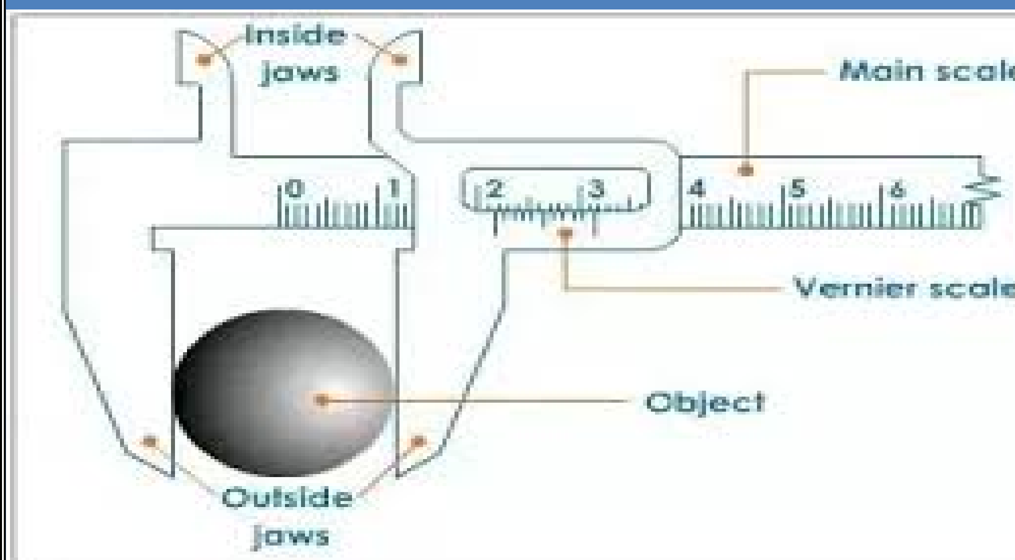
PHYSICS NOTES FORM ONE



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TOPIC 1:

INTRODUCTION TO PHYSICS

Defn: Physics is the study of the relationship between matter and energy**.**

The people who study physics is called **physicists**

Science

Defn: science is the scientific study of nature. For Example, how cooling effect occurs

Technology

Defn: technology is the application of science. For Example, cooling effect uses in refrigerator to cool different items

Relationship between Physics and Other Subject

Physics is the fundamental subject which other subject uses application of physics; the following is the relation with other subjects

i. **Chemistry**

Composition and decomposing of matter involves energy. For Example,

i. Cooking stoves, fuel burn to leased heat energy

ii. Insect killers and Perfumes packed in container by compressed which comes out with high pressure

iii. Fertilizer when they syntheses the heat energy should involved

iv. When tea and other food cooked the heat energy should involved

ii. **Biology**

Since biology is the scientific subject, which involves living and non-living things, which may be micro and macro organism, it uses application of physics. For Example,

i. Microscope which made by physicist is used to observe micro organism

ii. Syringe is based on pressure

iii. **Mathematics**

Physicist should master mathematics because physics problems may involve calculation

iv. **Astronomy**

Defn: *astronomy is the scientific study of universe*. Universe composed by moon, sun, stars, comets, planets etc. it uses different instruments to study the universe which are made by physicists. For

Example,

i. Periscope and telescope are used to observe distant objects like stars etc

ii. Material used to build the space like satellite are determined by physicists

v. **Geography**

Defn: geography is the study of man and his environment. It includes soil, rainfall, mountains etc. it uses application of physics, for Example,

i. Many instruments like rain gauge, wind vane developed by physicist

ii. Barometer which used to measure the atmospheric pressure made by physicist

iii. Formation of soil and rocks are explained by physics

Applications of Physics in Real Life

Discoveries in Physics have led to various inventions that influence our lives.

1. **At home;** All tools and machinery that we use in our homes to make work easier are made in accordance with the laws of Physics. They include crowbars, hammers, door handles, cutlery, hinges, car jack, pulleys, tillage implements, and so many other things. For example, it would be difficult for us to try to lift a car so as to change its tyres. However, using a car jack makes this task easy. Electrical appliances such as cooker, iron, heater, electric lamps, and washing machine and so on are a result of the application of the knowledge of physics.
2. **Medical field;** A variety of medical processes and machinery rely on the application of the knowledge of Physics. Some of these machines are used in diagnosis and treatment of various ailments as well as sustaining the lives of patients through certain forms of therapy. Examples of machines used in hospitals include laser, x-ray, incubators, and ultrasound and infrared machines. The knowledge used in handling and even actual use of these machines is based on the knowledge and skills acquired in Physics.
3. **Source of energy;** Some processes and machines help us to obtain energy for our daily use. These machines make use of various laws of physics to give us different forms of energy. For example, batteries and generators provide electrical energy that is readily used in radios and televisions. A car battery provides energy needed to drive a car. When devices like bulbs are connected to these sources, they provide light energy for daily use.
4. **Transport;** Application of laws of Physics governing concepts such as friction and frictional forces ensures that human beings and animals can walk, run and stop without falling over. Vessels used in transportation such as cars, ships, aeroplanes and trains are also able to move, brake and stop when necessary. This is all because the laws related to friction; flotation and balance are observed and applied accordingly. When these laws are disobeyed, ships sink and trains derail.

5. **Communication;** Devices used in communication systems such as telephones, modems for accessing the internet and television, use cables, telecommunication transmitters and receivers to relay information. The knowledge of Physics is essential, because these instruments make use of fiber optics and radio waves in order to relay messages. Newspapers, letters, electronic mails (email), fax messages from fax machines and short messages (SMS) through mobile phones are reliable means of communication. All these things require the knowledge of Physics.
6. **Entertainment;** Physics enables people to enjoy a variety of leisure activities as is evident in photography, digital appliances, exercise machines and other sport equipment.
7. **Industry;** Physicists have been able to come up with tools and process that have resulted in advanced technological equipment and new discoveries. These include highly accurate skills such as computer assembly and computer programs used in design; and instruments like binoculars and telescopes; the ability to land on the moon and measure the temperature of bodies are a few examples.
8. **In schools;**The instruments and apparatus used in school laboratories are made through the application of the knowledge and skill acquired in a Physics class. These apparatus have to meet certain specifications or standards that are universally accepted.

TOPIC 2:

INTRODUCTION TO LABORATORY PRACTICE

A Laboratory is a room or a building designed specifically for carrying out experiments.

OR

Laboratory is the special room that have been designed and equipped for carrying out scientific experiments for the purposes of study or research

Feature of good Laboratory

The laboratory should have the follows

i. Water supply system

ii. Drainage system

iii. Electricity supply

iv. Well illuminated

v. Well ventilated

vi. Door open out ward

vii. Gas supply

Laboratory Rules and Safety Guidelines

The follows include laboratory rules

i. Do not enter laboratory without permission

ii. Do not do an experiment without permission

iii. Do not start experiment without procedure information

iv. Follow instruction careful to avoid damage of apparatus

v. Follow instruction careful to avoid wrong result

vi. Handle apparatus with care to avoid damage

vii. Avoid handling apparatus and chemical until you asked by your teacher

viii. Avoid running, screaming or playing in the laboratory

ix. Avoid tasting, eating or drinking anything in the laboratory

x. Keep the window open for any fumes to flow out

xi. Do not touch any electrical equipment with wet hands

xii. Close gas and water taps before leaving the laboratory

xiii. All exits should be cleared of any obstruction

xiv. Arrange in orderly way material you want to use

xv. Report any accident and injuries to the teacher

xvi. Never use bare hand to handle hot object

xvii. Do not use dirty or broken apparatus

xviii. Solid wastes should not be disposed in the sinks

xix. Clean the working areas before leaving the laboratory

xx. Wash your hands with water and soap after perform an experiment

Safety measures in physics lab

Explain the safety measures in physics laboratory

1. All experiments which produce poisonous fumes must be conducted in the fume chamber.
2. Lab floor should not be polished to avoid slipperiness.
3. Lab should have large windows and doors should be opened outwards.
4. Ensure that the fire extinguisher is fixed to an appropriate place ready to be accessed in case of fire.
5. In a multi storey building, a physics lab should be in the lowest floor.

Using Use the First Aid Kit to render first aid

First aid is the immediate care given to accident victims or an injured person before he/she is taken to the hospital for further medical treatment. It reduces pain and it helps to bring hope and encouragement to accident victims.

Importance of First Aid

i. It helps to preserve life

ii. It prevents the victim's condition from becoming worse

iii. It promotes recovery by bringing hope and encouragement to the victim

iv. It helps to reduce pain and suffering

v. It prevents infection

A First Aid Kit is a small box which is placed in a safe and accessible place in the lab and is used for the storage of instruments and chemicals for first aid

Contents of a first aid kit and their uses

Contents	Uses
1. 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. Sterilised new razor blades	Used when treating new or old wound
5. Sterilised wound	To clean and cover wounds
6. Safety pin	To tighten clip bandages
7. One jar of petroleum jelly	To apply on burns
8. Iodine tincture	To clean fresh cuts and bruises
9. Soap	To wash hands and wounds
10. Antibiotic solution.	To clean wounds

Warning Signs

Warning signs are signs on the containers of chemicals as warnings about the danger of the contained chemical. There are six warning signs.

Explosives

These are substances can explode. An explosion is a forceful rapid reaction which involves the throwing off particles at high speeds.

The sign means that it is dangerous to keep explosives in glass containers.

Oxidant

This is a chemical/substance that helps a burning substance to burn faster.

Oxidising agent makes a small fire to become bigger. Heating a mixture of an organic material with an oxidising agent may cause explosion. Eg; heating potassium permanganate with saw dust.

Flammable

These substances catch fire easily. They should not be kept near open flames. If heated,anelectric heater should be used.

Corrosive

These substances burn skin as well can corrode floors and desktops.

If by accident, a corrosive substance comes into contact with your skin, go to the sink and wash your skin with a lot of water. Examples; Concentrated mineral acids like HCl and HNO3 II. Concentrated alkalis like NaOH and KOH

Toxic

These are very poisonous and can cause death immediately after use or after a few days. They should not be allowed to come into contact with you.

-If you come into contact with such a chemical accidentally, wash it away with a lot of water.

Harmful/irritant

Harmful - these substances may cause illness or endanger your health. They won’t kill instantly but they are lethal. Irritating substances- cause pain in eyes or on your skin and can endanger your health if you are in contact with them doe too long.

They should be handled according to the stipulated instructions.

Basic Principles of Science Investigation

The Concept of Scientific Investigation

Explain the concept of scientific investigation

Scientific investigation refers to the step-by-step procedures and methods employed in carrying out a scientific research.

Steps of Scientific Investigation

Identify the steps of scientific investigation

There are six different scientific step:

1. **Identification of a problem:** This is the first step where a problem is recognized. It provides explanations to the day-to-day questions which we come across in our lives Eg; It is observed that despite adequate feeding, vaccination, treatment and spacious rooms, hens lay fewer eggs each day. What is the cause of the fewer number of eggs?
2. **Formulation of hypothesis:** Hypothesis is an intelligent guess or a tentative explanation for the observation made. Using the example of a few eggs laid by hens per day the hypothesis could be; a smaller number of eggs are laid because of unusual high temperature in the room. In order to prove this hypothesis, an experiment has to be carried out.
3. **Experimentation:** The experiment involves a series of investigations intended to discover relationships or certain facts that may lead to the acceptance, rejection or modification of a hypothesis. The first step in experiment is to construct a plan of investigation.
4. **Observation and data recording:** After setting up the experiment, a researcher makes careful observation using their sense organs and records all events that considers relevant.
5. **Interpretation of data:** Once a researcher has collected data, he should try to explain the meaning of the experiment. This is an attempt to interpret the data. The data may be presented in a form of a table, bar chart, histogram or even graph.
6. **Conclusion:** This is either confirmation or rejection of hypothesis.

A Theory is a set scientific assumption consistent with one another and supported by evidence but not fully proved (is a hypothesis with more evidence).

Fact is a proved theory supported by evidence

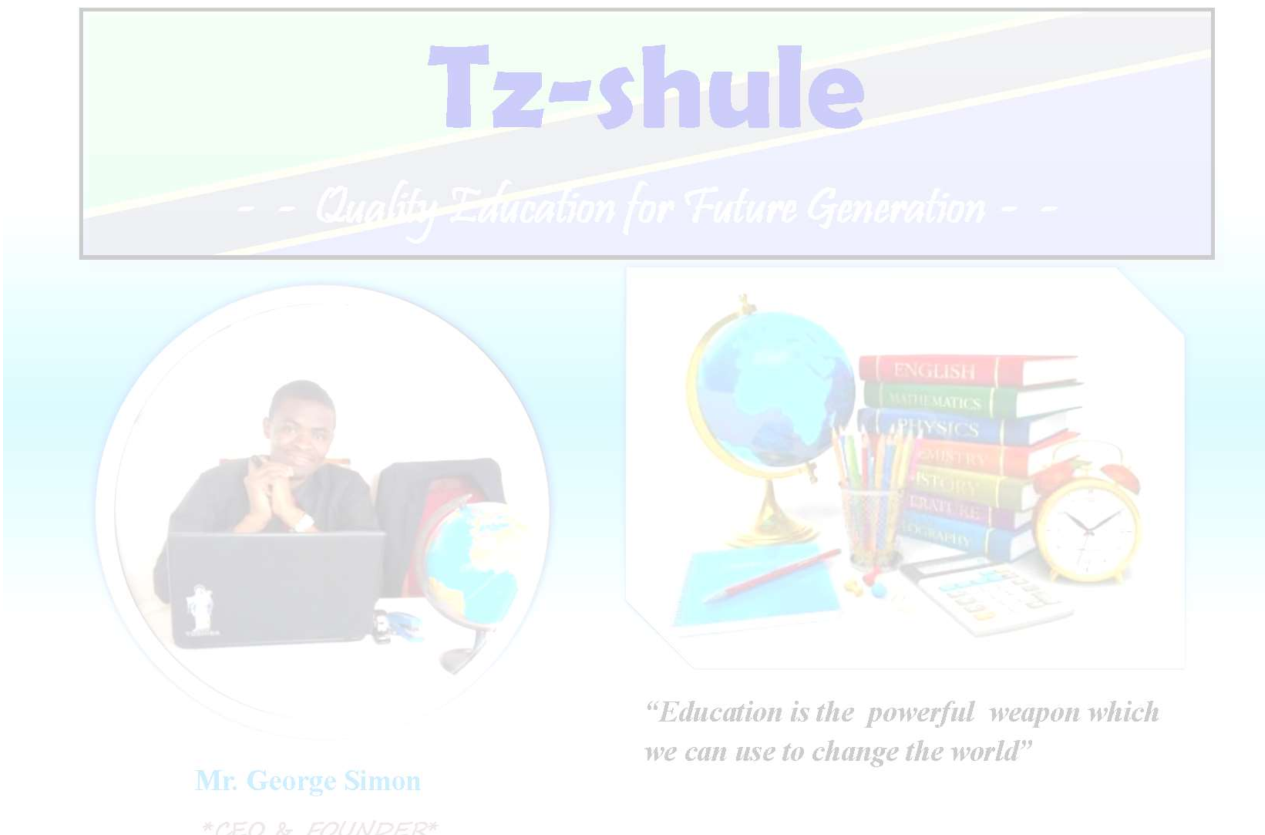
Hypothesis →Theory →Fact

Scientific Investigation Methods in Solving Problems

Use the scientific investigation methods in solving problems

Activity 2

Use the scientific investigation methods in solving problems



TOPIC 3:

MEASUREMENT

The Concepts of Measurement

Measurement is the process of assigning numbers to observations or events.

Importance of Measurement in Real Life

State the importance of measurement in real life

Measurements are so often taken for granted, we sometimes do not appreciate the grand importance measurements play in our lives. On a baseline level, measurements fall into the categories of weight, area, volume, length and even temperature. While we look at these various categories as stoic forms of mathematical measurements, a closer examination of things we do in everyday life reveals their clear importance.

Taking proper medicine. If you are ill (whether a serious or minor illness) you need to take your medicine and take it in the proper amount. If you take too little or too much then you are not going to get the proper benefit from it.

Cooking properly. Cooking of all forms is based on proper attention to measurement. Can you bake a chicken at 600 degrees? Well, you can but the results would be pretty catastrophic! Could you may a cup of tea by dipping a tea bag into a teaspoon of warm water?

Purchasing clothes. Now, how important could measurements be when selecting clothes? After all, to look good in clothing the main thing you need to pay attention to is style, right? Well, if you weigh 200lbs you aren't going to look stylish in an extra small shirt. Clothing is all based on size and proper fitting which are, of course, variants of measurement.

Playing sports. The importance of measurements may not necessarily reveal itself when you play sports but it is there in a big way. If you want to throw a runner out at first or make a 30 yard touchdown pass then you really need to be accurate and comes from a clear sense of depth and distance.

Making estimations. If you have to be at school at 9am what time would you have to leave in the morning if you are at your friend's house. Often we do not have an exact answer so we need to make an estimation which is essentially a guess of measurement.

Keeping yourself warm or cool. If the temperature outside dips or increases you have to make an adjustment on your thermostat in order to remain at a safe and healthy temperature. Understanding the measurement scale of a thermostat is critical in this regard or else you may find yourself feeling rather uncomfortable.

Understanding weight. Is that object too heavy to pick up by yourself or do you need to use something to lift it? Some may think this is not important but it is pretty easy to hurt yourself if you lift objects that are too heavy.

Proper use of capacity. Just how many clothes can you fit in a dresser or closet without it becoming too crammed? Without a clear concept of capacity you might find yourself pouring an entire half gallon of orange juice into a small glass!

Telling time. The ability to tell time is all based on measurement principles. Whether you are using a digital clock or an hourglass these devices measure the passage of time. Now, imagine how chaotic the world would be if if was impossible to measure the passage of time.

Transportation. How much weight is too much for a plane to take off or a car to move efficiently? How much fuel is needed to reach a certain point and how long will it take to get somewhere? Yes, measurements play a significant part in transportation.

Structure. This was saved for last because it is the common theme that is found in all the multitude of reasons for the importance of measurements. Measurements provide structure and remove the chaos that would result without any congruent method of understanding weight, mass, temperature, etc.

Basic Fundamental Quantities

A Fundamental Quantity

Define a fundamental quantity

Physical quantity: Is any character which can be measured by an instrument.

A Unit is the standard which is used to explain measurement of a body. Eg; kilogram, metre, second etc.

Fundamental quantities are numbers that we need to describe the world around us, which we cannot express in terms of "simpler," more basic **quantities**. Here is an example: My weight is not a **fundamental quantity**, because it depends on how much stuff makes up my body.

