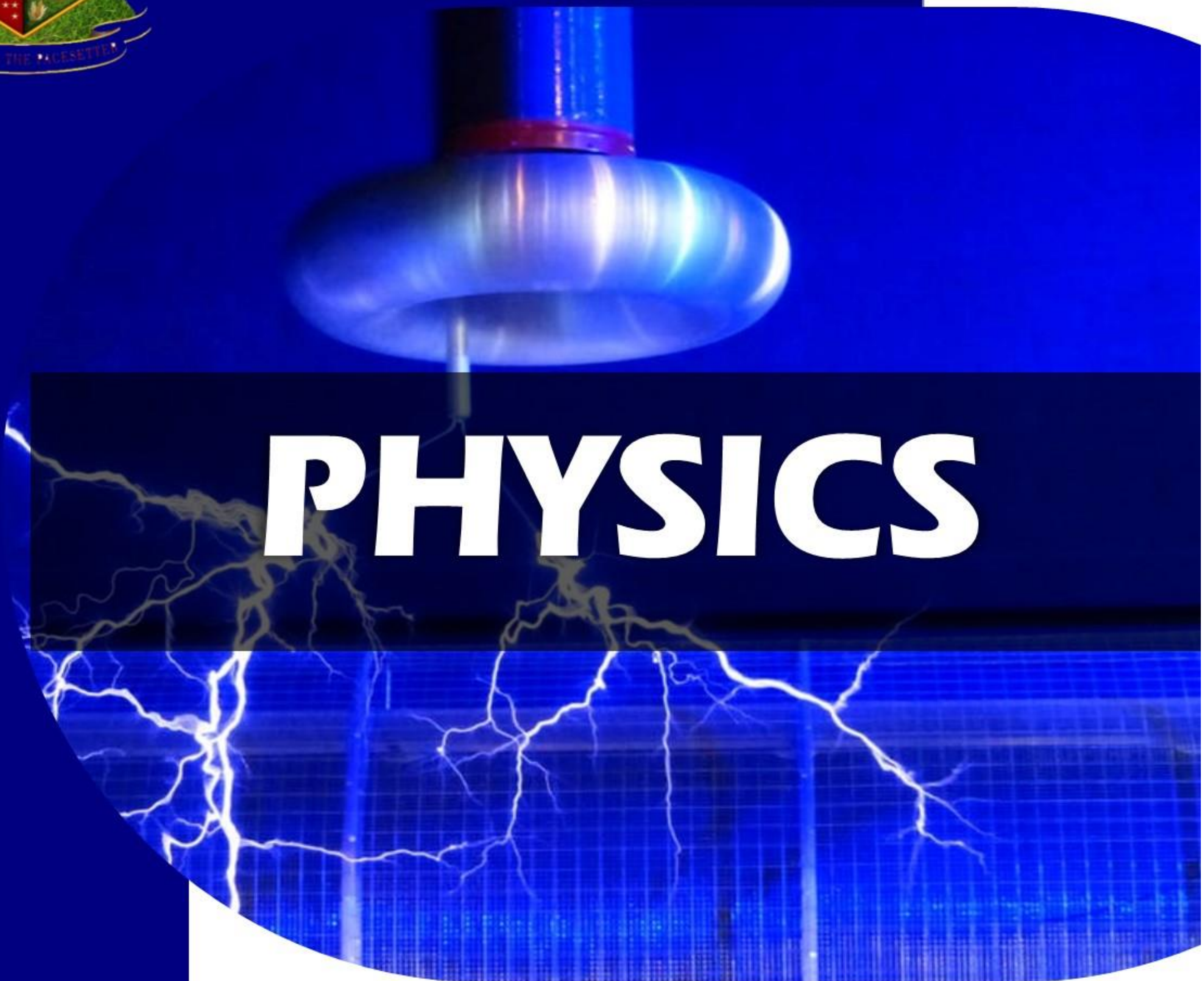
OYO STATE LECTURE NOTES



PHYSICS

COMPILED BY: Mr. M.M. Tajudeen

REVIEWED BY: Dr. T.A. Otunla (Physics Department, University of Ibadan)

EDITED BY: Mr. T.T. Junaid

DESIGNED BY: BROWT -ESSCON

SS1

Week: one

INTRODUCTION TO PHYSISCS

Physics is a branch of science that deals with the study of matter in relation to energy. The branches of Physics are: Mechanics, Light, Electricity, Waves, Magnetism, Atomic Physics, Electromagnetism, Dynamics, Heat, Sound etc.

CONCEPT OF MATTER

Matter is anything that has mass or weight and occupies space. The idea that matter is made up of minute particles called atom dated back to the ancient Greek. Atom is the smallest indivisible Particle of an element which can take part in a chemical change. It consists of proton, neutron and electron. Proton is positively charged, neutron is neutral and electron is negatively charged

Matter can exist in three states- Solids, Liquids and Gases

SOLIDS: The molecules of solids are closely packed together. They have definite shape and volume

LIQUIDS: Its molecule are freer than that of solid, they have definite volume but no definite shape

GASES: The cohesive force binding the gases molecules together is negligible. They have no definite shape and Volume

QUANTITIES AND UNITS

There are two types:

1. Fundamental Quantities
2. Derived Quantities

1. Fundamental quantities and units: These are basic physical quantities or units that are independent of others and cannot be defined in terms of other quantities or units. Examples of Fundamental quantities are: Mass, Length, Time, Temperature, Electric Current, Luminous intensity, Amount of Substance. While Fundamental Unit is given as: Kilogram (Kg), Meter (m), Seconds (S), Kelvin (k), Ampere (A), Candela (CD), Mole (Mol).

Fig.1.1

S/N	FUNDAMENTAL QUANTITIES	UNITS
1	Mass	Kilogram (kg)
2	Length	Meter (m)
3	Time	Seconds (s)
4	Temperature	Kelvin (k)
5	Electric Current	Ampere (A)
6	Luminous Intensity	Candela (Cd)
7	Amount of Substance	Mole (mol)

Fig 1.1 above shows examples of Fundamental quantities and their units

2. **Derived quantities and units**: These are quantities and units that are derived from fundamental quantities and units e.g. Area, Volume, Density, velocity, power, force, pressure etc. with their respective units given as m^2, m^3, Kg/m^3,m/s, Nm/s, N, Kgm/s^2

Fig.2.1

S/N	DERIVED QUANTITIES	UNIT
1	Volume	M^3
2	Acceleration	m/s^2
3	Work Done	Nm
4	Momentum	Kgm/s or Ns
5	Density	Kg/m3
6	Electric Charge	C
7	Speed	m/s

Fig.2.1 Above shows examples of Derived Quantities and their Units

POSITION, DISTANCE AND DISPLACEMENT

POSITION: Position of an object in space or on a plane is the point at which the object can be located with reference to a given point.

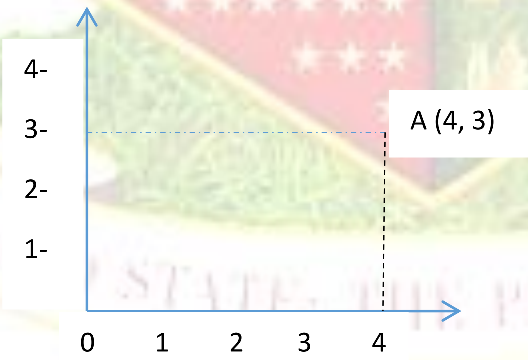


Fig.2.2 Location of Point A

Point A is located 4 units along the horizontal reference line OX from O and 3 units along the vertical reference line OY from Y. The point of intersection shows the location of A.

DISTANCE: This is the measure of separation between two points. To determine distance between two points located in a plane defined by two ordered pair of value (x_1, y_1) and (x_2, y_2) or assumed to be in space where they are defined by (x_1, y_1, z_1) and (x_2, y_2, z_2), the distance between them can be defined by applying the relation:

Distance, s= $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

Or Distance, s= $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$

Example: Calculate the distance between the points A(2,3) and B(-5,1) on a plane

Solution

Distance AB = $\sqrt{(-5-2)^2+(1-\ 3)^2}$

= $\sqrt{(-7)^2+(-2)^2}$

= $\sqrt{49+4}$

= 7.3 units

DISPLACEMENT: This is a distance covered in a specific direction.

Example: Calculate the displacement between the point A (2, 3) and B(-5,1) on a plane

Solution

Distance AB = $\sqrt{(-5-2)^2+(1-\ 3)^2}$

= $\sqrt{(-7)^2+(-2)^2}$

= $\sqrt{49+4}$

= 7.3 units

The angle between Point A and B is given as

tanΘ = $\frac{(y_2 - y_1)}{(x_2 - x_1)}$

tanΘ=$\frac{3-2}{1+5}$

tanΘ= $\frac{1}{6}$

tanΘ = 0.1667

Θ= $\tan^{-1}$ 0.1667

=9.5^0

Therefore, Object A is 7.3 unit distance to B in the direction 9.5^0

S/N	DISTANCE	DISPLACEMENT
1	It only measures the space between two points	It measures both the space between two points and the angular direction
2	It is a scalar quantity	It is a vector quantity
3	It can be measured with meter rule, tape rule etc. without including compass	Its involve the inclusion of Compass

