water is equal to volume of empty space of the battle = V_o

Therefore the sand that will fill this bottle occupy the same volume of that water.

(2) Measure of empty bottle on the beam balance and record it as M_b

(3) Fill sand in the bottle and measure the total mass on the beam balance then record it as M_T

Therefore; Mass of the sand is calculated as $M_s = M_T - M_b$

In so doing Density of the sand can be calculated as ;

$$\rho = \frac{M_s}{V_o} = \frac{M_T - M_b}{V_o}$$

Water:

How to measure Mass of water and Volume of water?

Procedures:

(1) Measure a mass of empty bottle on the beam balance and record it as M_b

(2) Pour water into the bottle and fill at the top. Then measure a total mass of water and bottle on the beam balance; and records as M_T

(3) Spill water into the measuring cylinder and records volume V_o.

(4) Calculate density as;

M_w = Mass of water as ;

$M_w = M_T - M_b$

$V_W = V_o$

$$\rho = \frac{M_W}{V_W} = \frac{M_T - M_b}{V_o}$$

2: RELATIVE DENSITY

Is not a quantity. Is just a common number that used to make comparison of different material

Since it has been discovered that water has a specific unit density of $1g/cm^3$ or $1000kg/m^3$; hence therefore density of water used to make comparison to density of water used to make comparison to densities of other materials.

As the great of relative density is the heavier material than a small relative density.

e.g Aluminum R. density=2.7 and Iron R. density=7

This means that Iron is heavier than Aluminum in comparison of the equal shape size. This lead Engineers to prefer Aluminum sheets to manufacture car bodies than Iron sheets. Therefore relative density;

Definition;

Is a common number given by a ratio of density of a substance per density of water.

$$R.d = \frac{Density\ of\ substance}{Density\ of\ water} = \frac{\rho_s}{\rho_w}$$

Example:-

What is R.d of Gold of $19.6g/cm^3$

$$R = \frac{\delta s}{\delta w} = \frac{19.6\ g/cm3}{1\ g/cm3} = 19.6$$

$$\therefore R.d\ of\ Gold = 19.6$$

A table of different common materials and their respective Relative densities.

SN	SUBSTANCE	R.D
1.	ALUMINIUM	2.6
2.	BRASS	3.8
3.	BRIC	1.4-2.2
4.	COPPER	8.94
5.	GLASS	2.6
6.	GOLD	19.3
7.	IRON(CAST)	7-7.7
8.	IRON(WROUGHT)	7.8
9.	LEAD	11.4
10.	MARBLE	2.6
11.	SILVER	10.5
12.	ZINC	7.1
13.	ALCOHOL	0.8
14.	GLYCERINE	1.3
15.	MERCURY	13.6
16.	PETROL	0.9

Q :-A liquid and water mixed together and gave a volume of 80cm3 with density of 5g/cm3.If volume of water is two third of that liquid; find relative density of liquid.