Three Basic Fundamental Quantities of Measurement

Mention three basic fundamental quantities of measurement

Basic fundamental quantities are physical quantities from which other physical quantities are derived from. This includes three quantities namely **mass**, **length** and **time**.

The S.I Unit of Fundamental Quantity

SI unit (International system of units): Is the system of units which is used internationally to measure three basic physical quantities.

SI units of fundamental quantities

Basic physical quantity	**SI unit**
Mass	Kilogram (kg)
Length	Meter (m)
Time	Second(s

Metric system

Is an international system which is a decimal based system, consequently, conversions from one unit to another within the metric system can accomplished by multiplying or dividing by ten or power of ten.

Note: With the exception of temperature, amount of substance and luminous intensity international other units of measurement that are smaller or larger than the most commonly used units are expressed by attaching a prefix to the most commonly used units.

More than 1 unit

- Giga(G) = 1,000,000,000 (10^9)
- Mega(M) = 1,000,000 (10^6)
- Kilo(K) = 1,000(10^3)
- Hector (h) = 100(10^2)
- Decca(da) = 10(10^1)1

Less than 1 unit

- Deci (d) = 1/10 (10^{-1})
- Cent (c) = 1/100(10^{-2})
- Mill (m) = 1/1000 (10^{-3})
- Micro(μ) = 1/1,000,000(10^{-6})

Appropriate Instruments for Measuring Fundamental Quantities

Use appropriate instruments for measuring fundamental quantities

Length, l

Length is the distance between two points, objects or space.The SI unit of length is **meter**(m). Other commonly used units are **kilometer**(km) and **centimeter**(cm).

1km = 1000m

1m = 100cm

The instrument used to measure length is the **metre rule.**

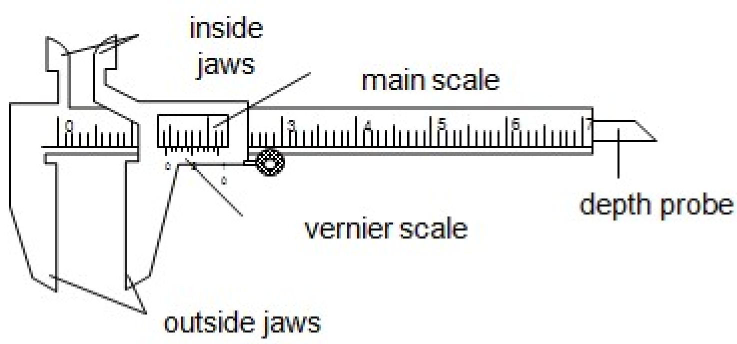
How to read the metre rule: Owing to the thickness of the wood, the eye must always be placed vertically above the mark being read, in order to avoid errors due to parallax.

Measuring of length (diameter) of small objects.

The diameter of small objects is measured by using two instruments:

a. Vernier caliper
b. Micrometer screw gauge

A venier caliper is the instrument used to measure length to the accuracy of **0.01cm.**It is used to measure lengths to the range of 1.0cm to about 12.0cm.The figure below describe the structure of vernier caliper.



The main scale is graduated in centimeter (cm) while the vernier scale is graduated in millimeter (mm).The vernier scale is a short scale 9mm long divided into 10 equal parts, so that the difference in length between a vernier division and the main scale division is 0.1mm or 0.01cm.

The inside jaws are used to measure the inside diameter while the outside jaws are used to measure outside diameter.The vernier slides over the main scale.

How to read

- The main scale reading is recorded. This is the reading which precedes the zero mark of the vernier scale.
- The vernier scale reading is recorded by reading the mark on it which coincide with a mark on the main scale (i.e. vernier scale reading x 0.01cm).
- The summation of these two readings is the length of the object measured.

A micrometer screw gauge: Is an instrument used to measure length to the accuracy of **0.001cm(0.01mm).**It is used to measure the diameters of wires and ball bearings. It can measure small lengths up to about 2.5cm.The diagram below describes the micrometer screw gauge.

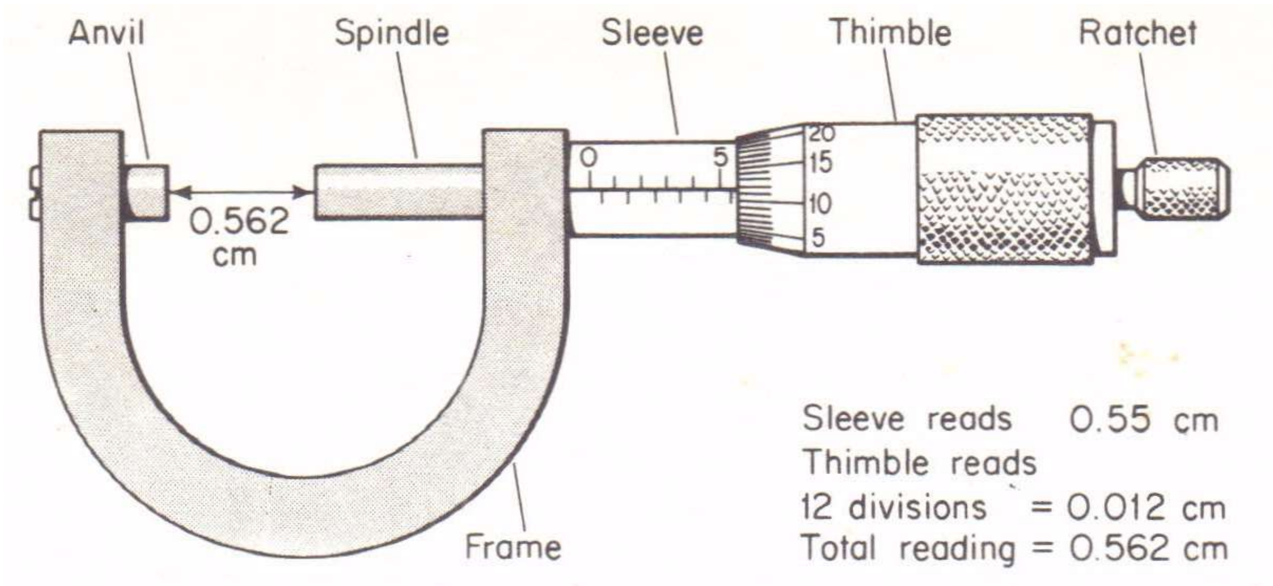


Fig. 1.6. Micrometer screw gauge

It consists of a spindle which is fitted with a graduated thimble. The screwed portion of a spindle is totally enclosed to protect it from damage.The pitch of the screw is 0.5mm, so that the spindle moves through o.o5cm for each complete turn.

The anvil and the spindle grip the measured object between them. The ratchet prevents the user from using undue pressure. The sleeve is graduated in mm, each graduation represent one complete turn of the screw.

How to read a micrometer screw gauge:

- Sleeve reading is recorded. This gives the units and the first two decimal places in mm.
- Thimble reading is then recorded. This gives the third decimal place (thimble reading x 0.001mm).
- The summation of these two readings gives the diameter of the object under measurement.

Precautions when using a micrometer screw gauge.

1. Before use, the faces of anvil and spindle should be wiped clean to remove any dirty particle which would give false readings.
2. Check and record for zero error then + or –the correction to the final answer.

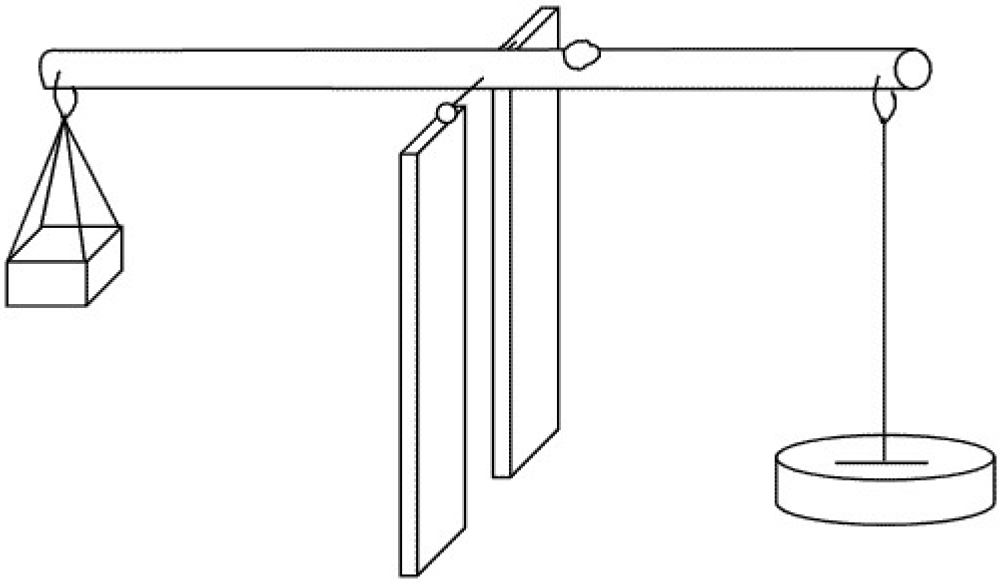
Mass

Mass of a body is the amount of matter it contains. The SI unit of mass is **kilogram** (kg). Other commonly used units are **gram**(g) and **tones**(t).

1kg = 1000g

1t = 1000kg

The mass of a body doesn't change from place to place. The instrument used to measure mass is called a**beam balance**.



Difference between mass and weight:

Mass	Weight
Is the amount of matter contained	Is the force by which the earth pull a body to its centre
SI unit is kilogram	SI unit is Newton
Doesn't vary from place to place on the earth's surface	Varies from place to place on the earth's surface
Measured by beam balance	Measured by a spring balance

Time

Is the gap between two occasions or events.The SI unit of time **second**(s). Other units used are minutes (min), hour(h),day etc.

1min = 60s

1h = 3600s

1day = 86400s

The instruments for measuring time are **clocks** and **watches**.

Derived quantities

Derived quantities are units which are derived from the fundamental quantities. Examples are volume, density, power, work, energy, weight, frequency etc.

The S.I Units of Derived Quantities

State the S.I. units of derived quantities

SI units of Derived quantities

Volume	Cubic meter (mˆ3)
Density	Kg/mˆ3
Power	Watts (W)
Work	Joules (J)
Energy	Joules (J)
Weight	Newton (N)
Frequency	Hertz (Hz)

Basic Apparatus/equipment's and their uses

Basic Apparatus/Equipments Used for Measurement

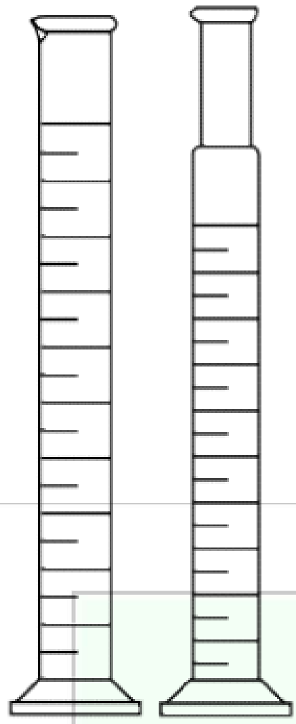
Describe basic apparatus/equipments used for measurement

Volume

Volume is the amount of space occupied by a substance. The SI unit is cubic meter (mˆ3).Other units used are cubic centimetre (cmˆ3) and litre(l).

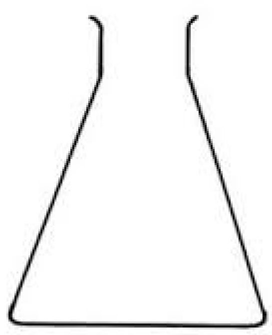
Instruments used to measure the volume of liquids:

Measuring cylinder-used for measuring or pouring out various liquids.

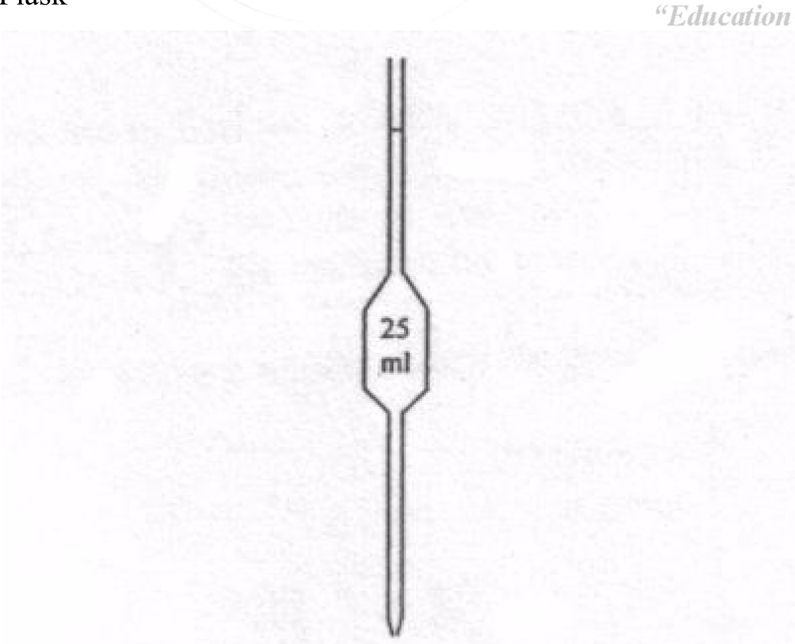


A B

Measuring flask and pipette are used for getting fixed pre-determined volume.



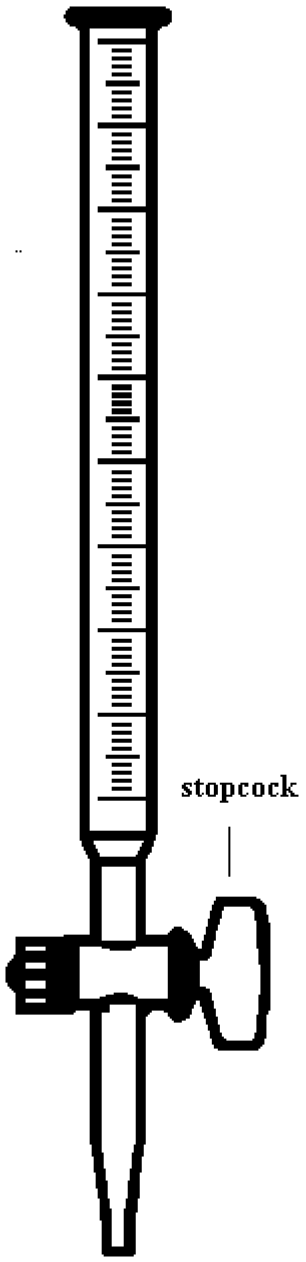
Flask



Pipette

Burette-used to deliver any required volume up to its total capacity.

1.26 Burette



How to read volume measuring instruments(precautions).

Readings are always taken at the level of the bottom of the meniscus or curved surface of the liquid. Mercury is an exception as its meniscus curves downwards.

Care should be taken to place the eye correctly to avoid parallax errors. When taking readings, the pipette and burette must be upright and the cylinder and flask must stand on a horizontal bench otherwise errors may arise from tilting.

Measuring volume of irregular objects.

The volume of an irregular solid can be determined by measuring the volume of water displaced in a measuring cylinder directly or with the aid of an overflow eureka can.

Activity 1

Experiment

Aim: To measure the volume of an irregular object.

Methods

By using a measuring cylinder directly

Materials and apparatus: Irregular object eg; stone, thread, measuring cylinder, eureka can and water.

Procedures

- Poor a known volume of water in a burette(V1)
- Tie a stone with a thread.
- Immerse the tied stone in water holding the thread and record the volume (V2)
- Make sure the stone is totally immersed in water.

Results

- Volume before introducing solid = V1
- Volume after introducing solid = V2
- Volume of irregular solid(V3) = V2 – V1

By using the eureka can

Procedureto follow:

- Poor water into eureka can up to its spout
- Immerse a well tied stone in water completely
- Collect the overflowed water in the water.
- Use a measuring cylinder to determine the volume of water collected

Observation

- When a stone was introduced in an overflow can, water overflowed to the measuring cylinder.
- The volume of water collected is equal to the volume of irregular object(stone)

Sources of Errors in Measurement

Identify sources of errors in measurement

Error is the difference between the measured value and the real or actual value (The difference in reading is known as the error).

There are two types of errors, namely:

a. Systematic errors
b. Random errors

Systematic errors

Systematic errors results in the measurement or reading being consistently over the actual value OR consistently smaller than the actual value.

Sources of systematic errors.

a. **Zero error:** Zero Error is caused if the reading shown is Not zero when the true value is actually zero. This is most probably caused by a flaw in the instrument for example when using a ruler that has lost its zero scale due to wear and tear hence causing an error in the measurement of length.
b. **Wrong assumptions:** For example if you assume that water boils at 100 degree Celsius but actually its boiling point is higher if there are impurities in it. (Pure water boils at 100 degree Celsius).
c. **Lag of reaction time:** For example in a sports day, when measuring a 100 m running time using a stopwatch. The observer may not press the stop button exactly when the foot of the runner touches the finishing line.
d. **Calibration errors:** Instruments that are not properly calibrated could also cause error and this has to be put in consideration when writing a report or when there is an anomaly in reading.

Random errors.

Random error is caused by the observer who reads the measuring instrument. Just like the systematic error, there is also positive or negative error. Positive error is when the reading is bigger than the real value and negative error is when the reading is smaller than the real value.

Ways of reducing errors

1. Taking several readings and then find the average.
2. Avoiding parallax error by positioning the instrument (meter rule) properly on the table with the eyes perpendicular to the scale.
3. Some instruments can be adjusted to eliminate zero error. For example when using an ammeter, there is an adjuster to set the indicator to zero before making any measurement.
4. In the case of a ruler, measurement can be carried out starting from the next clear scale for example if scale 0.0cm is blurred, we can start measuring the length from 2.0cm, of course taking the difference of value in consideration when recording the final reading.

Density and Relative Density

The Density of a substance is its mass per unit volume.

The unit of density is kg/m^3. Other unit used is g/cm^3.Density of regular solid object can easily be found by direct and easy measurements.-It involves measuring the mass and calculating the volume as described in the experiment below.

The Density of Regular and Irregular Solids

Determine the density of regular and irregular solids

Activity 2

Experiment

Aim; To measure the density of rectangular block.

Material and Apparatus :Ruler, beam balance and rectangular block.

Procedures: Using a beam balance measure mass of the block, m.Measure its length, width and height.