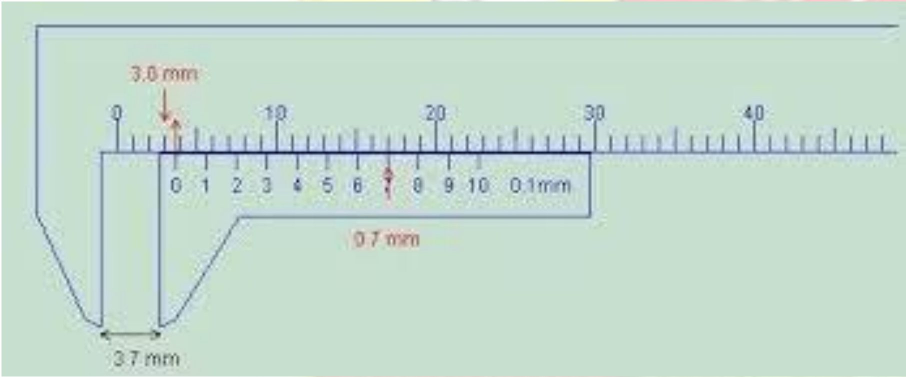
Week: **Two**

Measurement of distance

MEASUREMENT OF DISTANCE USING VERNIER CALIPER

Vanier Calipers can be used to measure the diameter of a rod or the inside diameter of a rod. It can also be used to measure the internal and external diameter of a tube. It has two set of jaws and two scales i.e. the main and the Vanier scale. It has a reading accuracy of 0.01cm

Example: Deduce the reading on the vernier caliper below



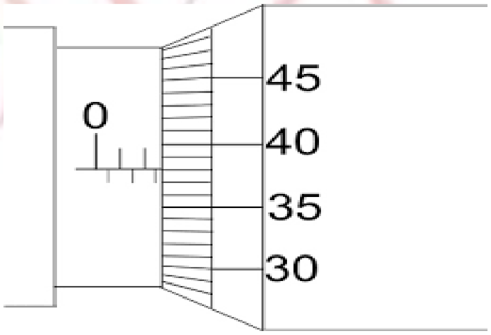
Solution
Main Scale Reading = 3.0cm
Vernier Scale = 0.7cm

Reading = Main Scale Reading + Vernier Scale Reading
= 3.0 + 0.7
= 3.7mm

MEASUREMENT OF DISTANCE USING MICROMETER SCEW GUAGE

Micrometer screw gauge is used to measure small length like the diameter of a small ball (like pendulum bob) or thickness of a piece of paper. It can measure the accuracy 0.001cm or 0.01mm on the main scale.

Example: Calculate the reading on the micrometer screw gauge below



Solution

Main Scale (Sleeve) Reading = 2.5mm

Circular Scale (Thimble) Reading= 0.38mm

Actual Reading = 2.5 + 0.38

= 2.88mm

MEASUREMENT OF DISTANCE USING METER RULE

The meter is graduated in centimeters and millimeters. The smallest graduation of the meter rule is 1mm or0.01m. Long distances such as the width or length of a large farm or football field can be measured with steel tapes graduated in meters.

WEEK: **Three**

MEASUREMENT OF MASS, WEIGHT AND TIME

MEASUREMENT OF MASS AND WEIGHT

Mass can be defined as the quantity of matter that is contained in the body. Its unit is kilogram.

While weight is defined as the force exerted on a body when freely suspended in air.Its unit is in Newton.

Instruments used for measuring mass are:

i. Top pan balance.
ii. Lever balance.

While the instrument for measuring weight is spring balance.

DIFFERENCES BETWEEN MASS AND WEIGHT

S/N	MASS	WEIGHT
1	It is a Scalar quantity.	It is a Vector quantity.
2	It is measured with Chemical balance.	It is measured with Spring balance.
3	It is measured in Kilogram (Kg).	It is measured in Newton (N).
4	It is Constant.	It varies from point to point.
5	It is the quantity of matter in a body.	It is the gravitational force exerted on a body when suspended in air.

MEASUREMENT OF TIME

Time is the duration of an event and it is measured in seconds. Measurement of time works on the principle of constant oscillation

The instruments used in measuring time are:

i. Ticker-tape timer
ii. Stop watch/clock
iii. Sand- clock
iv. Electric clock
v. Heart beat
vi.

WEEK: **Four**

DIMENSION AND DIMENSIONAL ANALYSIS

The dimension of a physical quantity is an expression which shows how the quantity is related to the fundamental units from derived units. Length is represented by (L), Time by (T) and Mass by (M).

For example,the dimension of Velocity can be derived as

Velocity = $\frac{Distance}{Time}$

Velocity = $\frac{L}{T}$

Velocity = LT^{-1}

Some Derived quantities are given as thus:

Acceleration= LT^{-2}

Pressure= $ML^{-1}T^{2}$

Density = ML^{-3}

USES OF DIMENSION

1. It is used in checking the validity of an equation.
2. Helps in recalling important formulae.
3. For solving physical problems theoretically.

WEEK: **Five**

CONCEPT OF MOTION

MOTION

Motion occurs when an object moves from one point to another. The study of motion without involving force which causes the motion is called **KINEMATICS**. The cause of every motion is **FORCE**.

TYPES OF MOTION

There are four types of motion. They are:

1. **Translational or Linear Motion**: This is when a body moves from one point to another in space without rotation. Some examples of Translational Motion are given as
   - A car travelling from one station to another.
   - A Student moving from one Class to another.
   - An aeroplane leaving Lagos to Ibadan.
2. **Rotational Motion**: This occurs when a body is moving in a circular form. For example
   - Rotation of fan blade
   - Rotation of Car Wheel
   - Rotation of Earth Around the sun
3. **Random Motion**: this is irregular movement of an object with no preferred direction. For Example
   - The motion of gas molecule
   - The motion of House fly
   - The motion of Woman in the market
4. **Oscillatory or Periodic Motion**: this is the to and fro motion of a body i.e. when a body is reversing the direction of its motion and returning regularly to its original position. For example
   - The motion of a Loaded Test Tube.
   - The motion of a suspended Pendulum Bob.
   - The motion of a Spiral Spring.

WEEK:Six

FORCE AND FRICTIONAL FORCE

Force is any agents that change or tends to change the state of rest or uniform motion of a body

TYPES OF FORCE

1. **CONTACT FORCE**: These are forces that are in contact with the body they affect e.g. Frictional force, Force of Pull and Push, Tension and Reaction etc.
2. **FORCE FIELD**: These are Forces experienced or felt by a body around a particular region, it does not require contact. For example Gravitational Force Field, Electric Force Field and Magnetic Force Field.

FRICTION

Friction can be define as a force which acts on the surface of separation of two bodies in contact and tend to oppose the motion of the surface.

TYPES OF FRICTION

1. **STATIC OR LIMITIING FRICTION**: This is a maximum friction to be overcome by a body starting to move.
2. **DYNAMIC OR SLIDING FRICTION**: This is a friction that has to be overcome by a body when it is in motion. It is also known as **KINETIC FRICTION**

LAWS OF FRICTION

1. Frictional force between two Solid surfaces (in Contact) opposes their relative motion.
2. Friction force is independent of the area in contact.
3. Limiting friction is directly proportional to the Normal reaction.
4. Frictional force depends on the nature of the surfaces in contact.
5. Frictional force is independent of the relative velocity of the surfaces in contact.

ADVANTAGES OR MERITS OF FRICTION

1. It prevents slipping of people while walking.
2. It provides air friction in parachute.
3. It holds nail and screws in the wood and nuts respectively.
4. It holds car tires firmly to the ground.

DISADVANTAGES OR DEMERITS OF FRICTION

1. It causes wear and tear of the machine's moving parts.
2. It wastes useful kinetic energy by converting it to heat energy (reduces efficiency of machine).
3. It causes unwanted Sounds.

HOW TO REDUCE FRICTION

1. By lubricating machine moving part.
2. By using roller or ball bearing.
3. By streamlining.
4. By smoothening.
5. By Polishing

CO- EFFICIENT OF FRICTION (μ)

$F \alpha R$

$F=\mu R$

$\mu= \frac{F}{R}$

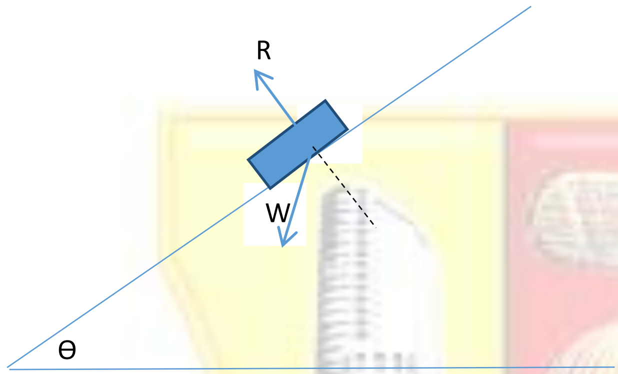
F= Frictional force

R= Normal reaction

W= Weight

Where μ represent constant of proportionality which is known as Coefficient of friction

DETERMINATION OF CO-EFFICIENT OF STATIC FRICTION ON AN INCLIDE PLANE



Resolving into vertical and horizontal components

I.e. F = WsinΘ…………….1

R= WcosΘ…………………2

Divide Eqn1by 2, we have

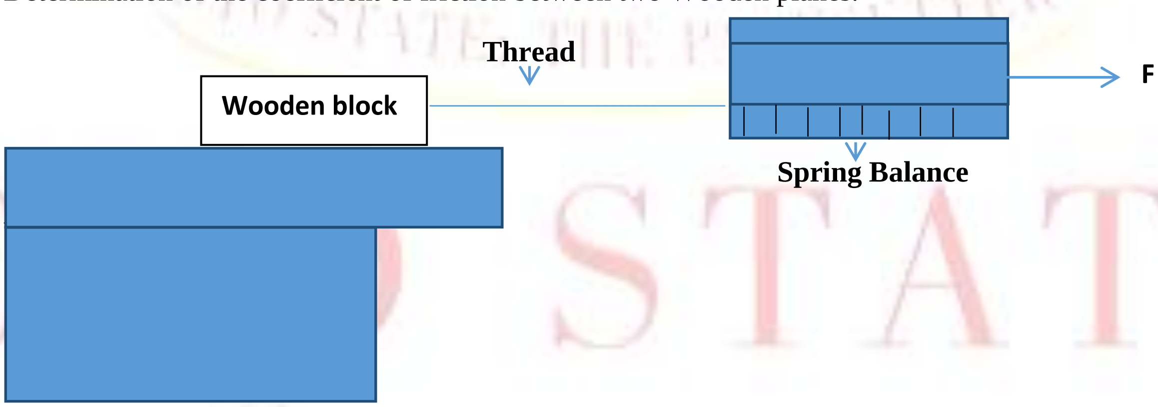
$\frac{F}{R} = \frac{WSin\Theta}{WCos\Theta}$

$\mu = \frac{F}{R} = \tan\Theta$

WEEK: Seven

EXPERIMENT ON FRICTION

Determination of the coefficient of friction between two Wooden planes.



A wooden block of mass m_o = 250g, placed on a horizontal wooden table, is pulled gradually and horizontally, using a short thread and a spring balance. The spring balance reading, F, when the block just start to move is recorded. Read and record values of F for **m = 200, 400, 600, 800 and 1000g** placed on then wooden Table and the puled.

i. Evaluate $M = m_0 + m$, $R = \frac{M}{100}$.
ii. Tabulate your readings.
iii. Plot the graph of F against R, starting both axis from origin.
iv. Determine the slope (S) of the graph and state its significant
v. State two precautions you took during the experiment.

Week: Eight

TOPIC: DYNAMICS

SPEED: This is the rate of change of distance with time. Speed = $\frac{Distance}{Time} = \frac{d}{t}$. Its Unit is ms^{-1}

VELOCITY: This is the rate of change in displacement withtime. Velocity = $\frac{Displacement}{Time} = \frac{d}{t}$

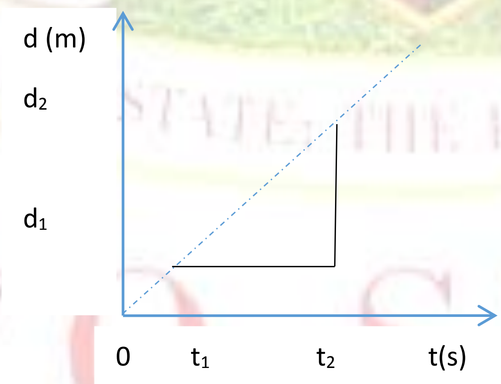
Its unit is also ms^{-1}

ACCELERATION: This is the rate of change in velocity with time. Acceleration = $\frac{Velocity}{Time} = \frac{V}{t}$

Its unit is in ms^{-2}

DISTANCE/DISPLACEMENT TIME GRAPH

This is obtained by plotting the distance covered or displacement of an object against time.

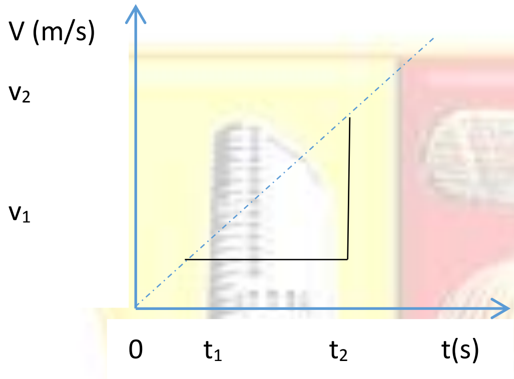


Slope (S) = $\frac{\Delta d}{\Delta t} = \frac{d_2 - d_1}{t_2 - t_1}$

I.e. slope= Velocity

VELOCITY TIME GRAPH

This is obtained by plotting the velocity ofa moving object against difference in time interval.



Slope (S)=$\frac{\Delta v}{\Delta t}$ = $\frac{v_2 - v_1}{t_2 - t_1}$

I.e. Slope (S) = Acceleration.

The Total distance covered (d) is represented by the area under the graph (i.e. area of triangle, since triangle is the shape formed) = ½ (V_2-V_1) X ($t_2 - t_1$)

WEEK: Nine

WORK, ENERGY AND POWER

WORK

Work done (W) is defined as the product of force and the distance moved in the direction of force.

Thus, Work done= Force x Distance (i.e. W= Fxd).

Since Force = Mass x acceleration.

Therefore, work done= Mass x Acceleration x Distance (i.e. F=mx a x d).

The unit of work is joule (J).

ENERGY

Energy can be defined as the ability or capacity to do work. It is measured in Joule (J). The forms of energy include: Mechanical Energy (Kinetic and Potential Energy), Heat Energy, Chemical Energy, Electrical Energy, Nuclear Energy, Solar Energy etc.

POWER

Power is defined as the time rate ofdoing work

Power = $\frac{Work\ done\ or\ Energy\ expended}{Time\ taken} = \frac{W}{t} = \frac{F\ X\ d}{t}$

Since Velocity (V) = $\frac{d}{t}$

Therefore, power =F X V.

Its unit is in Watts (W).

Example: A block of mass 5Kg is lifted 2cm in 3sec. Find the work done and Power. (Take g = 10 ms^{-2}.

Solution:

Mass (m) = 5Kg

Distance (d) = 2cm = 0.02m

Time (t) = 3s

Work done = F X d

= m x g x d

= 5 x 10 x 0.02

= 1J

Power = $\frac{work\ done}{time} = \frac{1}{3}$

=0.3333 W

WEEK: Ten

Thermal Expansion in Solid

This is the increase in size or volume of a substance due to heat applied.

Disadvantages of Expansion

- **i.** It deforms the bridge structure.
- **ii.** It can make thick glass to break.
- **iii.** It causes rail way line to buckle.
- **iv.** It affects oscillation of the pendulum clock and the balance wheel of watch.

Advantages of Expansion

- **i.** It can be applied in riveting two metal plates.
- **ii.** It can be applied in construction of automatic fire alarms.
- **iii.** It can be applied in bimetallic strips in electric iron.

Linear Expansivity (α): This is the fractional increase in length per unit length per degree rise in temperature.

$$.\alpha = \frac{Increase\ in\ lenght}{Original\ lenght\ x\ Change\ in\ temperature} = \frac{l_2 - l_1}{l_1(\theta_2 - \theta_1)}$$

Area Expansivity (β): This is the ratio of increase in length per unit length per degree rise in temperature.

$$.\beta = \frac{Increase\ in\ Area}{Original\ Area\ x\ Change\ in\ temperature} = \frac{A_2 - A_1}{A(\theta_2 - \theta_1)}$$

.β = 2α

Volume or Cubical Expansivity (γ): This is the ratio of change in volume per unit volume per degree rise in temperature.

$$.\gamma = \frac{Increase\ in\ Volume}{Original\ Volume\ x\ Change\ in\ temperature} = \frac{V_2 - V_1}{V_1(\theta_2 - \theta_1)}$$

.γ = 3α

Example: If copper metal 8m long has an initial temperature of 30^0C, what is its change in length if its temperature becomes 60^0C. (Take linear Expansivity of copper = 1.2 x $10^{-5}/K$)

Solution:

L_1 = 8m

$L_2 - L_1$ =?

$.\theta_2 - \theta_1 = 60^0 - 30^0 = 30^0$

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

$1.2 \text{ x } 10^{-5} = \frac{l_2 - l_1}{8(60 - 30)}$

$l_2 - l_1 = 1.2 \text{ x} 10^{-5} \text{ x } 8 \text{ x } 30 = 0.003\text{m}$

2ND TERM

WEEK: **One**

Description and Properties of Field

Field can be defined as a region or space under the influence of some physical agency such as gravitation, magnetism and electricity.

Types of Field

There are two types of field; scale field and vector field

i, **Scalar field**: A scalar field is a field that has a magnitude but no direction e.g. temperature, energy and density.

ii, **Vector field**: A vector field is a field that have both magnitude and direction e.g. gravitational, magnetic and electric field.

GRAVITATIONAL FIELD: Gravitational field is a force field that influences the motion of an object in the space where it operates without coming in contact with the object existing in the earth's gravitational field.

MAGNETIC FIELD: A magnetic field is the region or space around a magnetic material in which the influence of the magnet force can be felt or detected.

POLE: The pole of a magnet is the portion of the magnet where its magnetic attraction appears to be strongest.

PROPERTIES OF MAGNETIC LINE OF FORCE.

a, They originate from North pole and end in a South pole

b, Two lines of force do not cross each other

c, Where the line of forces are close together, the intensity of the field is greater.

d, Where the line of force are widely separated the intensity of the field is less.

ELETRIC FIELD

This is a region where an electric charge exerts a force on another charges.

The line of electric field is drawn in such a way that direction at any point gives the direction of the electric field.

PROPERTIES OF ELECTRIC LINE OR FORCE

1, They originate from positive charges and terminate at the negative charges.

2, Like charges repel while unlike charges attract.

3, They are in the state of tension.

4, The line of force never cross each other

WEEK: **Two**

GRAVITAIONAL FIELD

ACCELERATION DUE TO GRAVITY (g)

The force of gravity is the pull of attraction between the earth and objects on the surface of the earth. The value of acceleration due to gravity is constant in the region of the laboratory.

$g = \frac{Gm}{R^2}$

Where

G= Gravitational constant

M= Mass of the earth

R= Radius of the earth

g = Approximately $9.8ms^{-2}$

NEWTON'S LAW OF UNIVERSAL GRAVITATION

Newton's law of universal gravitation states that every particle of matter in the universe attracts every other particle with a force which is directly proportional to the product of their masses and inversely proportional to the square of radius between their centers.

Mathematically,

$F \alpha \frac{m_1 m_2}{r^2}$

$F = G\frac{m_1 m_2}{r^2}$

WEEK: **Three**

ELECTRIC CHARGES

These result as a flow of electronsfrom charged body to uncharged body.