Results

- The mass of the rectangular block is m.
- The volume of the rectangular block will be calculated by multiplying the obtained length, l height, h and width, w.
- Volume, V = l x h x w, But; Density = mass/volume
- The volume of a material can be obtained by using various methods depending on the shape of the material

Activity 3

Experiment.

Aim; To determine density of irregular solid.

Materials and apparatus:Irregular solid like stone, measuring cylinder, beam balance and water.

Procedures

- Obtain the mass of the given object using the beam balance.
- Fill water to the measuring cylinder to the volume V_1.
- Immerse the well tied irregular object totally in the cylinder containing water.
- Record the new volume V_2.

Results

- Volume of irregular object = V_2 - V_1
- Mass obtained = M

$$\text{Density} = \frac{mass}{volume} = \frac{M}{V_2 - V_1}$$

The Density of a Liquid

Determine the density of a liquid

Density of liquids can be determined by using a burrete or a density.

Activity 4

Experiment.

Aim: To determine density of liquids using a burette.

Materials and apparatus: Burette, beaker, beam balance and kerosene.

Procedures

- Record the mass of the empty beaker m_1 using a beam balance.
- Pour the known volume of kerosene into the beaker by using bur rete, V.
- Record the mass of the beaker and kerosene m_2.

Results

The mass of the kerosene = m_1 - m_2.

$$\text{Density of kerosene} = \frac{mass\ of\ kerosene}{volume\ of\ kerosene} = \frac{(m_2 - m_1)}{V}$$

Definition of the Relative Density of a Substance

Define the relative density of a substance

The Relative density of a substance is the ratio of its density to the density of water.

Relative density has no S I unit.

The density of water has the density of approximately 1.0g/cm³ or 1000kg/m³.

$$\text{RD of a substance} = \frac{Density\ of\ a\ substance}{Density\ of\ water}$$

$$= \frac{mass\ of\ substance}{volume} \times \frac{volume}{mass\ of\ water}$$

$$= \frac{mass\ of\ any\ volume\ of\ the\ substance}{mass\ of\ equal\ volume\ of\ water}$$

.

Note: Since the density of pure water is 1g/cm³, the RD of a substance will be represented by the same number as its density in g/cm³.RD **has no units** as its ratio of same quantities.

Applications of Density and Relative Density in Real Life

Interpret applications of density and relative density in real life

Application of RD in real life.

1. It is the key factor which is considered during the design of various structures and equipment. Eg. ships and planes.

2. Density is considered during the selection of materials.
3. Density is also considered during the design of equipment used in swimming.

TOPIC 4:

FORCE

Defn: *force is an influence that changes or tends to change the state of rest or uniform motion*

Or

Defn: *force is a push or pulls experience by an object.* It measured by device/instrument spring balance.

The SI Unit of force is Newton (N)

Nb:

Branch of science deals the effect of force on matter is called **Mechanics**

Types of Force

There are types of forces include

i. Fundamental forces

ii. Non fundamental forces

Fundamental Forces

Defn: *Fundamental force is the forces in which the two interacting object are not in physical contact with each other*. Fundamental force is the basic forces in nature that cannot be explained by the action of another force. Also is called interactive force or non-contact forces or action-at-a-distance force or field force. For Example,

i. Gravitational force

ii. Electric force

iii. Magnetic force

Types of Fundamental Force

There are four (4) types include

i. Force of gravity (weight)

ii. Electromagnetic force

iii. Strong nuclear force

iv. Weak nuclear force

Force of Gravity

Defn: *Gravitation force is the force pulls objects toward the Planet*. For Example, all object falls down if thrown up due to force of gravity is pulling the objects toward the earth surface. It represented by letter **g**, it has constant value of **10 N/kg** or **9.8N/kg**. It also called weight

W = mg

Where:

m = mass of object

g = gravitational force

Properties of Force of Gravity

i. It is always attractive

ii. Weakest force among others force

iii. It is central force (it act on object along the line joining the centre of object and planet)

iv. It operates over very long distance

Example,

Rocket moves from the earth to a planet x. if it weighs 10, 000N and 30N on the earth and on plane t x respectively determine the gravitation force on planet x

Data given

Earth Weigh, we = 10, 000N

Planet x Weigh, wx = 30N

Earth force of gravity, ge = 10N/kg

Mass of the rocket, m = ?

Planet x force of gravity, gx = ?

Solution:

From: w = mg

Then: we = mge – find value of m

M = we/ge = 10000/10 = 1000kg

M = 1000kg

Now: wx = mgx – find value of gx

gx = we/m = 30/1000 = 0.03N/kg

gx = 0.03N/kg

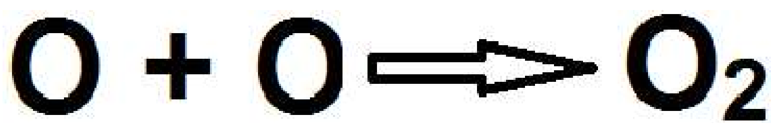
Electromagnetic Force

Defn: *Electromagnetic force is the force associated with production field due to movement of electrons*. Include both electric and magnetic forces. For Example, formation of water molecule, Atoms attract each other due to

Electromagnetic Force

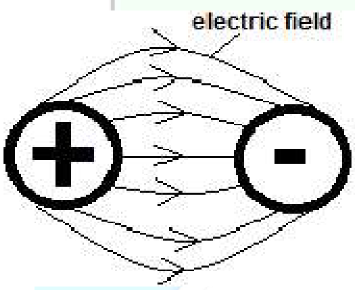
Defn: *Electromagnetic force is the force associated with production field due to movement of electrons*. Include both electric and magnetic forces. For Example, formation of water molecule, Atoms attract each other due to electromagnetic force

Diagram of formation of oxygen gas



In two charge placed near each other may attract (unlike charge) or repel (like charge) due to electromagnetic force

Diagram of attraction of charge



Properties of Electromagnetic Force

i. it may be attractive or repulsion in nature

ii. It is a central force

iii. It is stronger than gravitational force

iv. It is a long-range (operates over a very long distance)

Strong Nuclear Force

Strong nuclear force is the force which holds the constituents of the atomic nucleus. It acts within the nucleus of the atom. For Example, nuclear energy plant force obtained from the splitting (fission) or fusion of the nucleus of the atom

Diagram of fusion

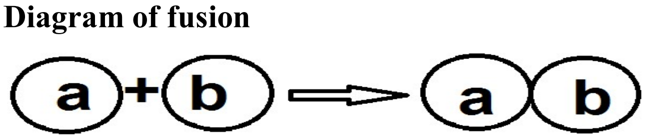
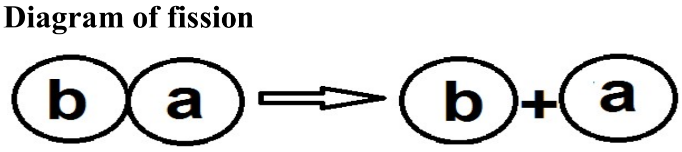


Diagram of fission



Properties of Strong Nuclear Force

i. It is basically an attractive force

Email: tzshule@gmail.com

ii. It is a short-range (operates only up to distance of the order of 10-14m)

iii. It is a non-central force (it does not act at the centre)

iv. It is stronger than gravitation force

Weak Nuclear Force

Weak nuclear force is the force which involve in certain nuclear. For Example, in formation of water from reaction between oxygen gas and hydrogen gas weak nuclear force is used to bond the water molecules

Properties of Weak Nuclear Force

i. Stronger than gravitation force

ii. Weaker than electromagnetic force

iii. Weaker than strong nuclear force

iv. Operates on small ranges of up to 10-17m.

Non - Fundamental Forces

Defn: *Non fundamental forces is the forces in which the two interacting object are in physical contact with each other*. Fundamental force is the basic forces in nature that can be explained by the action of another force. Also is called non-interactive force or contact forces. For Example,

i. Kicking a ball

ii. Compressing a spring

iii. Pulling a door

iv. Friction

v. Tension

vi. Resistance

vii. Elastic forces etc

Effects of Forces

Forces have several effects on object but the follows include the effects in daily life

i. Stretching or tensile

ii. Compression or restoring

iii. Attraction

iv. Repulsion

v. Torsion

vi. Friction

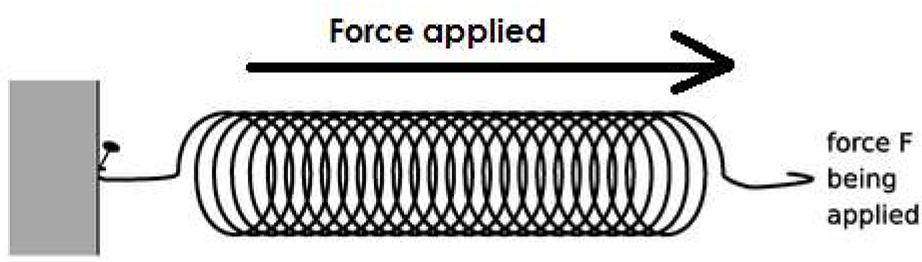
vii. Viscosity

viii. Air resistance

Stretching Force

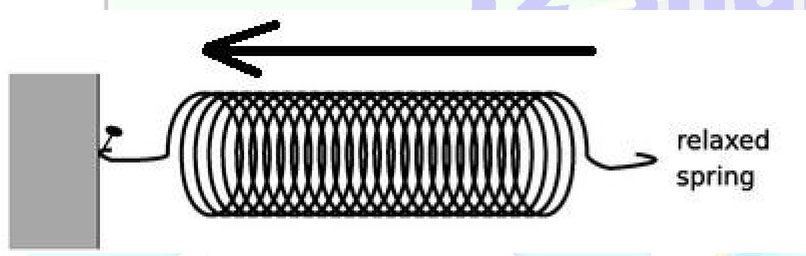
Defn: *Stretching force is the force produce elongation of object if pulled.* For Example, when spring is pulled the stretching force elongate the spring

Diagram



Defn: *Compression force is the force produce squeeze of object to original shape and size.* For Example, if stretching force removed elongated spring squeeze to its original size and shape

Diagram:



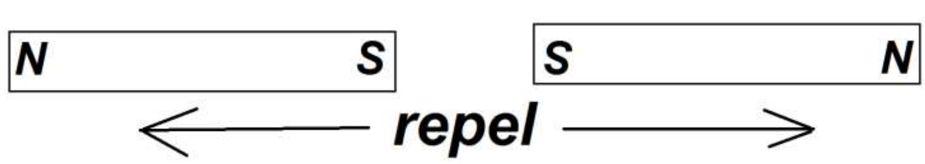
Attraction Force

Defn: *Attraction force is the force that pull object toward each other.* For Example Magnetic always attract other object like iron.

Repulsion Force

Defn: Repulsion is the force that push object against each other. For Example, when the same poles of magnetic are closer it pushes each other

Diagram:



Torsion Force

Defn: Torsion force is a force produced when a solid matter twisted

Friction Force

Defn: *Friction force is the force that prevents a body from sliding or rest.* For Example, an exercise book cannot slid on top of table due to friction between exercise book and table

Importance of Friction Force

i. Friction between feet and the ground enable man to walk

ii. Friction between object on the surface enable it to rest

iii. Friction between match and match stick produce heat

iv. Friction enable stopper to close the bottle of wine, juice etc

Disadvantage of Friction

i. Cause Heat and lead to heat energy which cause the efficiency of machine to be less than 100%

ii. Cause wear and tear of various bodies Example, shoes etc

iii. Cause accident due to wearing of our skin when we slide in rough surface

NB:

The fraction can be reduced by

i. Using lubricant e.g. oil, grease etc

ii. Rollers

iii. Polishing

iv. Watering

v. Balk bearing

Viscosity Force

Defn: *Viscosity force is the friction force of a fluid (liquid + gas) to flow. It involves the resistance to flow.* Water flow easy, cooking oil flow with resistance than water and honey flow with more resistance than cooking oil. Water has low viscosity, cooking oil has high viscosity than water and honey has most viscosity than cooking oil.

Air Resistance

Defn: *Air resistance is the force resists the movement of an object through the air. It is the Example, of viscosity*

Factor Affect Air Resistance

The follows the effect of air resistance

i. Size and shape of the body

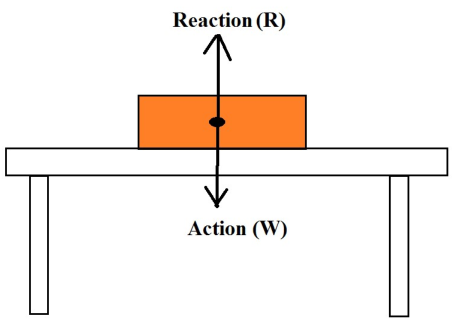
ii. The speed of fluid

iii. The density of the fluid

Normal Force

Defn: normal force is the force support force exerted up an object in contact with another stable object **or** normal force is the force equal and opposite direction to weight of a body

Diagram:



Where:

Mg = w = weight of body

N = normal force

Applied Force

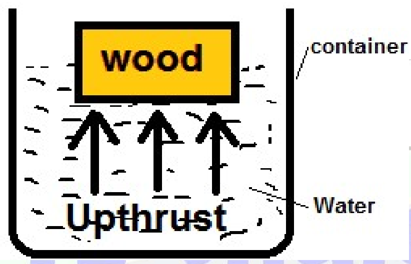
Defn: *Applied force is the external force that cause the system or body to change position*

TOPIC 5:

ARCHIMEDES' PRINCIPLE AND LAW OF FLOTATION

Archimedes's Principle

Consider the diagram below

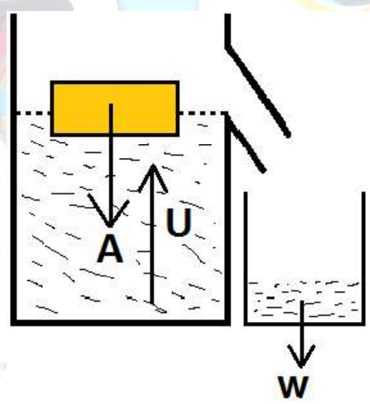


When piece of wood immersed in fluid then floats due to the buoyant force or upthrust. Where by upthrust force is the upward force enable the object to float or at least seem higher

Archimedes Principle

Archimedes principle also called the **law of buoyancy** which state that

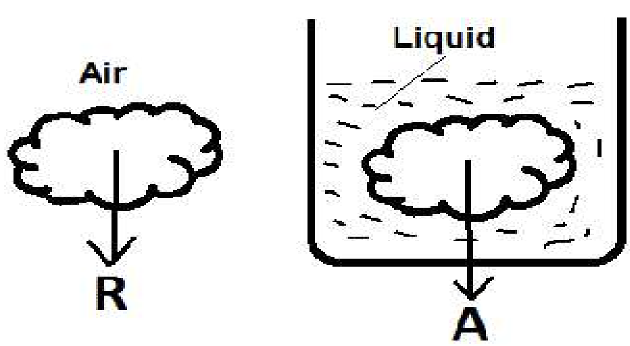
"*When a body is partially or totally immersed in a fluid it experiences an upthrust which is equal to the weight of the fluid displaced*"



U = W

Relationship between Real Weight and Apparent Weight

Consider diagram of the mass (weight) of the object below



Real Weight is the weight of object in air and **apparent weight** is the weight of object in fluid

Mathematically

U = R - A

Where:

U = Upthrust or Apparent weight loss

A = Apparent weight

R = Real weight

Nb:

i. fluid normally exerts an Upthrust

ii. Upthrust tends to reduce weight of body

iii. 1g of water = 0.01N of water

iv. 1g of water = 1cm3 = 1ml of water

Example,

Given Weight of body in air is 10.10N weight of body when immersed in water is 9.2N. Find the upthrust.

Data given

Real weight, R =10.10N

Apparent weight, A = 9.2N

Upthrust, U = ?

Solution

From: U = R - A

W = 10.10 – 9.2

W =0.9N

Example,

The weight of a body when totally immersed in a liquid is 4.2N if the weight of the liquid displaced is 2.5N. Find the weight of the body in air.

Data given

Apparent weight, A = 4.2N

Upthrust, U = 2.5N

Real weight, R =?

Solution

From: U = R - A - make W1 subject

R = U + A

R = 2.5 + 4.2

R =6.7N

Example,

When an object is totally immersed in water, its weight is recorded as 3.1N if its weight in air is 4.9N. Find upthrust.

Data given

Real weight, R =4.9N

Apparent weight, A = 3.1N

Upthrust, U = ?

Solution

From: U = R - A = 4.9 - 3.1

U = 1.8N

Example,

A body immersed in water displaced 1.1N of the liquid if its weight white in the water is 3.3N. Find they weight in air.

Data given

Apparent weight, A = 1.1N

Upthrust, U = 3.3N

Real weight, R =?

Solution

From: U = R - A - make W1 subject

R = U + A

R = 3.3 + 1.1

R = 4.4N

Relative Density by Using Archimedes Principle

Consider the formula below

R.D = msmw (Vw=Vs)

R.D = Ms x gmw x g

Where:

i. mw x g = upthrust = U

ii. Ms x g = real weight = R

iii. R.D = relative density

iv. ms = mass of substance

v. mw (vw = vw) = Mass of an equal volume of water or mass of water displaced

R.D = *R*U

But: U = R – A

R.D = *R*R−A

Example,

A piece of glass weight in air 1.2N and 0.7N when completely immersed in water calculate it's.

(a) Relative density

(b) Density of glass

Data given

Weight of body in air, R = 1.2N

Weight of body in water, A = 0.7N

Density of water, ρw = 10000kg/m3

Relative density of glass, R.D = ?

Density of glass, ρg = ?

Solution

(a) Relative density of glass, R.D = ?

From: R.D = R/(R - A) = 1.2/ (1.2 - 0.7) = 2.4

R.D = 2.4

(b) Density of glass, d = ?