TYPES OF CHARGES

1, Positive charge

2, Negative charge

PRODUCTION OF CHARGES

Electric charge can be produced by the following methods

1, Friction

2, Induction

3, Contact

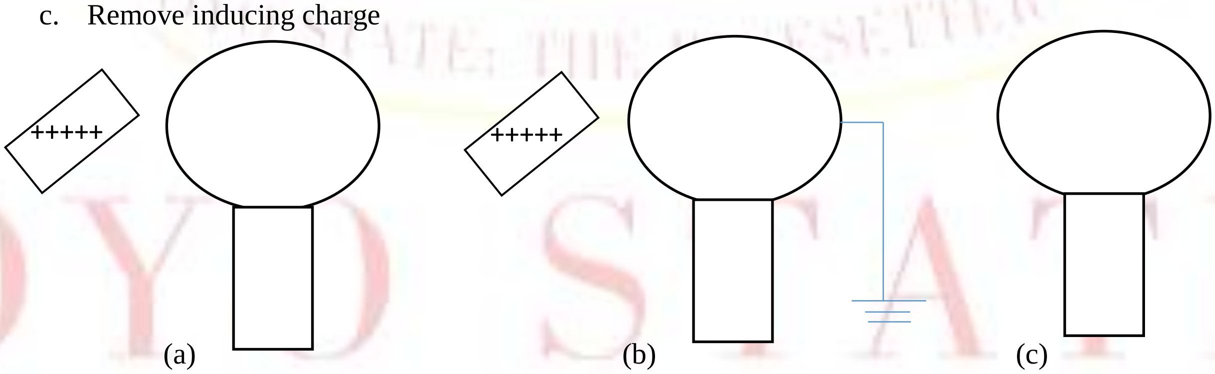
i,**By Friction**: When uncharged polythene rod is rubbed with fur, electrons are transferred from the fur to the polythene during the rubbing.

The polythene then becomes negative charged. Also when an uncharged glass rod is rubbed with silk, electrons are transferred from the glass to the silk. The glass rod becomes positively charged.

ii,**By Induction**: This involves the production of an Electric charge by placing a charged body near an uncharged body .

The activity can be carried out in the following steps.

a. Bringing a positive Charge close to an insulated body
b. Earth the insulated body by momentarily touching it so that the positive charge conduct away
c. Remove inducing charge



iii,**By Contact**: This method involves bringing a charged object in contact with a neutral object. If a positively charged glass rod is brought near neutral insulated body, the body acquires the same charge as the glass rod.

CONDUCTORS

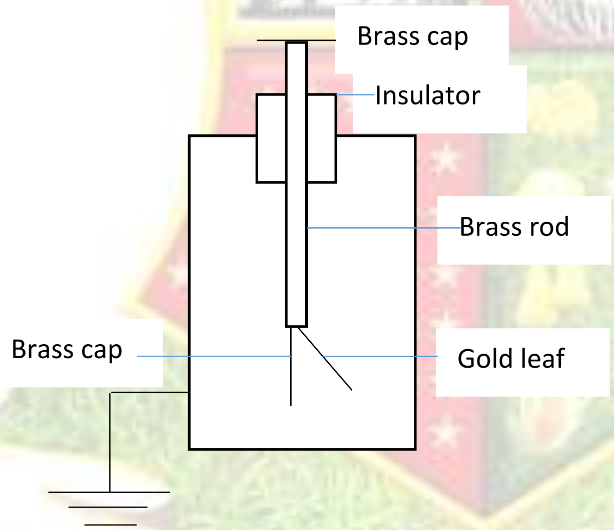
Conductors are materials that allow electron to pass through them easily, they can also conductor electricity. Examples are; some metals, graphite, acids, salt solution, the earth and human body.

INSULATORS

Insulators are material that do not allow electron to pass through them easily. Examples are; plastic, polythene, paper, ebonite, dry hair, silk, glass etc.

ELECTROSCOPE

An electroscope is an instrument used for detecting and testing small electric charges. It consist of a metal (brass) rod to which a thin gold-leaf (or aluminum leaf) is attached. The rod is by a brass cap or disc and insulated from the metal case.



A gold leaf electroscope can be charged by induction method. If a positive charged rod is brought near a positively charged electroscope, the leaf divergence increases more and decreases if it has opposite charge.

LIGHTNING: The atmosphere is known to contain ions or charged particles which have been produced by radiation from the sun body by what is known as cosmic radiation which enters the atmosphere from outer space.

Lightning is sudden discharge or neutralization of electric charges and it occurs when charges build up in a cloud

LIGHTNING CONDUCTOR

A lightning conductor is used to protect a building from lighting damage. It consists of a conductor made of a thick strip of metal cable to carry a large current without melting.

WEEK: Four

ELECTRIC CIRCUIT

An electric circuit is the path provided for the flow of electric current. The circuit consist of the source of electric energy (e.g. a battery) connected through a conductor (e.g. a wire) to a load (e.g. an electric bulb) and a key or a switch

PRODUCTION OF ELECTRIC CURRENT

Electric Current can be generated from

(a) Chemical Energy
(b) Heat Energy
(c) Mechanical Energy
(d) Solar Energy

(a) ELECTRICITY FROM CHEMICAL ENERGY

Electricity is produced from Chemical Energy through the use of electric cell. An electric cell is a device for converting chemical into electric energy. Examples of an electric cell are Voltaic (simple) cell, Daniel cell, Leclanche cell, Accumulator etc.

DEFECTS OF SIMPLY CELLS

Simple cell supplies current only for a short time. This occurs from the following chemical processes

(i) Polarization
(ii) Local Action

(i) **Polarization**: This is the formation of hydrogen bubbles around the copper plate of the simple cell. It can be reduced by the addition of suitable chemical known as **depolarizer** e.g. potassium dichromate.

(ii) **Local action**: This is the formation of impurities on the zinc plate. The impurities (Iron & Carbon) set up tiny cells around the zinc surface. Local action can be prevented by the process of amalgamation that is rubbing of mercury over the surface of zinc plate.

(b) ELECTRICITY FROM HEAT ENERGY

Solder two different metallic wires (e.g. copper & Iron) to produce bi copper–iron junction. Connect the free end of the wire to a galvanometer. Dip one end of the bi copper–iron junction in boiling water while the other end is connected to the galvanometer known as the **cold junction**. The essence of connecting galvanometer is to detect current flowing.

(c) ELECTRICITY FROM MECHANICAL ENERGY

The process involved in the production of electric current from a dynamo which illustrates the conversion of mechanical Energy to Electrical Energy. The dynamo operates on the principle of electromagnetic induction.

(d) ELECTRICITY FROM SOLAR ENERGY

This work based on the principle of photo-voltaic cell which provides a simple conversion of electrical energy to solar energy.

WEEK: Five

CURRENT ELECTRICITY

Electric current is the rate of flow of charge round a circuit. If a quantity of charge Q (coulomb) flow from the time t (sec) then the electric current, I = Q/t (c/s)

OHM'S LAW

Ohm's law state that a steady current flowing through a metallic conductor is directly propositional to the potential difference (P.d.) between it ends provided the temperature and other physical conditions are kept constant.

ELECTRICAL COMPONENTS AND THEIR SYMBOL

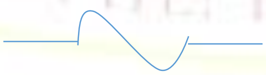
The following are electrical components and symbol

(i) Cell 

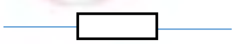
(ii) Battery 

(iii) Key 

(iv) Fuse 

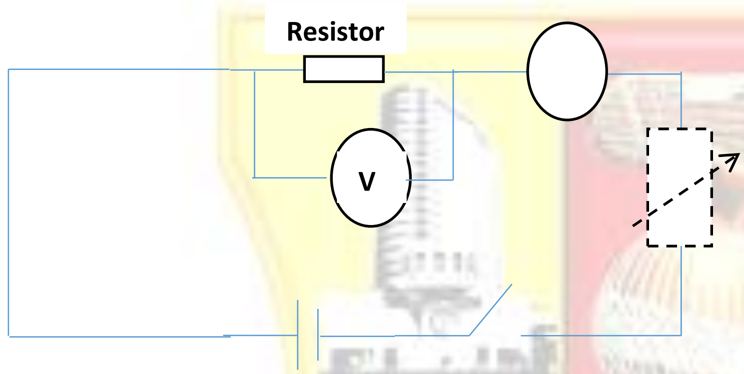
(v) A.C source 

(vi) Capacitor 

(vii) Resistor 

WEEK: **Six**

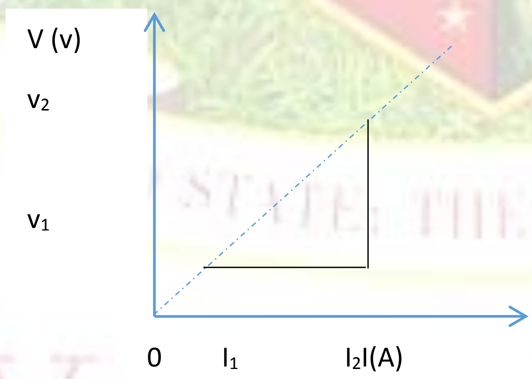
VERIFICATION OF OHM'S LAW



The ammeter which measures the current flowing through the metallic conductor (Constant wire) is connected in series with the wire and the cell. The voltmeter is connected in parallel with the conductor and measures the p.d. across it. The rheostat is used to vary the current flowing in the circuit.

We cause the current to flow by pressing down the switch. The graph of V against I is plotted and a straight line graph passing through the origin is observed. The **slope** gives **the resistance** of the wire.

Graph of Voltage (V) against Current (I)



Slope (S) = $\frac{\Delta V}{\Delta I} = \frac{V_2 - V_1}{I_2 - I_1}$

Slope (S) = Resistance (R).

WORK DONE IN ELECTRIC CIRCUIT/ ELECTRICAL ENERGY

Work done when electricity flows from one point to another of different potential is given by

W= QV

The Unit is Joule = Coulomb x Volt

Since Q = It

Therefore, W= QV = IVt

From ohms law, V= IR

:. W= QV

i. W = IVt
ii. W = I^2Rt
iii. W = $\frac{V^2}{R}t$

ELECTRICAL POWER

Power (P) is define the time rate of doing work.

$$P = \frac{Workdone/Energy\ dissipated(Joules)}{Time\ taken\ (Seconds)}$$

Electrical power is the amount of electrical work done or electrical energy dissipated per second.

P= $\frac{IVt}{t}$

Therefore, P= IV

Power P = IV = I^2R = $\frac{V^2}{R}$

Unit of power is Watt (W).

Large units of power are kilowatt (KW) and Megawatt (MW)
1kw = 1000 watts
1 MW = 10^6 W = 10^3 KW

Example: Calculate the Electrical energy and Power Used by an electric Heater of 11Ω when the voltage source is 220V ac source for 2seconds

Solution:

Resistance R = 11Ω

Voltage V = 220V

Time t = 2s

Electrical energy = $\frac{V^2}{R}t$

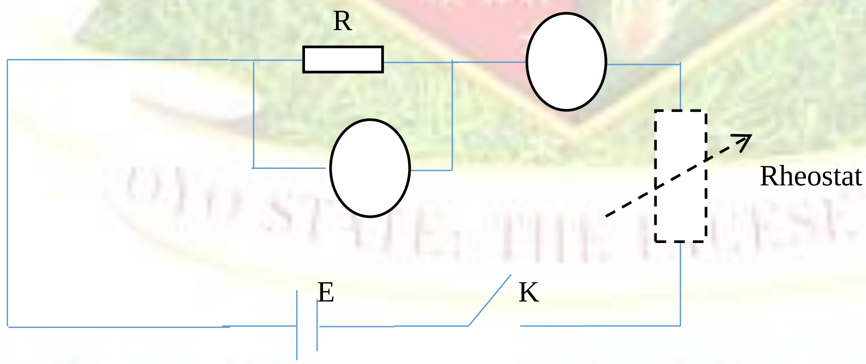
$= \frac{220^2}{11}\ x\ 2$

= 8800J = 8.8KJ

Power = $\frac{Workdone\ /\ Energy}{Time\ taken} = \frac{V^2}{R}$

$= = \frac{8800}{2} =$ 4400w = 4.4KW

WEEK: Seven
PRACTICAL
Verification of ohm's law using Standard Resistor (2Ω), Ammeter (0-2A), Connecting wires and Voltmeter.



Connect the circuit in the figure above (i) Close the key K and record the ammeter reading I_0. Remove the plug of the key. (ii) Connect the voltmeter across the resistor R = 2Ω and the rheostat in series with the resistor. (iii) With the key closed adjust the rheostat to make the ammeter reading I = 0.10A Record the corresponding Voltmeter reading V. **(iv)** repeat the experiment for **I**= 0.15A, 0.20A, 0.25A, 0.30A and 0.35A. In each case determine the corresponding values of V. **(v)** tabulate your readings.**(vi)**Plot the graph of I against V. **(vii)** Determine the slope s of the graph and evaluate 1/s.**(viii)** State two precautions you took to ensure accurate results.

WEEK: Eight

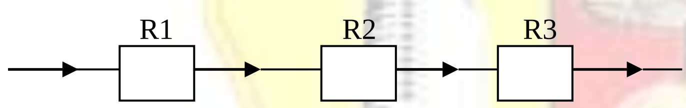
ARRANGEMENT OF RESISTORS

There are two arrangement of Resistor, which are:

a. Series arrangement
b. Parallel arrangement

SERIES ARRANGEMENT:

When the resistor are connected end to end as shown, they are said to be in **series connection**



For series connection, each Resistor (R) has different Voltage (V) but the same Current (I)

The total Voltage (V) in the Circuit is given as

$V = V_1+V_2+V_3$……… (x)

From Ohm's Law V = IR

Which gives, $IR = IR_1+IR_2+IR_3$

$IR = I\,(R_1+R_2+R_3)$

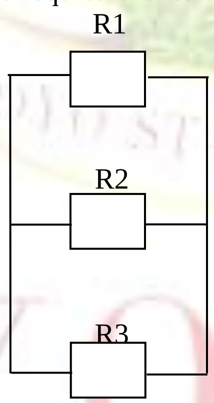
Therefore the equivalent resistance (R) of the combination is given by

$\mathbf{R = R_1+R_2+R_3}$

PARALLEL ARRENGEMENT

When resistor are arranged side by side such that their corresponding ends join together at two common junctions, the arrangement is known as **parallel arrangement.**

The combined or equivalent resistance (R) is given by



For parallel connection, each Resistor (R) has different current (I) but the same Voltage (V)

The total Current in the Circuit is given as

$I = I_1+I_2+I_3$…… xx

From Ohm's Law V = IR

So, $I = \frac{V}{R}$

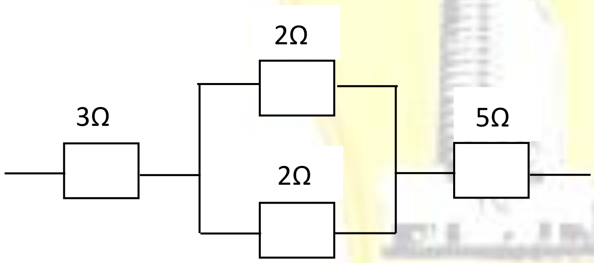
Which gives, $\frac{V}{R} = (\frac{V}{R_1} + \frac{V}{R_2}+\frac{V}{R_3})$

$\frac{V}{R} = V(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3})$

Therefore the equivalent resistance of the combination is given by

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Example: Find the equivalent Resistance in the Circuit below



Solution:

Two 2Ω Resistors are connected in series with 3Ω and 5Ω resistor.

Calculating the two parallel connected resistors:

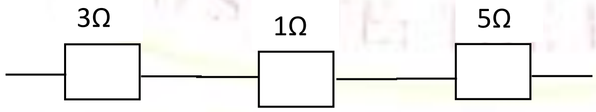
$R_1 = 2\Omega$ and $R_2 = 2\Omega$

$\frac{1}{R} = \frac{1}{2} + \frac{1}{2}$

$\frac{1}{R} = \frac{1}{1}$

$R = 1\Omega$

The circuit diagram becomes,



Now calculating the series connection of the resistor:

$R = R_1 + R_2 + R_3$

$R = 3 + 1 + 5$

$R = 9\Omega$

FACTORS AFFECTING ELECTRICAL RESISTANCE

These are;

(i) Length of conductor
(ii) Cross-sectional area of conductor
(iii) Temperature
(iv) Type or substance of material

3RD TERM

Week: One

PARTICULATE NATURE OF MATTER

STRUCTURE OF MATTER

(a) EVIDENCE OF THE PARTICLE NATURE OF MATTER

The idea that matter is made up of minute particles called atom dated back to the ancient Greek. Atom is the smallest indivisible Particle of an element which can take part in a chemical change. It consists of proton, neutron and electron. Proton is positively charged, neutron is neutral and electron is negatively charged.

MOLECULES

A molecule is the smallest particle of a substance which can have a separate existence and still retains the properties of that substance.

BROWNIAN MOTION

Brownian motion is the rapid, constant and irregular motion of tiny particles. This can be observed when a dust particle is in continuous state of haphazard movement caused by the impact of moving water molecules. This continuous motion also occurs in smoke molecule.

DIFUSSION

Diffusion is the tendency of molecule to migrate and fill an empty space due to their randommotions.

WEEK: Two

STATES OF MATTER

Matter can exist in three states- Solids, Liquids and Gases. The State of matter depends on Temperature and Pressure.

1. **SOLIDS**:The molecules of solids are closely packed together. They have definite shape and volume. Their molecules are arranged in a regular pattern and held rigidly by a strong intermolecular forces
2. **LIQUIDS**: Its molecule are freer than that of solid, they have definite volume but no definite shape. They have larger intermolecular distance than solid molecules.
3. **GASES**: The cohesive force binding the gases molecules together is negligible. They have no definite shape and Volume. Their molecules are at far distance apart. They have greater speed due to the space between its molecules. Their motion is linear except when they collide.

WEEK: Three

ELASTIC PROPERTIES OF SOLIDS

Elasticity is the ability of a substance to regain its original shape and size after being distorted by an external force.

HOOKES LAW

Hooke's law states that Provided that the **elastic limit** of an elastic material is not exceeded, the **extension** of the material is directly proportional to the **applied force or load**.

$F \alpha e$

$F = Ke$

Where

F= Force

K= Stiffness or force constant or elastic constant

e = Extension

Example:

Calculate the elastic constant of an elastic cord stretched by a loan of 8.0N by 250cm..

Solution:

F = 8N

e = 250cm = 2.5m

F = k e

$K = \frac{F}{e}$

$= \frac{8}{2.5} = 3.2\ Nm^{-2}$

Example: A Spring extends to 1.86cm when a mass of 20g was hung from it, if Hooke's law is obeyed. What is the extension when additional mass of 10g was hung, given that original length of the string is 1.0 cm.