From: R.D = ρg/ρw = make ρg subject

ρg = R.D x dw = 2.4 x 1000

ρg = 2400

ρg = 2400 kg/m3

Relative Density of other liquid from water by solid substance in Archimedes Principle

When solid immersed in liquid and water the relative density is given by liquid displaced over water displaced

Mathematically

R.D = weight of liquid displacedWeight of water displaced

R.D = weight of object in air − weight of object in liquidweight of object in air− weight of object in water

R.D = upthrust on liquidupthrust on water = $UlUw$

R.D = $R- AlR- Aw$

Where:

Ul= upthrust on liquid

Uw =upthrust on water

Al= Apparent weight on liquid

Aw = Apparent weight on water

Example,

In an experiment to determine the relative density of a liquid, a solid Q weighted as follows:

Weight **Q** in air, R = 8.6N

Weight **Q** in water, AW = 6.0N

Weight **Q** in liquid, AL = 5.4N

Data given

Weight of body **Q** in air, R = 8.6 N

Weight of body **Q** in water, AW = 6.0N

Weight of body **Q** in liquid, AL = 5.4N

Solution

From:

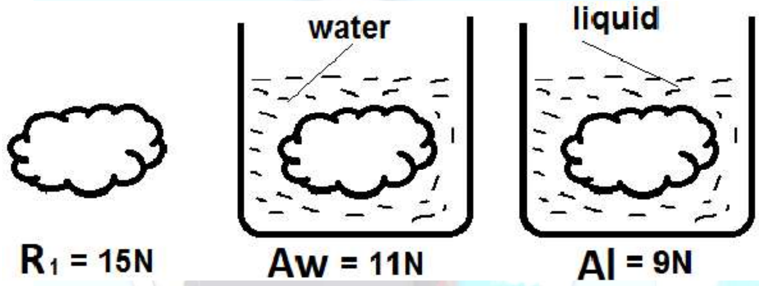
R.D = $R - Al$ / $R - Aw$

R.D = 8.6 − 5.4 8/6 – 6.0 = 3.2/2.6 = 1.2

R.D = 1.2

Example,

Using the data shown below and determine the relative density of the liquid



Weight of body in air, R = 15 N

Weight of body in water, Aw = 11N

Weight of body in liquid, Al = 9N

Relative density, R.D = ?

Solution

From:

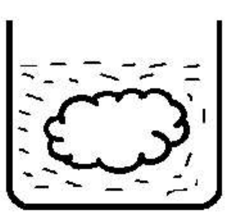
R.D = $R - Al$ / $R - Aw$

R.D = 15 – 9/18 – 11

Sinking

Defn: Sinking is the tendency of an object to fall or drop to lower levels in a fluid

Diagram



Condition for Sinking

i. Upthrust exerted by fluid is less than weight of object

ii. Object denser than fluid means object has great density than fluid

Floating

Defn: Floating is the tendency of an object to be suspended in (remain) on the surface of a fluid due to the upthrust

Nb:

The ability of an object to float is called **Buoyancy**

Condition for Floating

i. Upthrust exerted by fluid must be equal or greater to the real weight of the object

Nb: apparent weight approximately equal to zero

$A \approx 0\ N$

ii. The density of body must lees than that of fluid

iii. Volume of submerged object must be large enough to displace a lot of fluid

Law of Flotation

The law states that

"A floating body displaces its own weight of the fluid in which if floats"

Application of Flotation

Law of flotation is applicant in various substance include

i. Filling Balloons

ii. Filling Hot air balloon

iii. Submarines

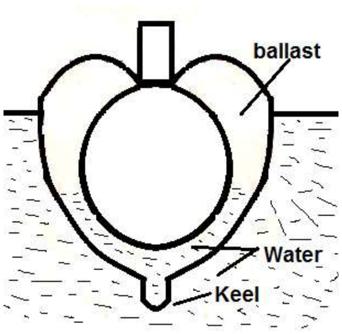
iv. Ships

v. Hydrometer

Sub Marine

Consider the diagram below

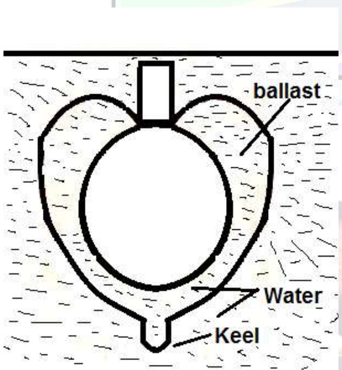
Diagram:



Mechanism

Submarine made with empty space filled with air called ballast in order to increase its volume in order to devise density of submarine and vice versa

Diagram:



When water filled in the ballast the submarine submerged and when balloon admitted to special tank its due and when ballast is filled with air the sub marine floats like other ship

Nb:

When water quantity increased/ filled in the blast is tend to reduce volume hence increase the density of submarine.

Ship

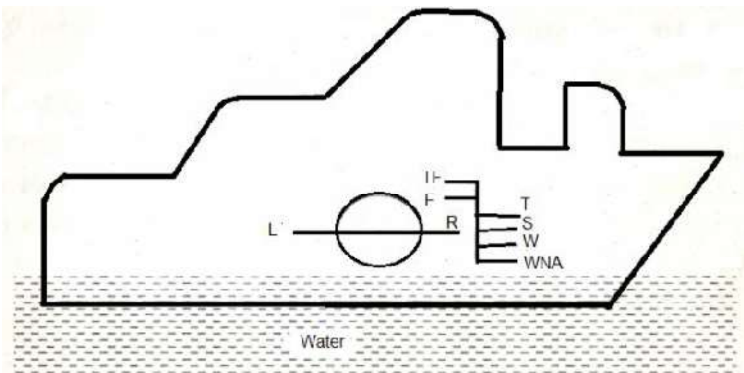
Ship is made of steel and is expected to sink due to its weight. it contains hollow which increase the volume of ship which help on making less dense that the water

$$\downarrow \rho = \frac{1}{V} \uparrow$$

But when load put on ship it tends to increase the density and mass of ship when overloaded the ship sink completely. To check on over wading ships are marked

Plimsoll line is line indicates the safe limit of loading.

Many plimsoll lines may be marked on a ship to show minimum heights above different types of water in different seasons.



Where

F = for fresh water

S = for sea in summer time

W = for sea in water time

TF = tropical fresh water

WNA = winter in Atlantic

T = Tropical

Balloons

Figure below shows the type of balloons used to carry instruments to a high altitude for recording meteorological measurements when filled with gas. E.g. helium, it displaces a volume of air equal to its volume.

Air has greater density compared to the density of a gas in the balloon. Therefore, the weight of air displaced is greater than that of balloon. The balloon drifts up by a force, which is equal to the difference between the upthrust and the total weight of the balloon (W).

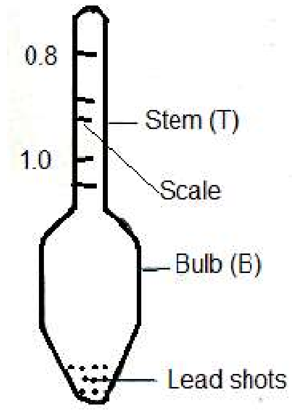
Submarine

The buoyancy of a submarine depends on the quantity of water in its ballast tanks. When it is required to drive, water is admitted to special tanks. When the water is ejected from the tanks by means of compressed air, the submarine raises to the surface and floats just like any other ship.

Hydrometer

Defn: hydrometer is an instrument used for measuring the densities of liquids or hydrometer is an instrument used for determine the relative density of liquids.

Diagram:



Structure of Hydrometer

i. Heavy sinker (bulb): containing mercury or lead shots that keep the hydrometer upright when it floats

ii. Air bulb: it increases volume of displaced liquid and overcomes the weight of the sinker

iii. Stem: stem is thin so that small changes in density (height) give large differences in reading

iv. Scale: inside stem graduated in densities

v. Made up of glass to prevent soaking of the liquid

Nb:

The greater the density of the liquid the shorter the stem of hydrometer immersed

Relative Density of Liquid by Hydrometer

i. When hydrometer floats over water the weight of hydrometer (wg) must equal to the weight of water displaced (ww)

wg = ww

ii. When hydrometer floats over liquid the weight of hydrometer (wg) must equal to the weight of liquid displaced (wl)

wg = wl

iii. since relative density of liquid is given by ratio of density of liquid (ρl) to the density of water (ρw)

R.D = ρl/ρw = wl/vl ÷ ww/vw

Where:

vl = volume of liquid displaced

vw = volume of water displaced

wl = ww

Then: R.D = vw/vl

iv. since cross-section area of the hydrometer is uniform, the volume of water and of liquid displaced are proportional to the lengths immersed in them

R.D = lw/ll

Where:

Lw = length of hydrometer immersed in water

Ll = length of hydrometer immersed in liquid

TOPIC 6:

STRUCTURE AND PROPERTIES OF MATTER

Structure and Properties of Matter

Matter

Defn: matter is anything that has mass and occupies space. Matter can be change state with vary in temperature

State Of Matter

Matter exist in three physical states include

i. Solid state

ii. Liquid state

iii. Gas (vapour) state

Structure of matter

Matter is made up of tiny particles. The particles are either atom or molecules

Atom

Defn: atom is the smallest part of an element, which can take part in chemical reaction. For Example, Sodium atom (Na), hydrogen atom (H) etc

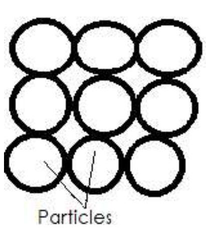
Molecules

Defn: a molecule is a group of atoms. For Example, water molecule (H_2O), hydrogen molecules (H_2)

Solid State

Solid substance has definite shape and definite volume. Particle in solid substance are closely packed together. For Example, of solid substance is Ice, Wood, Stone, Books, Shoes, and Plastic

Diagram



NB:

i. The particles vibrate in fixed position

ii. The particle are not free to move because they held by strong inter particle force

Properties of Solid Matter

i. Particles are closely packed together
ii. Has definite shape and volume
iii. Has strongest inter-particle force
iv. Particle are not free to move

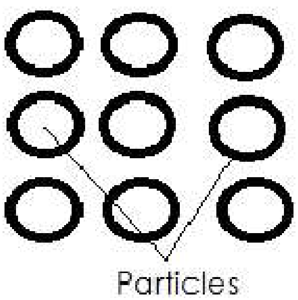
v. Has high density due to small volume

vi. Particle move very slow

Liquid State

Liquid substance has fixed volume but variable in shapes. Particles in liquid are slightly father apart. For Example, water, kerosene, milk etc

Diagram



Properties of Liquid Matter

i. Particles are slight father apart

ii. Have definite volume

iii. Have not definite shape

iv. Has medium density due to medium volume

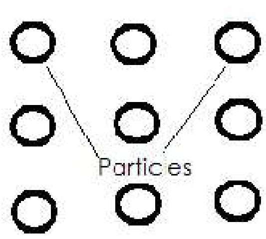
v. Has medium motion

vi. Inter-particle force is weak

Gas State

Gas has not definite shape or size. Particles are moving so fast and are so far apart that they do not interact with each other at all. For Example, oxygen gas, hydrogen gas, nitrogen gas etc

Diagram:



Properties of Gas Matter

i. Has not definite shape

ii. Has not definite volume

iii. Has largest inter particle distance

iv. Has low density due to largest volume

v. Has weakest inter particle force

vi. Particle move at high speed

The Particulate Nature of Matter

Brownian motion

Brownian motion state that

“***Matter is made up of tiny particle that are in a state of continuous random motion***”

Kinetic Theory of Matter

It describes the physical properties of matter in terms of the behaviour of its component atom or molecules. It state that

“All matter is made up of very small particles that are in constant motion”

NB:

i. Motion of solid particles are in vibration

ii. Motion of liquid and gas particles are in random

Elasticity

Defn: elasticity is the property/ability of a body to return to its original shape and size when deforming force removed

Nb:

i. A body/substance with ability to undergo elasticity is called elastic substance

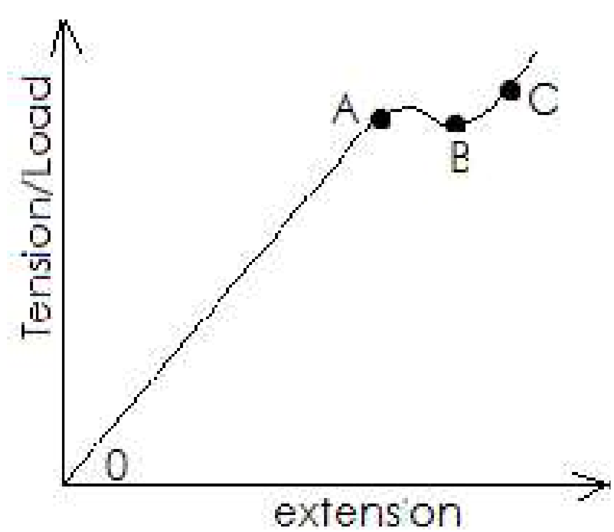
ii. Material are elastic to some degree until elastic limit is reached

iii. The materials which do not undergo elastic deformation are called brittle substance. For Example, glass, block etc

iv. When material deformed beyond elastic limit it become plastic, means it will not regain its original shape even though it doe s not break. This type of deformation is called plastic deformation

v. Material which undergoes plastic deformation is called inelastic or plastic materials.

Graph of Tension against Extension



Interpretation

i. Between point O and A

Tension is direct proportional to extension. This was discovered by Hooke and final he comes with law which called Hooke's law

Hooke's Law

It state that

"***Within the elastic limit extension is directly proportional to the force applied***"

Or

"***Provided that the elastic limit of a body not exceeded the extension is directly proportional to the force applied***"

Mathematically:

$F \alpha e$ - remove proportionality constant

$F = ke$ – make K subject

$\mathbf{k = F/e}$

Where:

k = elastic force constant

= spring constant

F = force applied

e = extension

SI unit of K is N/m

ii. **At point A**

At point A is called limit proportionality or elastic limit

iii. **Between point A and B**

Between Point A and B is called the region of elastic. In this region a small force produces a large extension which is not directly proportional to the extension

iv. **Between point B and C**

Between Point B and C is called the region of plastic deformation. At this region material will not return to its original shape and size when applied force/tension/load removed

v. **Beyond point C**

Beyond point C the material breaks

Application of Elasticity In Real Life

A. Domestic application

i. Rubber gaskets that seal the refrigerator door

ii. Clothing

iii. Springs in furniture

iv. Rubber bands that hold things together

v. Toys like balloons and ball

B. Transport application

i. Rubber tyres, hoses, belt and shock absorbing spring for car and trucks

ii. Aeroplane wings

iii. Supporting cable for bridges

C. Industry application

i. Conveyor belts

ii. Measuring weight

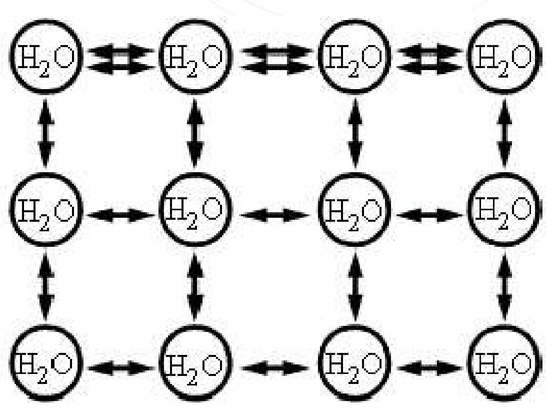
iii. Steel beams in construction

iv. Insulation of vibration and sound

Surface Tension

Defn: surface tension is the ability of a liquid surface to act like stretched elastic skin. Surface tension occurs due to the force of attraction between molecules of liquid

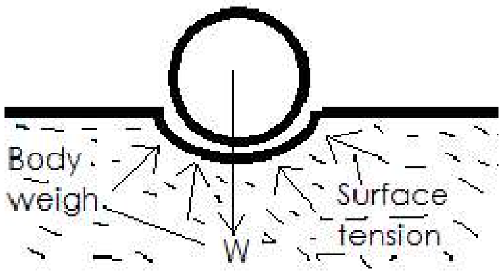
Diagram



How Surface Tensions Occur?

Particles at the surface have no neighbor molecules which tend to possess strongest attraction force up on their nearest neighbouring on the surface, this result elastic nature of the liquids surface. If an object placed on surface of liquid its weight pushes downward cause a deformation, which tends to increase the surface area of the liquid. The surface tension resists that increase in area by pushing upward on the object

Diagram:



Physical Phenomenon Show Presence of Surface Tension

i. **Walking on water**: Small insects such as the water strider can walk on water. Because their weight is not enough to penetrate the surface**. Pond skater (water strider) floats in pond due to surface tension**

ii. **Floating a needle**: A carefully placed small needle can be made to float on the surface of water even though it is several times as dense as water. If the surface is agitated to break up the surface tension, then needle will quickly sink. Pin floats over water due to surface tension

iii. Razor floats over water due to surface tension

iv. Formation of soap bubbles due to surface tension

v. formation of drops of water on leaves of a plant due to surface tension

vi. **Don't touch the wet tent**: Common tent materials are somewhat rainproof in that the surface tension of water will bridge the pores in the finely woven material. But if you touch the tent material with your finger, you break the surface tension and the rain will drip through.

vii. **Clinical test for jaundice**: Normal urine has a surface tension of about 66 dynes/centimeter but if bile is present (a test for jaundice), it drops to about 55. In the Hay test, powdered sulfur is sprinkled on the urine surface. It will float on normal urine, but will sink if the surface tension is lowered by the bile.

viii. **Surface tension disinfectants**: Disinfectants are usually solutions of low surface tension. This allows them to spread out on the cell walls of bacteria and disrupt them.

ix. **Soaps and detergents**: These help the cleaning of clothes by lowering the surface tension of the water so that it more readily soaks into pores and soiled areas.

x. **Washing with cold water**: The major reason for using hot water for washing is that its surface tension is lower and it is a better wetting agent. But if the detergent lowers the surface tension, the heating may be unnecessary.

xi. **Why bubbles are round**: The surface tension of water provides the necessary wall tension for the formation of bubbles with water. The tendency to minimize that wall tension pulls the bubbles into spherical shapes.

xii. **Surface Tension and Droplets**: Surface tension is responsible for the shape of liquid droplets. Although easily deformed, droplets of water tend to be pulled into a spherical shape by the cohesive forces of the surface layer

xiii. **Glass house leaks water inside during the starting of the rain season**, when glass roof partial wetted have poor/not surface tension of glass roof in which water leaks inside but when glass roof total wetted experience surface tension which prevent leaks of water inside the glass house

---

Factor Affect Surface Tension

i. **Nature of the liquid**

Different liquid have different surface tension, for Example, mercury has higher surface tension than water

ii. **Contamination/impurities**

Impurities in liquid lower the surface tension. The substance which lowers surface tension is called surfactants (acronym for surface active agent). Example, of surface tension lower is detergents

iii. **Temperature**

Surface tension of a liquid decreases with increase in temperature

Application of Surface Tension

i. Cleaning action of soap, e.g. detergent lower surface tension between particles of closes and dirty

ii. Mosquitoes normally lay their eggs in water. When small amount of oil is poured on the water, it lower the surface tension which results sinking of eggs

iii. Surfactants are also used to make emulsion of two liquids like oil and water

iv. It used in extraction of impurities in laboratory

v. Hot soup has lower surface tension as a result soup spread over a large area of the tongue, hence hot soup is tastier that cold one