Solution:

$L_2 = 1.86cm$

$L_1 = 1.0\ cm$

$M_1 = 20g = 0.2N$

$M_2 = 20 + 10 = 30g = 0.3N$

$e = L_2 - L_1$

$= 1.86 - 1.00 = 0.86cm = 0.0086m$

For the first force,

$F_1 = 0.2N$

$e_1 = 0.0086m$

$F_1 = K e_1$

$K = \frac{F}{e}$

$K = \frac{0.2}{0.0086}$

$K = 232.56Nm^{-2}$

$F_2 = k e_2$

$e_2 = \frac{F}{k} = \frac{0.3}{232.56}$

$= 0.0129m$

WEEK: Four

YOUNG MODULUS

This is the ratio of tensile stress to tensile strain of an elastic material

Young Modulus: $\frac{Tensile\ Stress}{Tensile\ Strain}$

STRESS: It is defined as the ratio of force to area

Stress = $\frac{Force}{Cross\ Sectional\ area}$

Its S.I. Unit is in NM^{-2}

STRAIN: This is the ratio of extension to its natural length

Strain: $\frac{Extension}{Natural\ Lenght}$

It does not have S.I. Unit

ENERGY STORED IN AN ELASTIC STRING

Energy stored = Work done during deformation of spring

Energy stored (E) = Average force x extension

= ½ F x e

Energy stored = ½ F e = ½ ke^2

Example: A metal wire of length 2.5m and diameter 2.0mm is stretched by a force of 400N. If the force constant of the wire is 5000N/m and $\pi = \frac{22}{7}$ calculate;

(a) The extension of the wire
(b) The tensile stress and strain on the wire
(c) The young modulus
(d) The work done by the wire

Solution:

L = 2.5m

d = 2.5mm = 0.0025m

F = 400N

K = 5000N/m

$r = \frac{d}{2} = \frac{0.0025}{2}$ = 0.00125m

(a) F = ke
400 = 5000e
e = 0.08m

(b) Stress = $\frac{Force}{Cross\ Sectional\ area}$

Stress = $\frac{F}{\pi r^2}$

$= \frac{400}{\frac{22}{7} x\ 0.00125^2}$

= 1.273 x 10^8N/m

(c) Strain = $\frac{Extension}{Natural\ Lenght}$

Strain = $\frac{0.08}{2.5}$

= 0.032

(d) Young Modulus $= \frac{Tensile\ Stress}{Tensile\ Strain}$

Young Modulus $= \frac{1.273\ x\ 10^8}{0.032}$

$= 3.978 \times 10^9 Nm^{-2}$

(e) Work done = ½ Fe

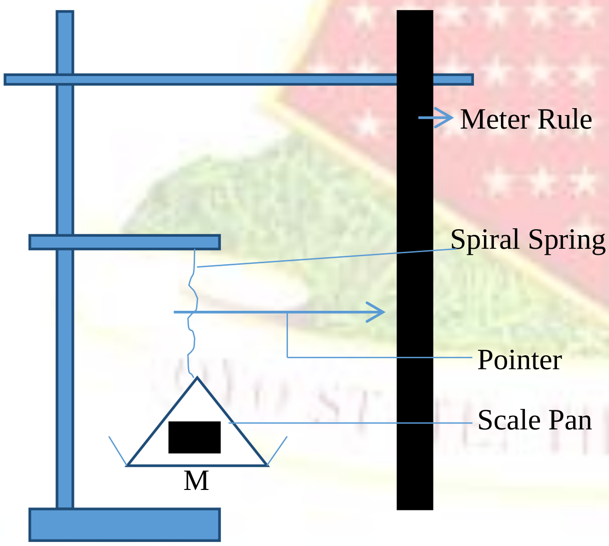
= ½ x 400 x 0.08

= 16J

WEEK: Five

Practical: Experiment on the verification of Hooke's law

APPARATUS: Spiral Spring, Mass hanger, Masses (100g, 200g, and 50g), Meter rule, Optical pin, Plasticine.



Set the apparatus as shown above. (ii) With no mass on the scale pan, note the initial pointer readingP_0. (iii) Load the scale pan, first with a mass, **M** = 150, 200, 250 and 300g. In each case, read and record the corresponding pointer reading$\boldsymbol{P_1}$. (iv) Unload the scale pan in steps of 50g and each time, record the corresponding pointer reading $\boldsymbol{P_2}$. (v) Find the mean pointer reading **P** = ½$(\boldsymbol{P_1} + \boldsymbol{P_2})$. (vi)Evaluate extension, **x = P -** $\boldsymbol{P_0}$. Tabulate your results. (vii) Plot the graph of **M** against **x**(viii) Determine the slope **L** and explain its physical meaning. (ix) State two precautions you took during the experiment.

WEEK: Six

CRYSTAL STRUCTURE

Crystal is a piece of solid matter which has its atoms, molecules or ions arranged in a highly regular repeating pattern or lattice. Solids are divided into Crystalline and non-crystalline or amorphous substance examples of crystalline substance are: Sodium Chloride, Diamond, copper (II) tetraoxosulphate (IV) etc.

Non Crystalline or Amorphous Substance are solids that does not have their molecules arranged in a regular pattern, they are mostly in liquids e.g. Sulphur, Graphite etc.

DIFFERENCES BETWEEN CRYSTALLINE AND ARMORPHOUS SUBSTANCES

S/N	CRYSTALLINE SUBSTANCES	ARMORPHOUS SUBSTANCES
1	They have definite shape	They have no definite shape
2	They have definite Boiling and Melting Point	They have no definite Boiling and Melting Point
3	They are soluble in Polar Solvents	They are not soluble in Polar Solvents
4	They can exist either in hydrated or anhydrous form	They exist only in anhydrous form

WEEK: Seven

FLUIDS AT REST AND IN MOTION

The molecules of gases are more free to move than those of solids. Therefore, both liquids and gases are able to flow. For this reason, they are grouped together as fluids.

SURFACE TENSION

This is the force of attraction between the molecules of the liquids, which make the liquid to act like an elastic skin. It can also be define as the force per unit length acting on the liquid surface at right angle to one side of an imaginary line drawn on the liquid surface. Some effects of surface tension forces are: drops of water dripping slowly from tap water has a spherical shape, Mercury forms spherical pellet when poured on a table, Greased needle floats when gently dropped on water etc.

Surface tension can be reduced by (i) Adding of soap or detergents (ii) Heating (iii) Contamination etc.

Surface tension can be expressed mathematically as:

$r = \frac{F}{2L}$

r= Surface tension

F= Force

L= Length

Its S.I. Unit is Nm^{-1}

APPLICATION OF SURFACE TENSION

1. Waterproof Material e.g. Umbrella, Raincoat etc.
2. Cleansing action of soaps and detergents.

CAPILARITY: Capillarity or capillary action is the tendency of liquid to rise and fall in a narrow capillary tube when the tube is dipped into a liquid that wet it. The rising of the liquid depend on the following factors:

a. Cross-sectional area of the tube.
b. Surface tension.

COHESION: Is the force of attraction between molecules of the same kind. For example, the cohesion between mercury molecules makes mercury stick together when poured into a glass without wetting it.

ADHESION: This is the force of attraction between molecules of different substances. For example, the adhesion between water molecule and glass makes water to wet glass.

WEEK 8

VISCOSITY:

This is the internal friction between the layers of a liquid or gas in motion. It increases with increase in temperature.

$$F \propto \frac{(V_1 - V_2)A}{h}$$

$$F = \eta\frac{A(V_1 - V_2)}{h}$$

F = force exerted between layers

η = Coefficient of viscosity

V_1 and V_2 = Velocities of the two layers

A = Cross-sectional area

h = height

TERMINAL VELOCITY: When a stone falls through a liquid, it is subjected to three forces, the weight of the stone acting downward, the uptrust of the liquid acting upward and its viscous force opposing its motion. Terminal velocity is the constant velocity attained by the stone when moving down the liquids

I.e. W= V + U = mg

Where, W = weight,

V = Viscous force,

U = Uptrust

APPLICATION OF VISCOSITY

Oil, grease and air are used as lubricants because of their Viscosity. Engine oil are also used to keep metal from rubbing against each other

WEEK: Nine

SOLAR ENERGY

The sun core temperature is about 15 million degree centigrade, but its surface temperature is 6000^0C.

The energy is as a result of nuclear fusion of the hydrogen molecules.

SOLAR COLLECTOR

These are devices that are used to store solar energy or to convert solar energy to other forms of energy. They are:

(a) Flat plate collector
(b) Focusing collector

*a) **Flat plat collector**: is a large shallow metal box typically mounted on a roof or a high stand. It is usually designed to operate in low temperature range starting from ambient or surrounding to 100^0C.

*b) **Focusing Collector**: The type of collector uses a concave reflector (mirrors or lens) to concentrate the solar beam. The intensity of the beam is raised from 2 to 10000 times.

APPLICATION OF SOLAR COLLECTOR

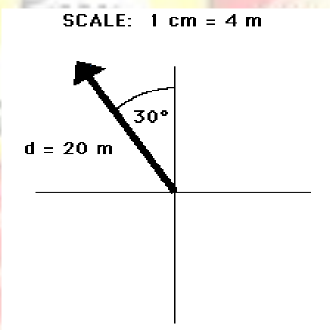
(1) It is used where hot water is in high demand
(2) It is used as source of heat in the evaporation of salt water
(3) Heat source for electricity supply

SS2

1ST TERM

WEEK 1: VECTORS

This is a quantity that has both magnitude and direction. It is typically represented by an arrow whose direction is the same as that of the quantity and whose length is proportional to the quantity's magnitude. For example, displacement, velocity, and acceleration are vector quantities.Vector quantities are often represented by scaled vector diagrams. Vector diagrams depict a vector by use of an arrow drawn to scale in a specific direction.



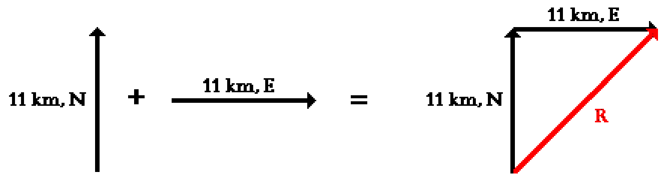
The magnitude and direction of the vector is clearly labeled. In this case, the diagram shows the magnitude is 20m and the direction is (30 degrees West of North).