Adhesion and Cohesion

As we learnt that particle are bonded by force of attraction called intermolecular force

Intermolecular Force

Defn: intermolecular force is force of attraction or repulsion between particles of matter (atom or molecules)

Types of Intermolecular Force

There are two include

i. Cohesive force

ii. Adhesive force

Cohesion

Defn: cohesion force is the force of attraction between the molecules of the same kind. For Example, water and water molecule

Adhesion

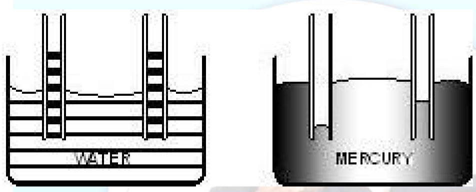
Defn: adhesion is the force of attraction between the molecules of the different substance. For Example, water and glass molecules

Effect of Adhesion and Cohesion

i. Mercury form convex (downward) meniscus because it possess strong cohesive force than adhesive force

ii. water form concave (upward) meniscus because it possess strong adhesive force than cohesive force

Diagram



iii. Drop of water on the surface of some leaves is perfect sphere due to strong cohesive force than adhesive force

iv. Drop of mercury on the surface of different material is perfect sphere due to strong cohesive force than adhesive force

v. water spread over glass because it possess strong adhesive force than cohesive force

Diagram

Application of Adhesive and Cohesive

i. Adhesive Used to stick two different objects. For Example, using glue or tape

ii. Plant use the cohesive of tissue to repair damage

iii. Ink stick on paper

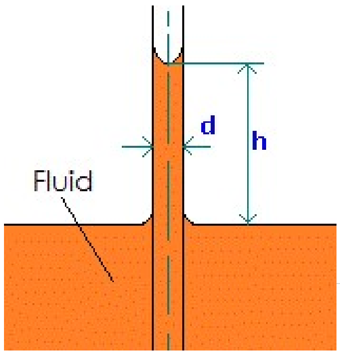
iv. Transport of water in plant and animal due to adhesive force

v. Adhesive is the source of friction

Capillarity

Defn: capillarity is the rise or fall of liquid in nallow tube. A tube with a very hole (bore) is called capillary tube

Diagram:

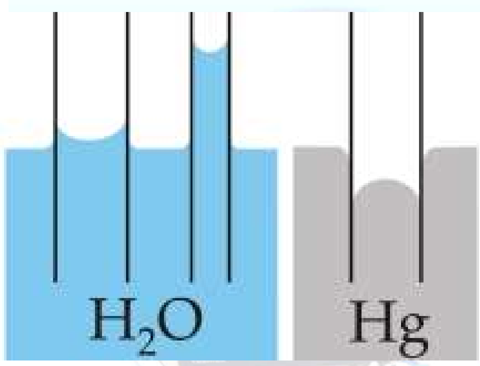


Nb:

i. When you dip a capillary tube in water , the water rise due to greater adhesive force

ii. When you dip a capillary tube in mercury, the mercury fall due to greater cohesive force

Diagram



iii. The greater adhesive and cohesive the greater the capillarity action

Application of Capillarity

i. The raising of oil in the wicks of lamps in the cotton threads

ii. The absorption of water by a towel

iii. Water rises in the soil because the soil is composed of fine particles

iv. It facilitates the transport of water and nutrients from the roots

v. Ink rises into the blotting paper through those fine pores

Osmosis

Defn: osmosis is the movement of a solvent from a region of low concentration to one of high concentration through a semi-permeable membrane. Consider the experiment below

i. Peal a potato

ii. Keep over salts

iii. The potato shrinks due to movement of water from potato (low concentration) to salt (high concentration)

Application of Osmosis

i. Absorption of water molecules from soil to plant

ii. Aquatic life is controlled by osmosis

iii. Filtration process

Diffusion

Defn: diffusion is the movement of particles from a region of high concentration to one of low concentration. For Example, perfume

Application of diffusion

i. Detecting harmful substance in the environment

ii. In the use of refreshers and other sprays

iii. Respiration process, oxygen diffuses into blood stream

iv. Balance concentration of water and nutrients in and out of the cells of living organisms.

TOPIC 7:

PRESSURE

Defn: pressure is the force per unit area

Mathematically:

P = F/A

Where:

P = pressure

F = force

A = surface area

Si Unit of Pressure

From: P = F/A

P = F/A = N/m^2

The SI unit is Newton per square metre (N/m^2)

Note

Some pressure is higher and lower is small to cope with this great difference, there other unity obtains from the N/m2, namely

i. Pascal (Pa)

ii. Atmosphere (atm)

iii. Millimetre of mercury (mmHg)

iv. Torre bar (bar)

Their equivalent is

i. 1Pa = $1N/m^2$

ii. 1atm = 760mmHg

iii. 1atm = $100000N/m^2$

iv. 1atm = 1bar

Pressure due to Solid

Pressure on solid depends on force applied and the surface area.

Mathematically:

P = F/A

Example,

A rectangular block weighting 250N has dimension 34cm, 25cm by 10cm. what is the greater pressure and the least (minimum) pressure it can be exerts on the ground

Data given

Maximum area, Amax = 0.25 x 0.34 = 0.058m^2

Minimum area, Amin = 0.25 x 0.1 = 0.025m^2

Weight of block, F = 250N

Maximum pressure, Pmax = ?

Minimum pressure, Pmin = ?

Solution

From: P = F/A

Maximum pressure, Pmax = ?

Note: To get maximum pressure the area must minimum

Then: Pmax = F/Amin

Pmax = 250/0.025 = 10000 N/m^2

Pmax = 10000 N/m^2

Minimum pressure, Pmin = ?

Note: To get minimum pressure the area must maximum

Then: Pmin = F/Amax

Pmin = 250/0.085 = 2941N/m^2

Pmin = 2941 N/m^2

Example,

A woman weighting 500N wear a pair of shoes with heels of area 250m^2, what is the pressure exerted on the floor by a heel of her shoes?

Data given

Area, A = 250m^2

Weight of woman, F = 500N

Pressure exerted, P = ?

Solution

From: P = F/A

Pressure exerted, P = ?

Then: P = F/A

P = 500/250 = 2 N/m^2

P = 2 N/m^2

Example, s We Experience Solid Pressure

We can prove the pressure due to solid as the following reasons

i. We experience pain discomfort when we lift a bucket of water made by thin (small area) handle

ii. Sharp edges (small area) of knife or razor cut easily than blunt knife or razor

iii. Sharps pointer (small area) of nail, screw, push pin, spear and an arrow has high penetrating power

iv. Wide wooden or concrete (large area) sleepers are placed below the railway track to prevent railway track to penetrate on ground.

v. Building are constructed with wide (large area) foundation to increase to increase surface are to prevent wall from penetrate on ground

vi. It pain full to walk bare foot on road covered with small stone (small area)

vii. Feet of elephant cannot sink into soft soil even is very heavy due to large surface area over elephant feet

viii. A tractor works on soft ground cannot sink due to large surface area (wide tyres)

ix. Duck cannot sink on soft mud due to large surface area on his webbed feet

x. Potter put some soft material on his/her head for heavy load to increase surface area

xi. The sharp fins inflict pain on an intruder body

xii. It is painful to walk barefoot on a road that is covered by pebbles

PRESSURE IN LIQUIDS

It difficult to obtain the area and force applies on that liquid, in order to solve that problem, we to derive new formula

From: $P = F/A$

But: $F = mg$, $m = \rho v$, $v = hA$

Then: $P = \rho hAg/A = \rho hg$

$$P = \rho hg$$

Note:

i. Since the gravitation force (g) is constant Pressure on liquid depends on

a/ Depth (height liquid rises)

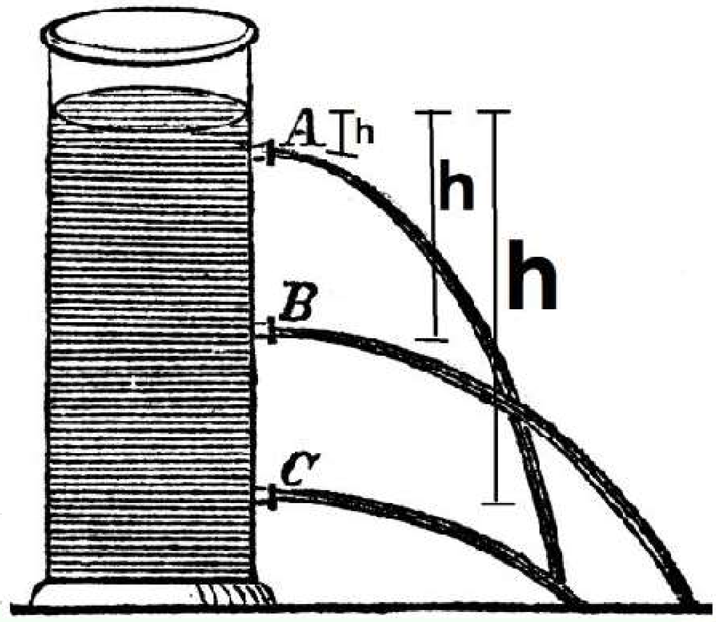
b/ Density of liquid

ii. Pressure on solid depends on

a/ Force applied (F)

b/ Surface area (A)

Consider the diagram below



At hole C water pushed in high speed due to high pressure causes by long depth than hole A and hole B, due different in height (depth)

Example, s We Experience Liquid Pressure

We can prove the pressure due to liquid as the following reasons

i. The water bubbles increase its volume if moves from bottom of the pond to the top of the pond (depth decrease)

ii. Water tanks have their outlets fixed at the bottom (large depth)

iii. A person at great height suffers from nose bleeding

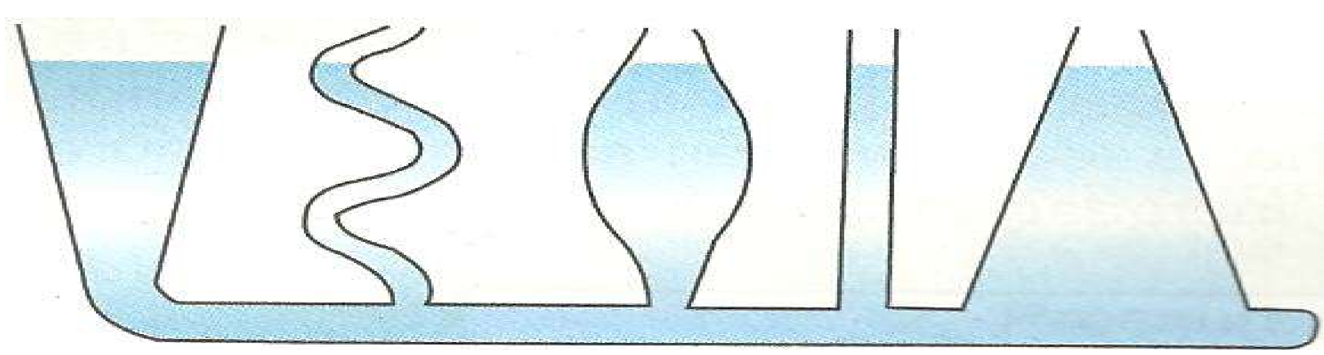
iv. A hole at the bottom of a ship is more dangerous than one near the surface

v. A dam is thicker at the bottom than at the top

Communication Vessel

Communication vessel find its own level even though each part has different shape, the liquid will be at the same level in all part

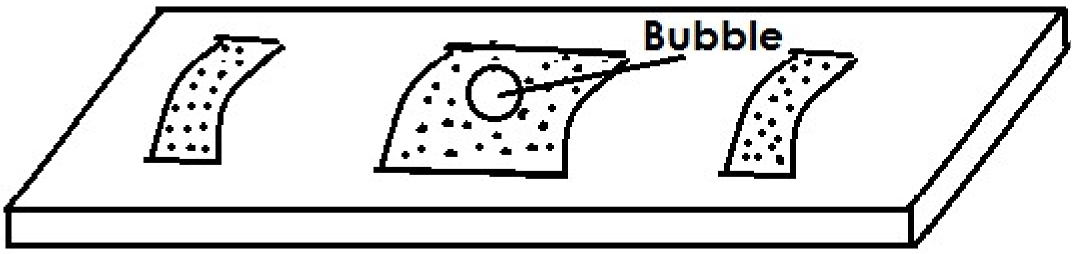
Diagram:



Spirit Level

Defn: spirit level is an instrument used to test whether a surface is horizontal or vertical. It consist of a slightly curved glass tube which is not completely filled with a liquid (yellow in colour) leaving a bubble in the tube

Diagram



Mechanism

A spirit level works on the fact that a liquid in a vessel will always find its own level.

Spirit level used by

i. Mason

ii. Carpenters

iii. Surveyors etc

Example,

What will the pressure due to column of water of height 4m?

Data given

Height, h = 4m

Density of water, $\rho = 1000kg/m^3 = 1g/cm^3$

Gravitation force, g = 10N/kg

Pressure exerted, P = ?

Solution

From: $P = \rho hg$

$P = 1000 \times 4 \times 10 = 40000$

P = 40000 N/m2

Example,

The pressure at a bottom of a well is $98000N/m^2$. How deep is the well?

Data given

Density of water, $\rho = 1000kg/m^3 = 1g/cm^3$

Gravitation force, g = 10N/kg

Pressure exerted, $P = 98000N/m^2$

Height, h = ?

Solution

From: $P = \rho hg$ - make h subject h = P/(ρg) = 98000/(1000 x 10)

h = 98000/10000 = 98

h = 98m

Example,

A cube of sides 2cm is completely submerged in water so that the bottom of the cube is at depth of 10cm. find

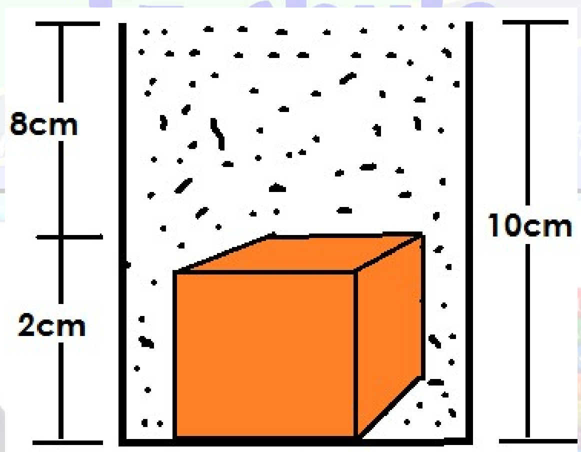
a) Different pressure between top and bottom of the cube

b) Different force between top and bottom of the cube

c) Weight of water displaced by the cube

Solution

Consider the diagram below



a) Different pressure between top and bottom of the cube, Δρ = ?

Data given

Water density, ρ = 1000kg/ m^3 = 1g/cm^3

Gravitation force, g = 10N/kg

Height at top, h1 = 8cm = 0.08m

Pressure exerted at top, P1 = ?

Height at top, h1 = 8cm = 0.1m

Pressure exerted at bottom, P2 = ?

Solution

Δρ = P2 – P1

But: P1 = ρxh1xg and P2 = ρxh2xg

Then: Δρ = P2 – P1 = (ρxh2xg - ρxh1xg)

Δρ = ρg(h2 - h1) = 1000 x 10 x (0.1 – 0.08)

Δρ = 1000 x 10 x 0.02 = 200

ΔP = 200 N/m2

b) Different force between top and bottom of the cube, Δf = ?

From: $\Delta f = \Delta P \times \Delta A$

Where: ΔA = area between top and bottom
But: A = 2cm x 2cm = 4cm2 = 0.000m2
Then: $\Delta f = \Delta P \times \Delta A = 200 \times 0.0004 = 0.08$
Δf = 0.08N

c) Weight of water displaced, w = ?

But: due to Archimedes principle volume of water displace is equal to volume of cube while due to flotation law weight of water displace is equal to weight of cube

Then: volume of water (cube) = 8cm3

But: 1g = 1cm3 = 0.01N/g

Then: 1cm3 = 0.01N/g

8cm3 = w?

w = 8 x 0.01 = 0.08N

w = 0.08N

Example

Calculate the pressure exerted on a diver at a depth of 20m below the surface of water in a sea

Data given

Height, h = 20m

Density of water, ρ = 1000kg/ m3 = 1g/cm3

Gravitation force, g = 10N/kg

Pressure exerted, P = ?

Solution

From: $P = \rho hg$

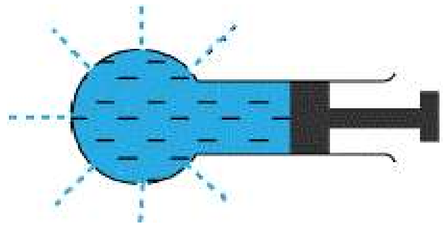
P = 1000 x 20 x 10 = 200000

P = 200000 Pa

Pascal's Principle

Consider the diagram below

Diagram:

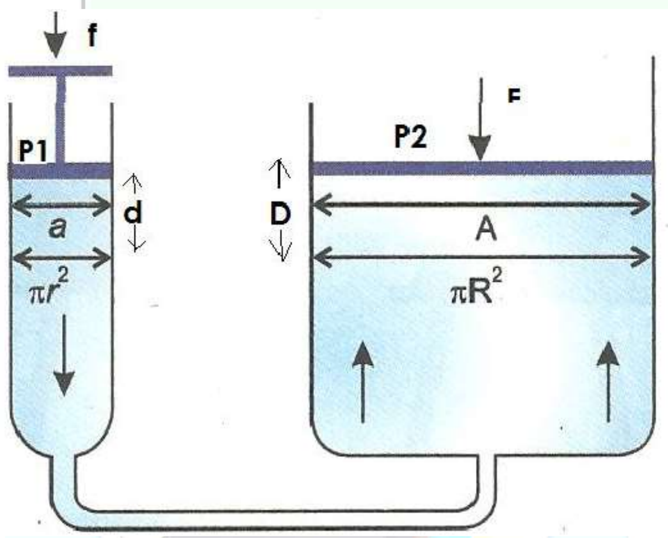


When the container with holes contain water compressed, water will come out with equal force in all directions due to equal force of water come out, it concluded by the Pascal which say that

"Any external pressure to the surface of an enclosed liquid will be transmitted equally throughout the liquid"

Hydraulic Press

Hydraulic press uses a principle of Pascal to multiply an applied effort using the pressure of a liquid or gas. This allows the lifting of a heavy load by applying little effort



According to the Pascal principle pressure will transmitted equally through the fluid (oil)

Then: $P2 = P2$

But: $P1 = f/a$

$P1 = F/A$

Then: $F/A = f/a$

$F/A = f/a$

But: $A = \pi R^2$

$a = \pi r^2$

$F/\pi R^2 = f/\pi r^2$

$\mathbf{F/R2 = f/r^2}$

But: $R^2 = (D/2)^2 = D2/4$

$r^2 = (d/2)^2 = d2/4$

$F/R^2 = f/r^2$

$F/(D^2/4) = f/(d^2/4)$

$F/D^2 = f/d^2$

From: principle of moment

Anticlockwise moment = clockwise moment
F x D = f x d
Since: f = p2 x a
F = p1 x A
But: p1 = p2 = p
p x A x D = p x a x d - divide by p
Therefore: AD = ad
AD = ad

Example

In a hydraulic press the area of the piston to which the effort is applied is 5cm2. If the press can raise a weight of 2KN when an effort of 400N is applied, what is the area of the piston under the load?

Data given

Small Piston Force, f =200N

Large Piston Force, F = 2KN = 2000N

Small piston area, a = 5cm^2

Large piston area, A = ?

Solution:

From: F/A = f/a – make A subject

A = (F x a)/f

A = (2000 x 5)/400 = 10000/400 = 25cm^2

A = 25cm^2

Example,

Hydraulic press has a large circular piston of diameter 0.7m and circular piston to which the effort is applied of diameter 0.21m. A force of 300N is exerted on small piston. Find the force required to lift a heavy load

Data given

Small piston diameter, d = 0.21m

Large piston diameter, D = 0.7m

Small Piston Force, f =300N

Large Piston Force, F = ?

Solution:

From: F/D^2 = f/d^2 – make F subject

F = (D^2 x f)/d^2

F = (0.7 x 0.7 x 300)/(0.21 x 0.21) = 147/0.0441

F = 147/0.0441 = 3333.33

F = 3333.33N

Example,

Piston of hydraulic press has their areas given as 0.0003m2 and 0.02m2 respectively. The 120N is required to push down the small piston, find the force required to push large piston

Small Piston Force, f =120N

Small piston area, a = 0.0003m2

Large piston area, A = 0.02m2

Large Piston Force, F = ?

Solution:

From: F/A = f/a – make F subject

F = (f x A)/a

F = (120 x 0.02)/0.0003 = 2.4/0.0003 = 8000

F = 8000N

Example,

A hydraulic lift has piston with areas of 0.02m2 and 0.1m2. A car with a weight of 5000N sits on platform mounted on the large piston

a) How much force applied on small piston

b) How for must small piston fall when large piston raise the car at 0.3m?

Data given

Small piston area, a = $0.02m^2$

Large piston area, A = $0.1m^2$

Large Piston Force, F = 5000N

Large Piston distance moved, d =0.3m

Small Piston distance moved, d =?

Small Piston Force, f =?

Solution:

a) Small Piston Force, f =?

From: F/A = f/a – make f subject

f = (F x a)/A

f = (5000 x 0.1)/0.02 = 500/0.02 = 10000

f = 10000N

b) Small Piston distance moved, d =?

From: AD = ad – make d subject

d = (A x D)/a

d = (0.1 x 0.3)/0.02 = 0.003/0.02 = 0.15

d = 0.15m

Example,

A car of mass 8000kg, one of its tyres having an area of 50cm2 in contact with ground. Find the pressure of the four wheel car exerted on ground by the car

Data given

Area of one tire, A = 50cm2
Area of four tires, at = 4xA = 200cm2= 0.02m2
Mass of car, m = 8000kg
Gravitation force, g = 10N/kg
Weight of car, F = mg = 80000N
Pressure exerted, P = ?

Solution

From: P = F/A

Pressure exerted, P = ?

Then: P = F/A

P = 80000/0.02 = 4000000 N/m^2

P = 4000000 N/m^2

Uses of Hydraulic Press in Daily Life

i. It lifts heavy loads

ii. In ginneries to compress a lump of cotton into small bales

iii. In industries to form car bodies into the required shapes

iv. It used to make hydraulic brakes

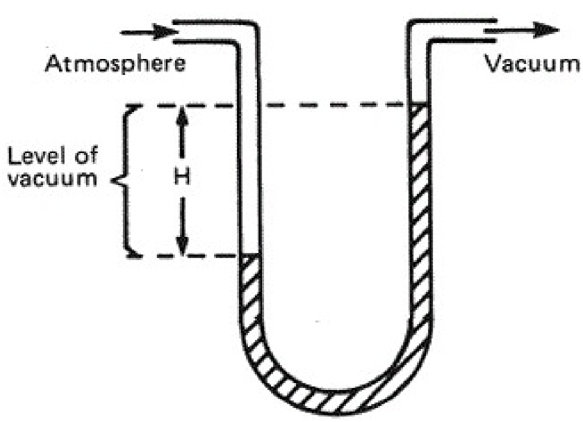
v. It used to make hydraulic jack

vi. Extraction of oil from the oil seed

Manometer

Defn: manometer is device for measuring fluid pressure

Diagram:



It is u shaped glass tube, open at both ends and holding liquid (water/mercury)

Mechanism of Manometer

One limb is connected to the fluid supply and the other limb is opened to the atmosphere. The pressure exerts on fluid causes level of water or mercury on manometer to rise at a certain height as shown in the diagram above. The height rise by water or mercury is called liquid head. The pressure is calculate from

P = ρhg

Where:

P = pressure of fluid

ρ = density of water/mercury

g = acceleration due to gravity

Atmospheric Pressure

Defn: Atmospheric pressure is the air pressure due to the force (gravity) per unit area of the air molecules

How Gas Exerts Pressure?

Gas exerts pressure on wall of its container by the movement of its particles due to kinetic energy hence momentum increased which produce high force/pressure, which they have frequencies striking the wall, creates pressure on the wall of its container

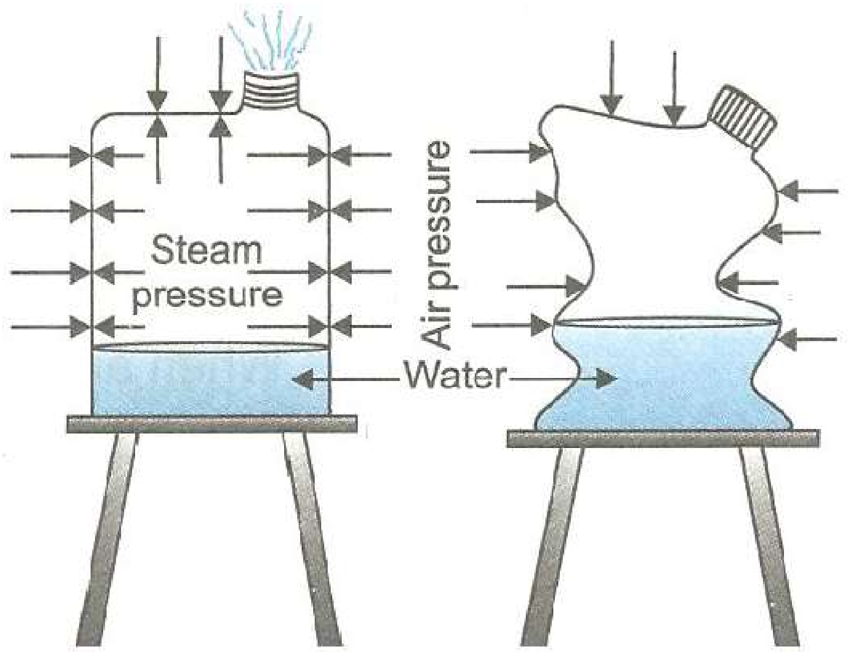
Experiment Demonstrate Atmospheric Pressure

i. If there is no air between the card and water in the glass tumbler full filled with water when be upside down the card holds on the tumbler due to the existence of atmosphere

ii. When the bottle poured by hot water and cork the bottle tightly and allowed to cool , the bottle crushed due to atmospheric pressure

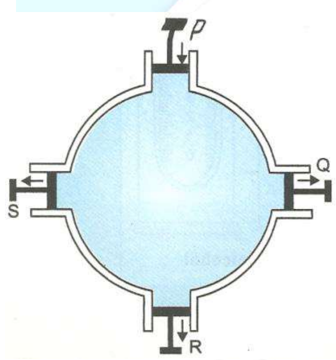
Mechanism

In vacuum (no air) there is no pressure. When bottle has hot water and vapour water particle are apart and when condensed by cooled it leaving partial vacuum inside the bottle which tend to cause bottle to crush



iii. When air pumped out of the Magdeburg hemispheres a vacuum is created inside the hemispheres and the pressure of the atmosphere exert a greater force on the surface of the sphere. Hence it will be found impossible to pull the hemispheres apart. If air is allowed to enter into the hemisphere it becomes easily to pull the hemisphere apart

Diagram:



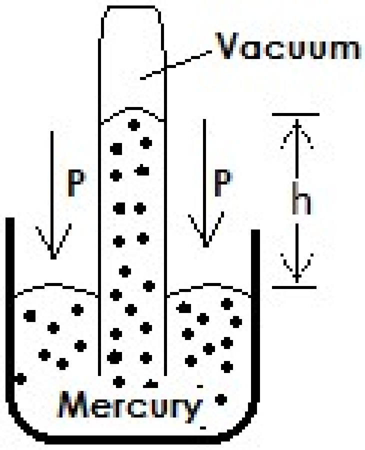
Barometer

Defn: Barometer is an instrument used to measure atmospheric pressure

Simple Barometer

Simple Barometer is the most fundamental of the other types of barometer. The barometer liquid used is mercury

Diagram



The atmospheric pressure is given by:

$P = \rho hg$

Where:

P = atmospheric pressure

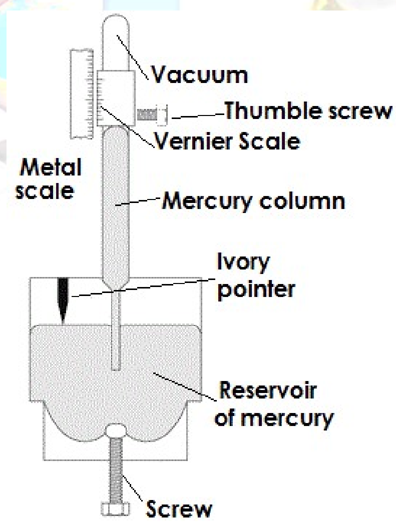
h = height raised by mercury

ρ = density of mercury

Fortin Barometer

Fortin Barometer is the modified simple barometer. It is a very accurate type of mercury barometer for measuring air pressure. It perform function like simple barometer

Diagram:



i. Vertical tube (mercury column) contain mercury with a vacuum above it

ii. Reservoir bag at the base as a reservoir of mercury

iii. ivory pointer with a sharp point at the bottom which correspond to the zero error

iv. Metal and movable Vernier scale for reading the height of the mercury level accurately

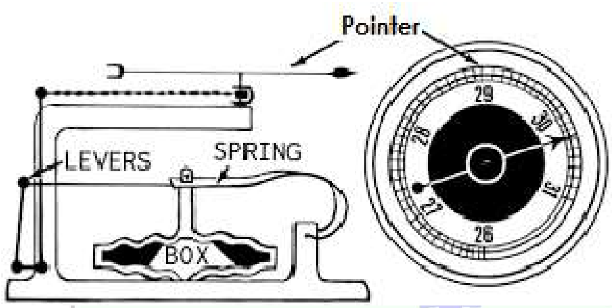
Question:

i. Why barometer uses mercury instead of water?

Aneroid Barometer

Aneroid Barometer does not use any liquid. It consists of an evacuated metal box connecting a system of levers and a pointer. It is compact and portable

Diagram:



Mechanism

When the atmospheric pressure increase, the centre of the partially evacuated box moves inwards and this small movement is magnified by a system of levers. The chain attached to the end lever moved the pointer. The large spring prevents the box from collapsing

Disadvantage of using forting barometer

i. Mercury is expensive

ii. Aneroid barometer is portable

iii. Forting barometer must be mounted in a vertical position

Nb:

Aneroid barometer which used in aircraft to show the height at which the plane is flying is called Altimeter

Application of Atmospheric Pressure

There are a variety of common and even simple device that make use of the atmospheric pressure to work. There include

i. Siphon

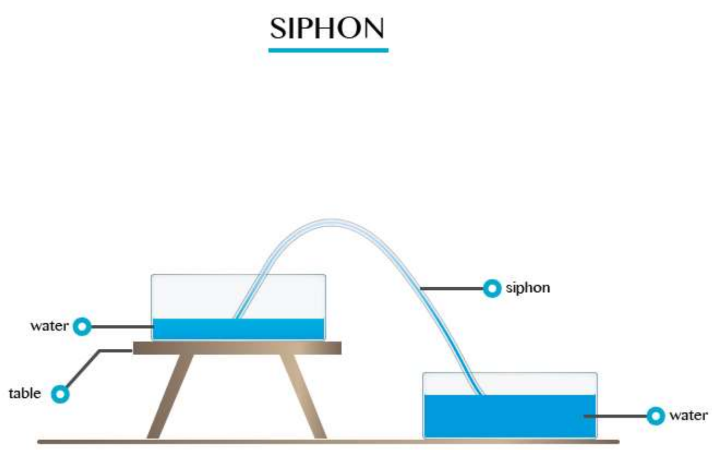
ii. Lift pump
iii. Force pump
iv. Syringe
v. Bicycle pump

Siphon

Defn: Siphon is a tube or pipe used to transfer liquid from one to another container by using atmospheric pressure to make liquid flow

Mechanism

Consider the diagram below



Nb:

Siphon can lift water about 10m below the ground

Application of Siphon

Siphon is applied in many areas and devices that we use every day include

i. Chain and ball flushing tank

ii. Automatic flushing tank

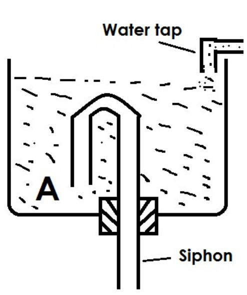
iii. A siphon cup is a reservoir attached to a gun

iv. It is used in some drainage system to drain water to another point

Automatic Flushing Tank

It is used in special rain gauge called siphon rain gauge which are able to automatically drain out excess water

Diagram:



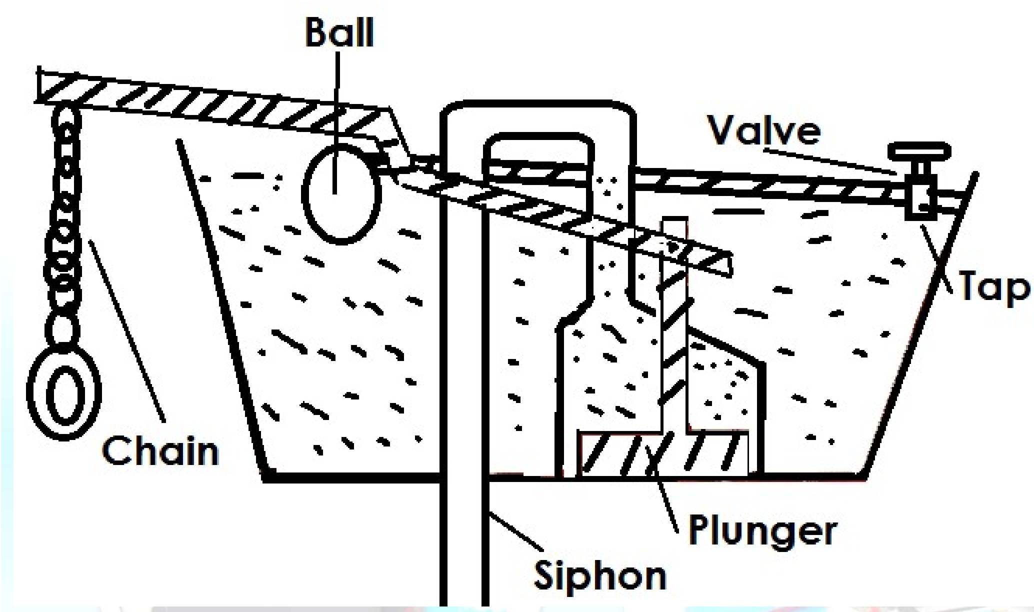
Mechanism

Water flows slowly from the tap into the tank, raises above the top of the siphon tube to complete the height, h. The siphon flushes water until it reaches the bottom of the shorten limb at A. this action is repeated after every few minutes. This kind of appliance is used in places which have to be kept clean continually. E.g. urinating places

Chain and Ball Flushing Tank

It consist ball associated with incomplete of height of water which tend to create pressure which flushes water

Diagram:



Mechanism

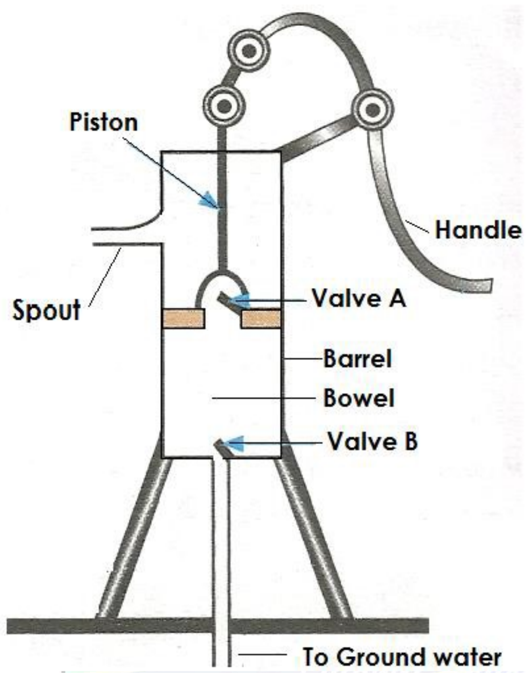
As water increase, the ball float (moves up) until it reaches at the top which close the valve tap to prevent completes of the height. The siphon action is start when the chain is pulled to complete the height, the chain pulls the plunger pushes water into the bend of the siphon which complete the height which flashes water

Lift Pump

Lift pump is used to raise water from underground water sources. Lift pump is a pump that used to lift the liquid rather than force liquid up

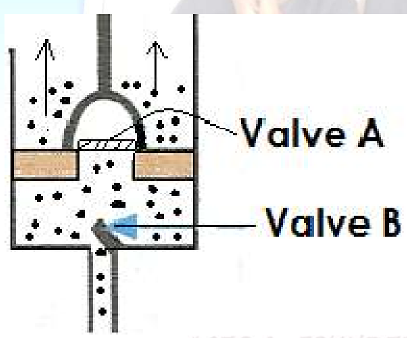
Diagram:

Mechanism



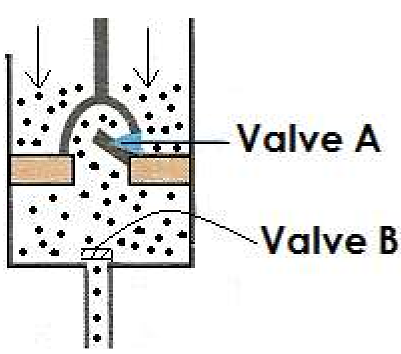
When a piston is raised (upstroke) valve A closed and valve B opens, which create partial vacuum between valve A and the piston and the atmospheric pressure pushes water up the pipe into the bowel.