ADDITION OF VECTOR

There are a variety of methods for determining the magnitude and direction of the result of adding two or more vectors. The two methods that will be discussed in this lesson and used throughout the entire unit are:

- the Pythagorean theorem and trigonometric methods
- the head-to-tail method using a scaled vector diagram

To see how the method works, consider the following problem:
Wasiu leaves the base camp and runs 11 km, north and then runs 11 km east. Determine Eric's resulting displacement.



$$11^2 + 11^2 = R^2$$

$$242 = R^2$$

$$15.6 = R$$

R = 15.6Km

VECTOR RESOLUTION

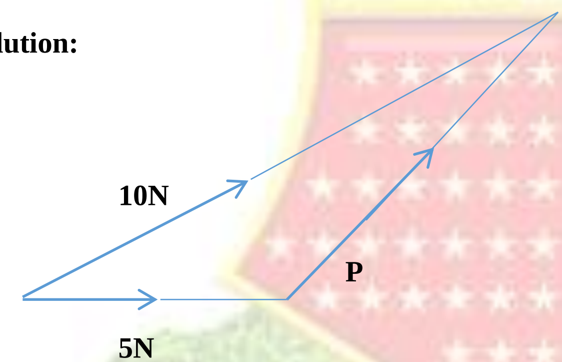
The process of determining the magnitude of a vector is known as **vector resolution**. The two methods of vector resolution are:

- the parallelogram method
- the trigonometric method

Parallelogram law of vector addition states that if two vectors acting at a common point are represented in magnitude and direction by the adjacent sides of a parallelogram, their resultant is represented in magnitude and direction by the diagonal of the parallelogram drawn from their common point of intersection and direct away from that point.

Example: Two forces with magnitudes of 25N and 18N respectively are inclined at an angle of 120^0 to each other. Calculate the resultant force and the angle it makes with the 18N force.

Solution:



$R^2 = A^2 + B^2 – 2AB\cos(180^0-\Theta)$

$R^2 = 25^2 + 18^2 – 2 \times 25 \times 18\cos(180^0-120^0)$

$R^2 = 625 + 324 – 900\cos60^0$

$R^2 = 499$

Resultant, R = 22.34N

. $\frac{Sin\alpha}{A} = \frac{Sin\ 60}{R}$

. $\frac{Sin\alpha}{25} = \frac{Sin\ 60}{22.34}$

$Sin\alpha = 0.9691$

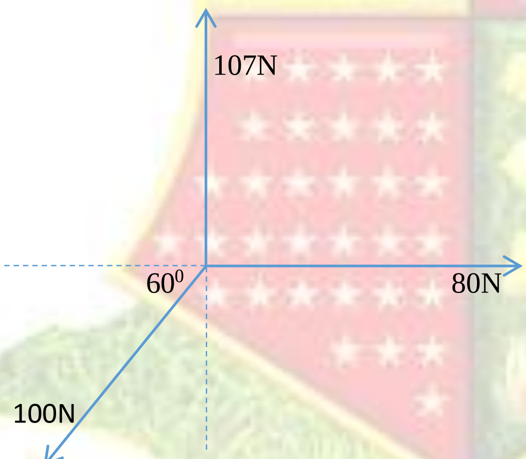
$\alpha = 75.73^0$

RESULTANT OF TWO OR MORE VECTORS BY RESOLUTION

The resultant of two or more vectors can be found by taking the following simple steps:

a. Resolving each vector into vertical and horizontal component.
b. Summing all the components along vertical axis to obtain vertical resultant i.e. ΣF_x
c. Summing all the components along horizontal axis to obtain horizontal resultant i.e. ΣF_y
d. The final Resultant of the vectors is the vector sum of the vertical and horizontal resultants $F = \Sigma F_x + \Sigma F_y$
e. The direction (Θ) of the resultant with the horizontal is given by $\tan\Theta = \frac{\Sigma Fy}{\Sigma Fx}$

Example: Three coplanar forces act simultaneously at a point as shown below



Find the resultant of the forces and its direction with respect to x-axis.

(Take $\sin 60^0 = 0.87$, $\cos 60^0 = 0.50$

Solution:

VERTICAL COMPONENT R_y	HORIZONTAL COMPONENT R_x
$107 \sin 90^0$	$107 \cos 90^0$
$-100 \sin 60^0$	$-100 \cos 60^0$
$80 \sin 0^0$	$80 \cos 0^0$
$\Sigma F_y = 20N$	$\Sigma F_x = 30N$

Resultant $R = \sqrt{R_x^2 + R_y^2}$

$R = \sqrt{30^2 + 20^2}$

$R = \sqrt{1300}$

$R = 36.1N$

Direction is given as $\tan\Theta = \frac{\Sigma Fy}{\Sigma Fx}$

$\tan\Theta = \frac{\Sigma Fy}{\Sigma Fx} = \frac{20}{30}$

$\Theta = 33.7^0$

WEEK: Two

MOTION

SPEED: This is the rate of change distance with time

Speed = $\frac{distance}{time}$

VELOCITY: This is the rate of change of displacement with time

Velocity = $\frac{displacement}{time}$

ACCELERATION: This is the rate of change of velocity with time

Acceleration= $\frac{velocity}{time}$

EQUATIONS OF MOTION

1. $V= U+at$
2. $V^2= U^2 + 2as$
3. $S= ut + ½ at^2$
4. $S = \frac{(V + U)t}{2}$

Example: A car travelling at $54kmh^{-1}$ slows down uniformly to a velocity of $18kmh^{-1}$ when the brakes were gradually applied (a) how long does it take to cover a distance of 50m. (b)What is the deceleration?

Solution:

a) Initial velocity, $U = 54kmh^{-1} = 15ms^{-1}$

Final velocity, $V =18kmh^{-1} = 5ms^{-1}$

Distance covered, s = 50m

$S = \frac{(V + U)t}{2}$

$50 = \frac{(15 + 5)t}{2}$

50 = 10t

t = 5s

b) To determine the deceleration (negative acceleration)

V = u + at
5 = 15 + 5t
-10 = 5a
a = $-2ms^{-2}$

Example: A body, starting from rest, travels for 30s. Determine the final velocity attained after covering a distance of 40m

Solution:
U = 0
t = 30s
S = 40m
S= ut + ½ at^2
40 = 0 x t + ½ x a x 30^2
80 = 900a
a = $0.0889m/s^2$
The final velocity, v = u + at
V = 0 + 0.0889 x 30
V = 2.7m/s

PROJECTILE

A projectile is an object that once *projected* or dropped, continues to move along a curved path by its own inertia and is influenced only by the downward force of gravity.
Projectile motion is a plane- curved motion of an object thrown vertically or obliquely into space and with constant motion
<u>TERMS USED WITH PROJECTILE MOTION.</u>

TIME OF FLIGHT (T)
The total time for which the projectile remains in the air is called the time of flight.

$$T = \frac{2U\sin\theta}{g}$$

MAXIMUM HEIGHT (H)
This is the highest maximum vertical displacement reached by the projected object

$$H = \frac{U^2 Sin^2\theta}{2g}$$

RANGE (R)
The horizontal range *R* of the projectile is the horizontal distance it has traveled when it returns to its initial height

$$R = \frac{U^2 \sin 2\theta}{g}$$

Example: An arrow is shot into space with a speed of 125m/s at an angle of 15^0 to the level ground. Calculate the:

(a) Time of flight
(b) Maximum height attained
(c) Range of the arrow

Solution:

(a) $T = \frac{2U\sin\theta}{g}$

$= \frac{2 \text{ x } 125 \text{ x } \sin 15}{10}$

= 6.47seconds

(b) $H = \frac{U^2 Sin^2\theta}{2g}$

$H = \frac{125^2 Sin^2(15)}{2(10)}$

= 52.33m

(c) $R = \frac{U^2 \sin 2\theta}{g}$

$R = \frac{125 \text{ x } \sin 2(15)}{10}$

= 781.25m

WEEK: Four

EQUILIBRIUM FORCES

The sum of the forces acting on a particle is called the **resultant**. If the resultant of the forces acting on a particle is zero we say that these forces are in equilibrium. The forces acting on a particle at rest or moving with constant velocity are in **equilibrium**. In practical terms this means, for forces in equilibrium the sum of the components of the forces in any direction must be zero.

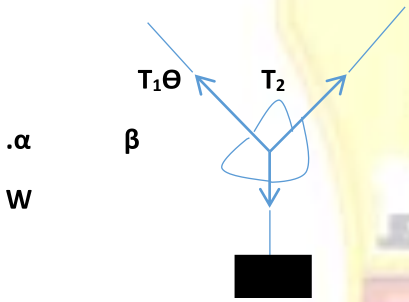
EQUILLIBRIUM OF THREE COPLANAR FORCES

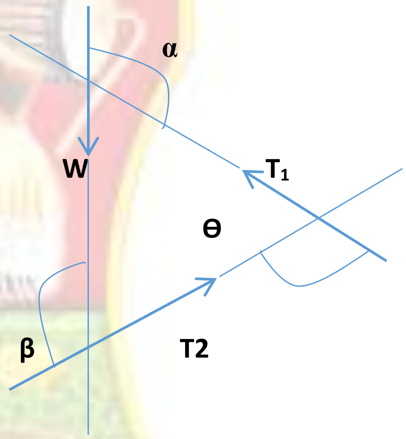
Three coplanar forces T1, T2 and W are in static equilibrium if their point of intersection O is at rest.

Equilibrant: is a force which is equal in magnitude to the resultant of two or more forces, but its direction is opposite to the resultant

HOW TO DETERMINE THE EQUILLIBRANT

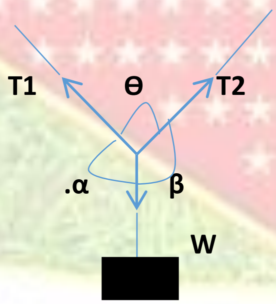
1. **Using Parallelogram law of forces**: which states that if two forces acting at a common point are represented in magnitude and direction by the adjacent sides of a parallelogram, their resultant force is represented in magnitude and direction by the diagonal of the parallelogram drawn from their common point of intersection and direct away from that point
2. **Triangle law of forces:** It states that three forces acting simultaneously at a point are in equilibrium if their force vectors form a close triangle.