Diagram:



When the piston is lowered (down stroke) valve A open and valve B closed due to the weight of water, the valve A allow water to rise over barrel. Repetition of stokes the water can collected on spout

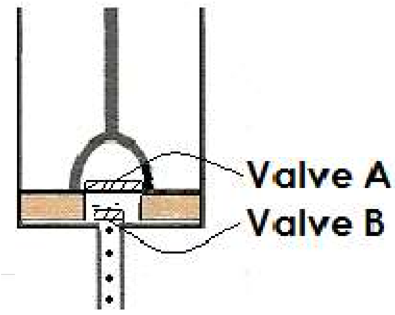
Diagram:



Nb:

The lift pump starts with the piston at the bottom of the empty cylinder and both valves closed

Diagram:



Limitation of Lift Pump

i. It can lift water up to height of 10m

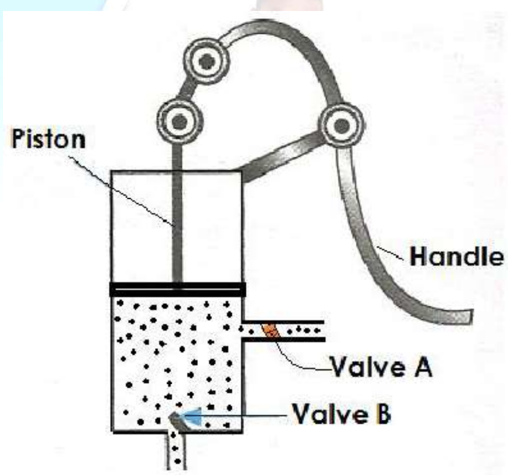
ii. Few strokes are required

Force Pump

Force pump is a modified of lift pump

Mechanism

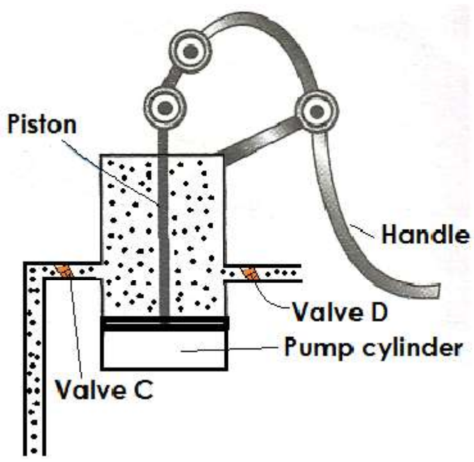
Diagram



During up stoke of piston, a partial vacuum (low pressure) is formed between valve A and the piston. This cause valve A to close and pressure forces water into the barrel through valve B. during down stroke water is compressed, valve B closes and valve A opens. As a result water is forced by piston along the spout

Mechanism

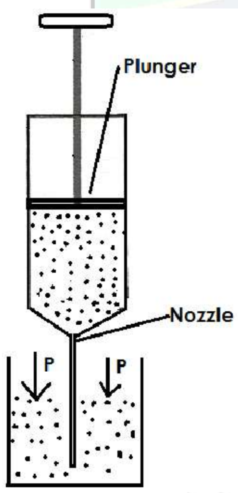
Diagram



During upstroke of piston the valve C closes and the valve D open, this force the water in the cylinder out of the pump. During down stroke the valve C open and valve D closes due to the low pressure created between piston and the valve C, this tend to draw water from the external source into the pump cylinder

Syringe

Diagram:



P = atmospheric pressure

Mechanism

When the plunger is withdrawn a partial vacuum is formed in the barrel, atmospheric pressure pushes water through the nozzle up into the barrel. Water will be forced out when the plunger is pushed down again

Uses of the Syringe

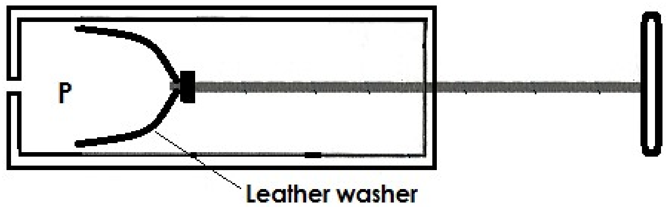
i. Used for medical purpose e.g. Injecting vaccines

ii. They are used to measure liquids and gases in the laboratory

iii. Used to apply certain compound such as glue or lubricant

Bicycle Pump

Diagram:



Mechanism

When the piston is pushes forward, air in the space p is compressed; the pressure pushes back the leather washer on the wall of barrel, taking an air tight seal, the tyres valve opens and air is forced into tyres. When the piston is pulled back, the tyres valve closes and a low pressure is created in the space, P. Air at atmospheric pressure forced its way past the leather washer and fill space p with air. In this way the tube

Topic 8

WORK, ENERGY AND POWER

WORK

Defn: Work is the forces acts on a body and the moves in the direction of force

Or

Defn: Work is the product between force applied and the distance in the same direction

Mathematically:

w.d = F x d

SI unit of work

SI unit of work is Joule abbreviated as J

Where:

w.d = work done

F = force applied

d = distance in the same direction

Joule

Defn: one joule of work done is a force of 1N moves an object through a distance of 1m in the same direction

Equivalent Unit of Work

1Nm = 1Joule = Kgm2S-2 = 0.001KJ

Nb:

i. If there not force no work done, F = 0N

w.d = F x d = 0 x d = 0J

ii. If there not force no distance in the same direction, d = 0m

w.d = F x d = F x 0 = 0J

iii. When the body moves in the opposite direction with the force applied there are work is done by the object

iv. When the body moves in the same direction with the force applied there are work is done by the force applied

Example, s of Phenomenal

i. When the person push a wall, d = 0m. there no work done

ii. When you carry a load on your head or arm, d = 0m. there no work done

iii. When a farmer carrying a hole, d = 0m. there no work done

iv. Holding load, d = 0m. there no work done

v. Lift jerry can, d > 0m. work is done

vi. Lift a pen, d > 0m. work is done

vii. Lift a cup, d > 0m. work is done

Example,

A sack of maize which weights 800N is lifted to height of 2m. What work done against gravity

Data given

Wight, w = 800N

Distance, d = 2m

Work done, w.d = ?

Solution

From: w.d = F x d

w.d = 800 x 2

w.d = 1600J

Example,

How much work is done to lift a 7kg object a distance of 2m and hen hold it at that height for 10s

Data given

Mass, m = 7kg

Force of gravity, g = 10N/kg

Wight, w = (7 x 10)N = 70N

Distance, d = 2m

Work done, w.d = ?

Solution

From: w.d = F x d

w.d = 70 x 2

w.d = 140J

therefore work done used to lift 7kg about 2m in the same direction is 140J and the work done used to hold (d = 0m) for 10s is 0J

Example,

A force of 80N pulls a box along a smooth and level ground a distance of 5m. Calculate the work done by force.

Data given

Wight, w = 80N

Distance, d = 5m

Work done, w.d = ?

Solution

From: w.d = F x d

w.d = 80 x 5

w.d = 400J

Energy

Defn: energy is an ability of doing work. SI unit of energy is Joule like work.

Forms of Energy

Energy can be exists in various forms, include

i. Chemical energy

ii. Heat energy

iii. Electromagnetic energy

iv. Sound energy

v. Electric energy

vi. Nuclear energy

Chemical Energy

It is the energy stored in the food and other fuels. Human get energy from the food that they eat

Thermal/Heat Energy

It can obtained at fire places

Electromagnetic Energy

It is associated with movement (acceleration) of electric charge. Include;

i. Infrared radiation

ii. Light energy

iii. Ultraviolet radiation

iv. Solar energy etc

Nb:

Radiant light is the most common form of electromagnetic energy

Sound Energy

It is the energy transfers in form of waves. Microphone converts sound energy to electrical energy. Loud speaker convert electrical energy to sound energy

Electric Energy

It is due to the movement of charge in a current and also it can produce field whether attract or repulsion when two wire are near or far apart each other.

Nuclear Energy

Nuclear energy is the energy from the weak and strong nuclear force. It can produce by

i. Nuclear fission (splitting)

ii. Nuclear fusion (joining)

iii. Radioactive decay

Nb:

i. Solar energy obtained from the sun by use of solar cells, also is known as radiant energy

ii. sources of energy can be divided into non-renewable energy and renewable energy

Renewable/Sustainable Energy

Defn: renewable is the energy that can be replaced within a short period of time. For Example, wind energy, thermal energy etc

Non Renewable Energy

Defn: renewable is the energy that cannot be replaced within a short period of time. For Example, natural gases, biomass etc

Types of Energy

Energy they can be in motion or in position. Example, electric energy is in moving and chemical energy is not in moving (on position). So we have about two main types

i. Kinetic energy

ii. Potential energy

Kinetic Energy

Defn: kinetic energy is the energy due to motion possessed by a body. For Example, of kinetic energy is

i. Wind energy

ii. Water moving

iii. Ocean Waves

iv. Ocean Tides

v. Moving machines

vi. Falling bodies

Mathematically:

$$k.e = 1/2mv^2$$

Example,

An object has a mass of 5kg. What is its kinetic energy if its speed is (a) 5m/s (b) 10m/s

Data given

Mass, 5kg

Speed, $v_a = 5m/s$

Speed, $v_b = 10m/s$

Solution

(a) Kinetic energy, k.e = ?

From: $k.e = 1/2mv^2$

k.e = 1/2 x 5 x 5^2

k.e = 1/2 x 5 x 2^5

k.e = 22.5J

(b) Kinetic energy, k.e = ? From: k.e = 1/2mv^2

k.e = 12 x 5 x 102

k.e = 12 x 5 x 100

k.e = 250J

Example,

What is the kinetic energy of a 12g bullet travelling at 320m/s?

Data given

Mass, 12g = 0.12kg

Speed, v = 320m/s

Kinetic energy, k.e = ?

Solution

From: k.e = 1/2mv^2

k.e = 1/2 x 0.12 x 320^2

k.e = 6144J

Example,

Anna has a mass of 80kg. If she runs at a speed of 10m/s. calculate her kinetic energy

Data given

Mass, m = 80kg

Speed, v = 10m/s

Kinetic energy, k.e = ?

Solution

From: k.e = 1/2mv^2

k.e = 1/2 x 80 x 10^2

k.e = 4000J

Potential Energy

Defn: potential energy is the energy due to position possessed by a body. For Example, of potential energy

i. Energy stored in food

ii. Gravitational potential energy etc

Mathematically:

p.e = mgh

Example,

A stone of 2kg falls from a height of 25m above the ground. Calculate potential possessed by the stone

Data given

Mass, m = 2kg

Height, h = 25m

Gravitational force, g = 10N/kg

Potential energy, p.e = ?

Solution

From: p.e = mgh

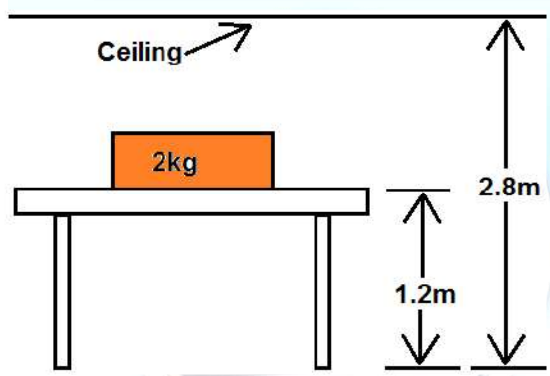
p.e = mgh = 2 x 25 x 10

p.e = 2 x 25 x 10

p.e = 500J

Example,

A 2kg object is at rest on a table 1.2m above the floor. The ceiling in the room is 2.8m above the floor



What is the potential energy of the object relative to?

{a} Top of the table

{b} The floor

{c} The ceiling

Data given

Mass, m = 2kg

Height of object relative to ceiling, h1 = -1.6m

Height of object relative to top of table, h2 = 0m

Height of object relative to table, h3 = 1.2m

Gravitational force, g = 9.8N/kg

Potential energy of object relative to top of table, p.e1 = ?

Potential energy of object relative to ceiling, p.e2 = ?

Potential energy of object relative to table, p.e3 = ?

Solution

From: p.e = mgh

{a} p.e1 = ?

p.e1 = mgh = 2 x 0 x 9.8

p.e1 = 0J
{b} p.e2 = ?
p.e2 = mgh = 2 x -1.6 x 9.8
p.e2 = -31.36J
NB: negative means p.e is below the ceiling

{c} p.e3 = ?

p.e = mgh = 2 x 1.2 x 9.8

p.e = 23.52J

Transformation of Energy

Energy can be changes from one form to another by the device known as **transducer**

Transducer

Defn: transducer is a device used to transform energy from one to another form. For Example,

i. Battery convert chemical energy to electrical energy

ii. Generator convert mechanical energy to electrical energy

iii. A motor convert electrical energy to mechanical energy

iv. A microphone convert electrical energy to sound energy

v. Solar panel convert solar energy to electrical energy

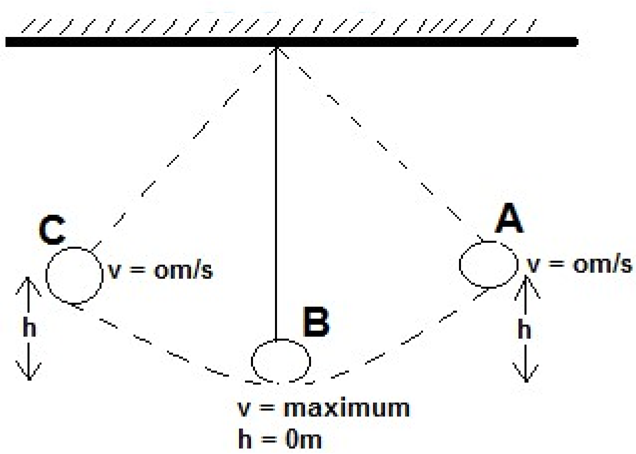
vi. Heater convert electrical energy to heat energy

Principle of Conservation of Energy

The law of conversation of energy states that

"***Energy can neither be created nor destroyed but can be transferred from one form to another***"

Consider the diagram below



At point A and C

Velocity, v = o. K.e = 0J

Height, h = maximum. P.emax = mgh

Since: energy cannot destroyed

E = k.e + p.e

E = 0 + mgh

E = mgh

Where:

E = total energy

k.e = kinetic energy

p.e = potential energy

At point B

Velocity, v = maximum. K.emax = $\mathbf{1/2mv^2}$

Height, h =0. P.e = 0mgh

Since: energy cannot destroyed

E = k.e + p.e

E = $\mathbf{1/2mv^2}$ + 0

E = $\mathbf{1/2mv^2}$

Where:

E = total energy

k.e = kinetic energy

p.e = potential energy

NB:

At any point the total energy (mechanical energy) is equal to the sum of kinetic energy and potential energy

E = p.e + k.e

Power

Defn: power is the rate of doing work or power is the rate at which energy is consumed.
Its SI unit is Watt (w)

Mathematically:

P = w.d/t

or

P = E/t

Unit Equivalent

1W = 1J/s

1h.p = 750W or 746W

1KW = 1000W
1MW = 1000000W
Where:
h.p = horse power used by engineering
KW = kilowatt
MW = megawatt
Example,
A pump raises 100kg of water through a height of 30m in 10s. What is the power developed by the pump
Data given

Mass, m = 100kg

Height, h = 30m

Time taken, t = 10s

Gravitation force, g = 10N/kg

Power, p = ?

Solution

From: P = w.d/t

But: W.d = Fxd and F = mg

Then: P = mgd/t

P = (100x10x30)/10 = 30000/10 = 3000W

P = 3000W

Example,

How much power is required to accelerate a 1000kg car from rest to 26.7m/s in 8s?

Data given

Mass, m = 1000kg

Initial velocity, u = 0m/s

Final velocity, v = 26.7m/s

Time taken, t = 8s

Power, p = ?

Solution

From: P = E/t = k.e/t = 12mv2/t

P = (12 x1000 x 26.72)/8

P = (12 x1000 x 26.72)/8

P = 44500W

Example,

A 50kg girl runs up a staircase of 50 steps each step is 15cm in height in 5s. Find

i. Work done against gravity by the girl

ii. Power she use to run

Data given

Mass, m = 50kg

Steps, n = 50

Height of each step, h = 15cm = 0.015m

Total Height, d = n x s = 50 x 0.015m

Total Height, d = 0.75m

Time taken, t = 10s

Gravitation force, g = 10N/kg

Work done, w.d = ?

Power, p = ?

Solution

i. Work done, w.d = ?

From: w.d = F x d = 0.75 x 50

w.d = 0.75 x 50 = 37.5

w.d = 37.5J

ii. Power, p = ?

Then: P = w.d/t

P = (37.5)/5

P = 7.5W

Topic 9
LIGHT

Defn: light is an invisible form of energy that causes the sensation of vision in us through eyes

Sources of Light

Sources of light is the original or initial of light in which the light are comes from whether natural or artificial

Types of Sources of Light

i. Natural sources of light. Example, sun, star and lighting

ii. Artificial sources of light. For Example, torch, candle, kerosene lamp etc

Properties of Light

i. Light radiates (spread out) from its source

ii. Light travels in straight lines

iii. Light transfers energy. Object gain energy when they absorb light. For Example, solar cells(panel)

iv. Light travels in vacuum

v. Light travels at the fasters speed, about 300,000,000m/s

NB:

i. All objects which give out its own light is called luminous object. e.g. star, sun, torch, candle, electric bulb etc

ii. All objects that do not emit their own light instead became visible when they reflect light from another source is called non luminous objects. E.g. moon

iii. All objects that emit light as a result of being heated are called incandescent object. e.g. light bulb, fire flame, candle flame etc

iv. The spreading of light from its source to the environment in straight lines is referred as rectilinear propagation of light

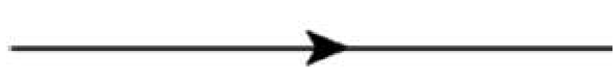
Propagation of Light

Since a light travels in a straight line, the path travel and by a light is called Ray. More than one rays is called beam

Ray

Defn: Ray is the path travel by a light. Ray is represented in a diagram by full straight line with an arrow to show the direction of light.

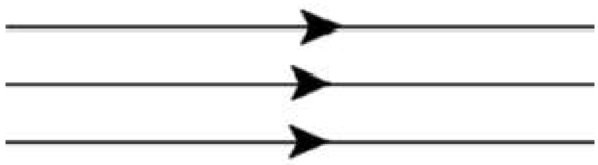
Diagram:



Beam

Defn: Beam is the collection of rays

Diagram:



Types of Ray

The beam of light is transfer in straight line which can be

i. Parallel rays

ii. Converging rays

iii. Diverging rays

Parallel Rays

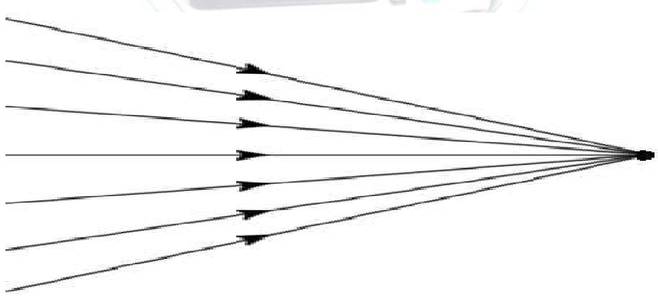
Defn: Parallel ray is the collection of rays which are perpendicular to each other and can never cross each other

Diagram

Converging Rays

Defn: Converging ray is the collection of rays to one point

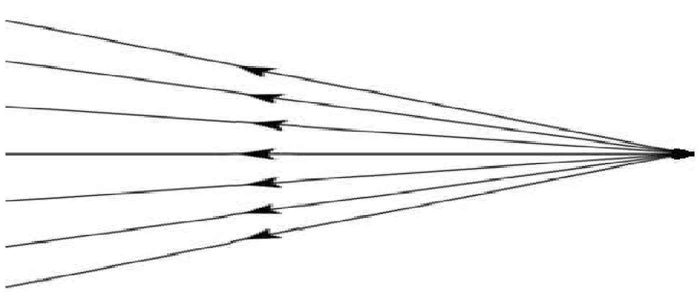
Diagram



Diverging Rays

Defn: Diverging rays is the spread out of rays from one point

Diagram



Transmission of Light

Light travel in the different material, for Example, it can travel from air to vacuum. But sometimes it can undergo obstacles when they travel from one object to another. This object are grouped as

i. Opaque object/material/substance

ii. Translucent object/material/substance

iii. Transparent object/material/substance

Opaque Object

Defn: Opaque object is the object which do not allow light to pass through them. For Example, stone, wood, concrete walls, books etc

Translucent Object

Defn: Translucent object is the object which allow small amount of light to pass through them. For Example, oiled paper, tinted glass, some plastic materials etc

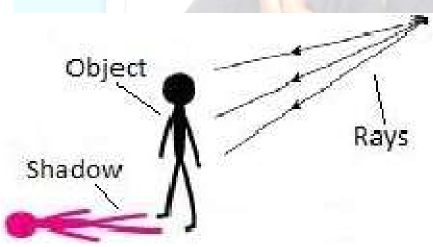
Transparent Object

Defn: Transparent object is the object which allows all light to pass through them. For Example, glass, pure water, air etc

Shadow

Defn: shadow is the dark area behind the opaque body when light pass through the opaque bodies.

Diagram



Types of Shadow

We have about two types of shadow include

i. Umbra shadow

ii. Penumbra shadow

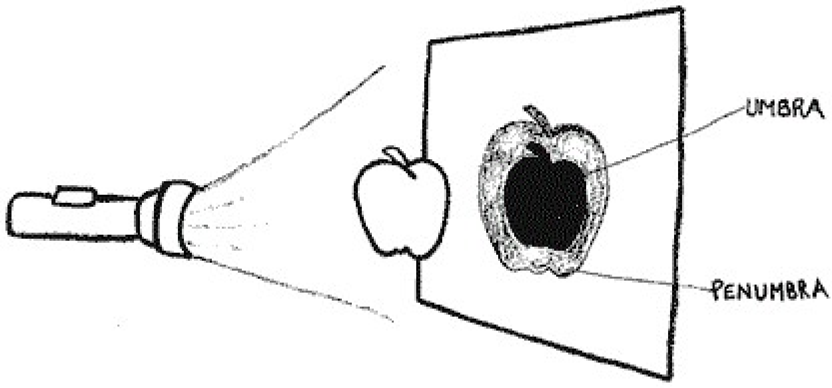
Umbra Shadow

Defn: Umbra shadow is the total shadow formed behind the opaque bodies. It receives no light at all from the source.

Penumbra Shadow

Defn: Penumbra shadow is the partial shadow formed behind the opaque bodies. It receives some light from the source

Diagram



NB:

When source of light are small than opaque only umbra are formed

Eclipse

Defn: eclipse is the shading or shading of one heavenly in the shadow of another.

Types of Eclipse

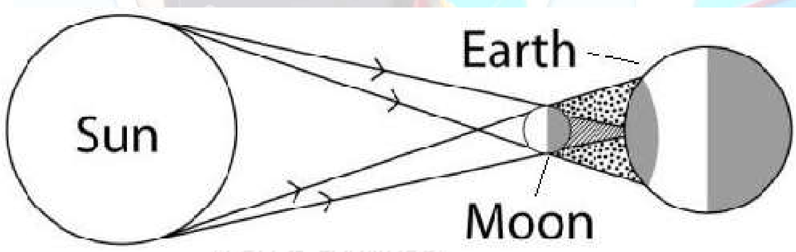
i. Solar eclipse

ii. Lunar eclipse

Solar Eclipse

Defn: Solar eclipse is the kind of eclipse in which the moon is between sun and earth. Always occurs during the day.

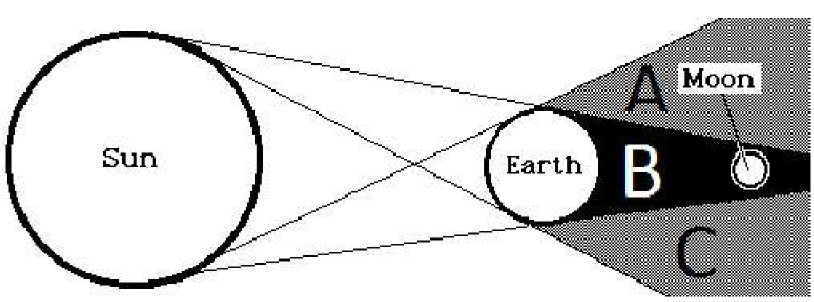
Diagram:



Lunar Eclipse

Defn: Lunar eclipse is the kind of eclipse in which the earth is between sun and moon**.**

Diagram:



From The Diagram Above

i. At point A and C: the moon is less bright but not eclipse

ii. At point B: lunar eclipse occur the moon did not light during the night

Reflection of Light

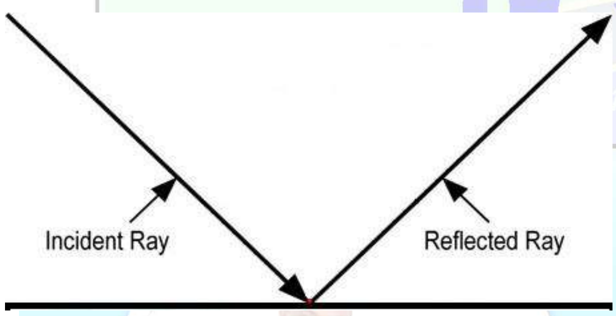
Defn: reflection of light is the throwing back of rays of light when they encounter an obstacle in their path **or** reflection of light is the is the bounce back of light

Terms Used

i. **Reflected ray** are those that are not transmitted or absorbed but bounced back when they encounter an obstacle

ii. **Incident ray** is the ray of light which strikes the shiny surface

Diagram



Types of Reflection

There are two types of reflection include

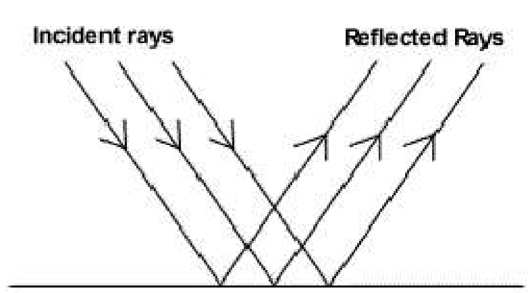
i. Regular reflection

ii. Diffuse reflection

Regular Reflection

Defn: Regular reflection is the reflection where by all reflected ray reflected in one direction. The ray is in parallel to each other. Occurs at smooth surface

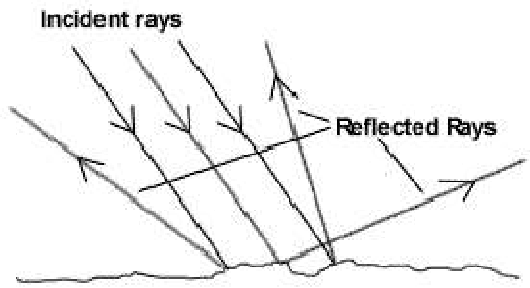
Diagram



Diffuse Reflection

Defn: Diffuse reflection is the reflection where by all reflected ray reflected random or in different direction. Occurs at rough surface

Diagram

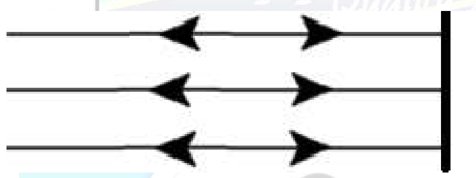


NB:

i. We see our image clear in plane mirror as a result of regular reflection.

ii. If light falls in polished surface at right angle reflect back into the air on the same pass

Diagram:



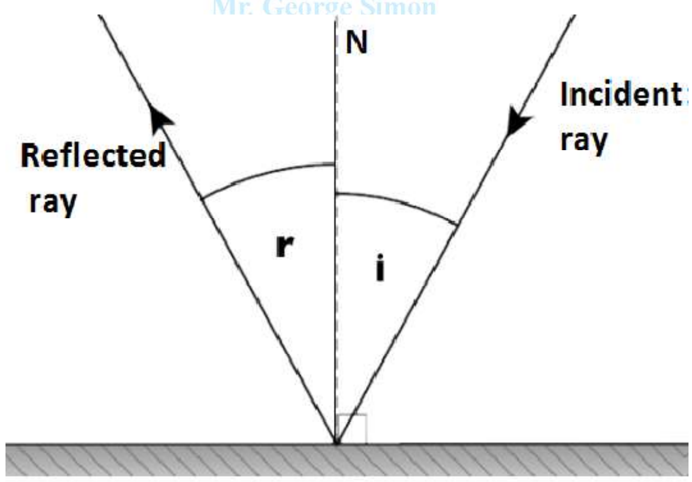
iii. Diffuse reflection also called **scattering/ irregular reflection**

iv. When sun rays inters the earth's atmosphere, it begins to be scattered by molecules of nitrogen and oxygen

Laws of Reflection

Consider the figure below

Dia0gram:



Where:

i = angle of incident

r = angle of reflected

N = normal line

From above diagram, the laws of reflection states that

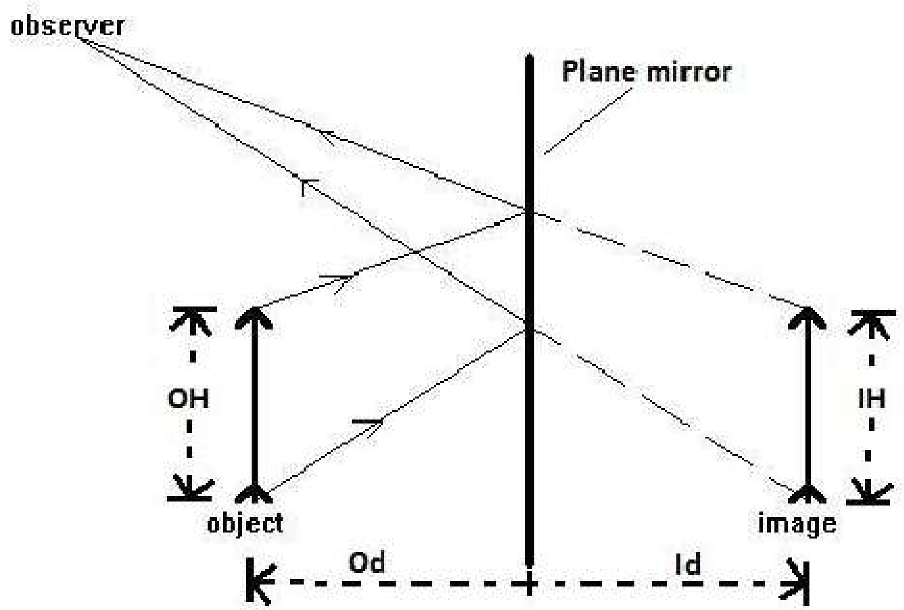
1st. "*the incident ray, the reflected ray and the normal all lie in the same plane*"

2nd."*The angle of incidence equals to the angle of reflection*"

Image Formed In a Plane Mirror

When object kept front of plane mirror the image is formed due to the reflection of light

Diagram:



Where:

M = magnification

Id = image distance

Od = object distance

IH = image height

OH = object height

Characteristics of Image Formed In Plane Mirror

i. The image is virtual (not real)

ii. The image is upright

iii. Image and object has the same size

iv. Distance of image and object from the plane mirror are the same

v. Image has a left-right reversal

Magnification

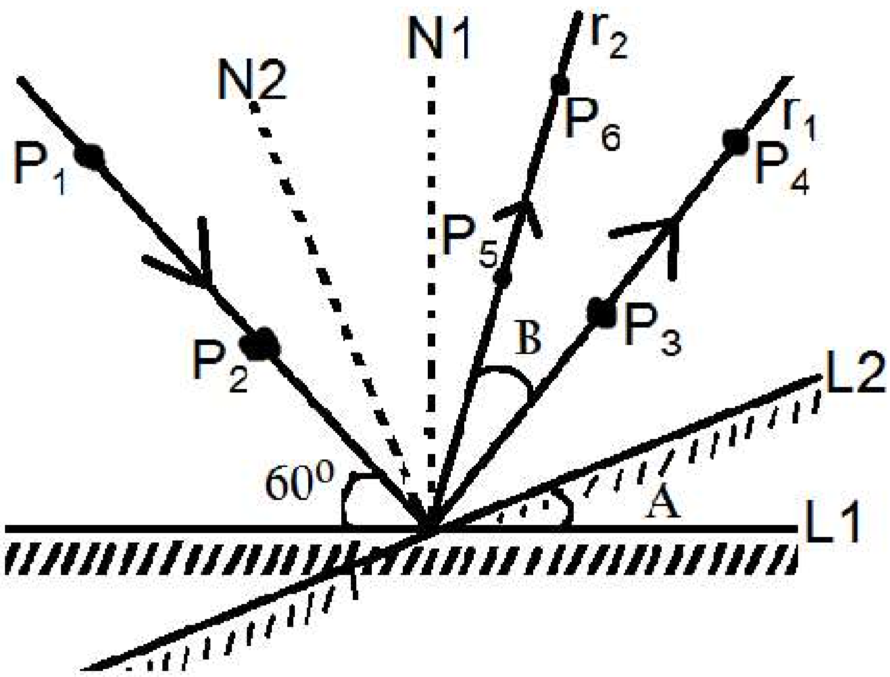
Magnification is given by the formula

M = Id/Od = IH/OH

Rotating a Mirror

If the mirror was rotated through certain angle (θ), then the angle between reflected rays after mirror rotated would be twice of certain angle (2θ)

Diagram:



Where:

θ = angle in which mirror rotates

2θ = angle former between reflected rays

2 = angular magnification

N1 = normal along P1 (plane mirror, θ =00)

N2 = normal along P2 (plane mirror, θ = θ0)

i = incident ray

r1 = reflected ray at P1 (plane mirror, θ =00)

r2 = reflected ray at P2 (plane mirror, θ = θ0)

Multiple Mirrors

There are systems which consist of two or more mirrors and produce several image of the same object. One such system is called a right angle mirror (two mirrors joined at 900)

Diagram

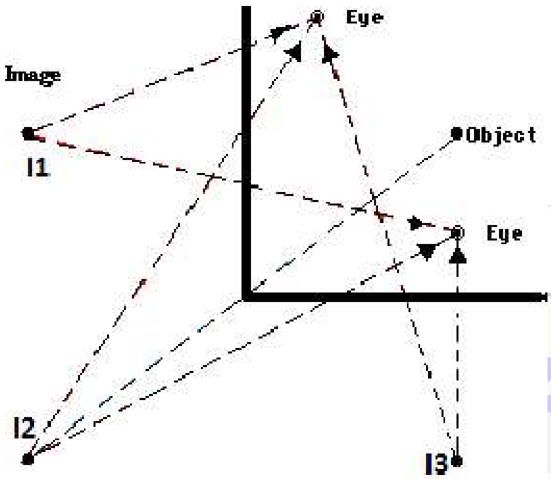


Image in parallel mirror (two mirrors joined at 00). The image is infinite in each mirror because there is repetition of images

Nb:

i. The number of image increase as if the angle between mirror decreases

ii. Parallel mirrors are used commonly used in salons and barber shops

iii. The number of image can gives as

n = (360°C/θ°C) **-1**

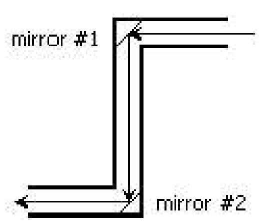
Application of Reflection of Light

Reflection of light finds applications in a periscope

Periscope

Defn: periscope is the device for used to see over an obstacle from a concealed position. It consist of two mirrors fixed facing each other at an angle 450. Light is reflected by two mirrors so that an object can be seen by the observer.

Diagram:



Uses of Periscope

The periscope is used in many aspects of everyday life, include.

i. When submarine are submerged at a shallow depth, periscope are used to look for targets or threats in the surrounding sea and air

ii. Solder use periscopes to observe any potential danger while they hide in trenches

iii. Periscope form part of telescope

Telescope

Defn: telescope is the instrument containing lenses that are used to make far away object to appear larger and near. Often are used to observing stars.