It is given as $\frac{T_1}{Sin(180-\beta)} = \frac{T_2}{Sin(180-\alpha)} = \frac{W}{Sin(180-\theta)}$

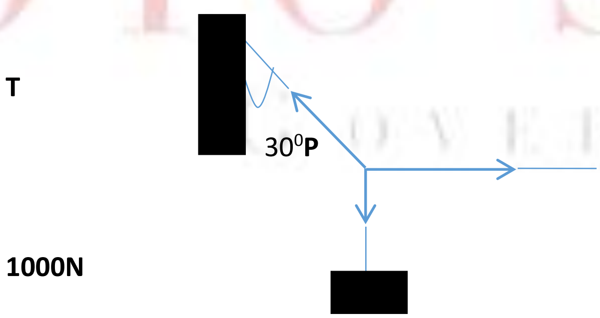
3. **Lami's theorem:**



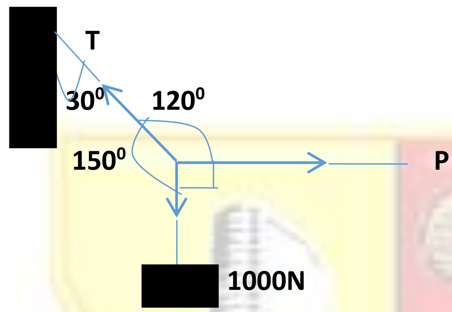
Lami's theorem is given as $\frac{T_1}{Sin\beta} = \frac{T_2}{Sin\alpha} = \frac{W}{Sin\theta}$

4. **Resolution of Vectors**

Example: A weight of 1000N is suspended using a chain fixed on a vertical wall. The chain makes an angle 30^0 with the wall when a horizontal force P is applied to the chain as shown below. Calculate the magnitudes of the tension T in the chain and the horizontal force P if the system is in equilibrium.



Solution:



Using lami's theorem:

$$\frac{T}{Sin90} = \frac{P}{Sin150} = \frac{1000}{Sin120}$$

$$\frac{T}{Sin90} = \frac{1000}{Sin120}$$

T = $\frac{1000 \ x \ sin90}{Sin120}$

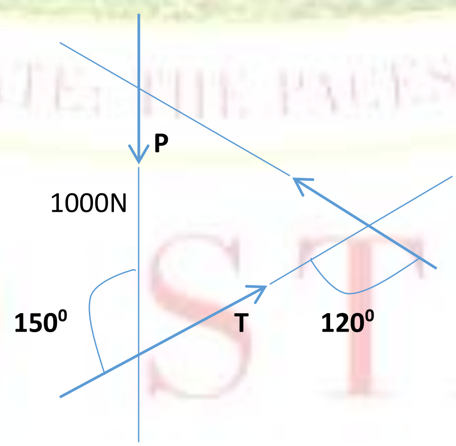
= 1154.7N

= $\frac{P}{Sin150} = \frac{1000}{Sin120}$

P = $\frac{1000 \ x \ sin150}{Sin120}$

P = 577.4N

Using triangle law of forces:



$$\frac{T}{Sin(180-90)} = \frac{P}{Sin(180-150)} = \frac{1000}{Sin(180-120)}$$

$=\frac{T}{Sin90} = \frac{1000}{Sin60}$

T = 1154.7N

$.\frac{P}{1000}$ = tan 30^0

P = 1000tan30^0

P = 577.4N

WEEK: Five

MOMENT OF A FORCE

This is the product of force and the perpendicular distance to the line of action of the force from the turning point.

Moment M = Force (F) x perpendicular distance (d)

M = F x d

Moment of an inclined force is given as M = F x dsinϴ

MOMENT AND EQUILIBRIUM

The principle of moment states that if many parallel forces act on a body, equilibrium is maintained if the sum of clockwise moments about any point is balanced by the sum of anticlockwise moment about the same point. It can also be stated as a body will be in equilibrium if the resultant moment about any point on the body is zero.

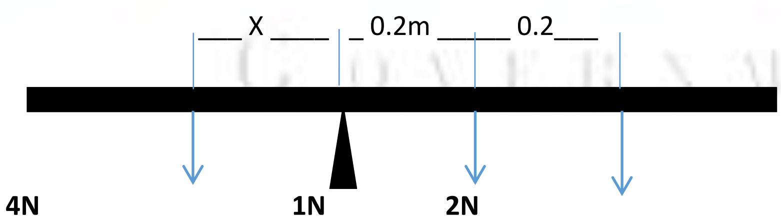
Conditions of equilibrium for parallel coplanar forces

A body acted upon by many parallel forces is in static equilibrium if:

1. The resultant force acting on the body is zero.
2. The resultant moment about a turning point is zero.

Example: The diagram below shows a ruler balanced at the center of gravity.

(a) Calculate the value of (X) if the forces shown act upon the ruler.
(b) What is the reaction at the fulcrum?



Solution:

(a). Taking moment about the fulcrum,

Sum of clockwise moments = Sum of anticlockwise moment

$4(0.5 - x) = 1(0.2) + 2(0.4)$

$4(0.5 - x) = 0.2 + 0.8$

$2 - 4x = 1$

$X = 0.25m$

(b). R = the reaction at the support

$R = 4N + 1N + 2N = 7N$

WEEK: Six

STABILITY

A stable body does not topple over if it is slightly displaced from its equilibrium position. Stability of a body depends on the position of the center of gravity.

TYPE OF EQUILIBRIUM

1. **<u>Stable equilibrium</u>:** A body is in stable equilibrium if when it is slightly displaced from its rest position it does not topple over e.g. A cone sitting on its base, A Bunsen burner standing on a large base etc.

A body will be stable equilibrium if:

a. The position of center of gravity is as low as possible.
b. It rests on a large base.
c. The position of the center of gravity is increased slightly when it is displaced a little from equilibrium position.
d. On a slight displacement from the equilibrium position, the line of action of its weight passes through the base.

2. **<u>Unstable equilibrium</u>:** A body is in a state of unstable equilibrium if when slightly displaced from its rest position, it tend to seek for a new position where the center of gravity is lowest e.g. A cone standing on its v vertex.

A body will be Unstable equilibrium if:

- **a.** The position of center of gravity is high.
- **b.** It lies on a small base.
- **c.** The position of the center of gravity is decreased slightly when it is displaced a little from the equilibrium position.
- **d.** On a slight displacement from the equilibrium position, the line of action of its weight falls outside the base.
- **e.** It tends to seek for a new position where the center of gravity is lowest.

3. **Neutral equilibrium:** A body is in neutral equilibrium if the position of center of gravity does not change when it is slightly displaced from its rest position e.g. A cone standing on its side, a football on a flat floor, a cylinder on its side etc.

APPLICATION OF EQUILIBRIUM

1. Racing car, Lorries and ships have very low center of gravity to prevent the tendency of toppling when going round a sharp bend.
2. Items like drinking glass, retort stand, Bunsen burners and a standing fan are built with large base to make them stable.
3. Stable toys are weighted at the base to make them stable.

WEEK: Seven

EQUILIBRIUM OF BODIES IN FLUID

DENSITY AND RELATIVE DENSITY

Density can be defined as the mass of a substance per unit volume, while **Relative density** is defined as the ratio of the mass of a given volume of a substance to the mass of an equal volume of water

R.D. $= \frac{Mass\ of\ substance}{Mass\ of\ equal\ volume\ of\ water}$ Density $= \frac{Mass}{Volume}$

The unit of density is Kgm^{-3}, while relative density has no unit.

Archimedes' Principle states that when a body is totally or partially immersed in a fluid, the upthrust on it is equal to the weight of the fluid displaced.

Upthrustcan be defined as the reaction force exerted on a body when wholly or partially immersed in a fluid. It depends on the volume of solid immersed and the nature of the liquid in which the body is immersed.

Upthrust = Weight of water displaced = Mass of water x gravity

Upthrust = Density of water displaced x Volume of water displace x gravity

Upthrust = ρVg

DETERMINATION OF RELATIVE DENSITY (R.D.) OF SUBSTANCES USING ARCHIMEDES PRINCIPLE

Relative density of a substance is given as:

R.D. = $\frac{weight\ of\ substance}{Weight\ of\ the\ same\ volume\ of\ water} = \frac{W_1}{W_{1-}\ W_2}$

W_1 = Weight of solid in air

W_2 = Weight of solid in water

$W_1 - W_2$ = Upthrust

Relative density of a liquid is given as:

R.D. = $\frac{W-W_1}{W_-\,W_2}$

W = Weight of solid in air

W_1 = Weight of solid in liquid

W_2 = Weight of solid in water

Example: If a body weighted 10N when suspended on a spring balance, if it weighted 8.5N when dipped in kerosene and weighted 8N when immersed in water. Calculate the relative density of kerosene

Solution:

W = Weight of solid in air = 10N

W_1 = Weight of solid in liquid = 8.5N

W_2 = Weight of solid in water = 8N

R.D. = $\frac{W-W_1}{W_-\,W_2}$

R.D. = $\frac{10-8.5}{10-8}$

R.D. = 0.75

FLOTATION

Two forces act on a body immersed or floating in a liquid, the weight acting downwards and the uptrust acting inwards. The body floats in the liquid if the upthrust on it is equal to its weight and sinks if the weight is greater that the upthrust.

Principle of floatation states that when a body is totally or partially immersed in a fluid, its weight is equal of the fluid displaced.

I.e. **Weight of body floating = Weight of fluid displaced**

Objects such as ship and ice float simply because:

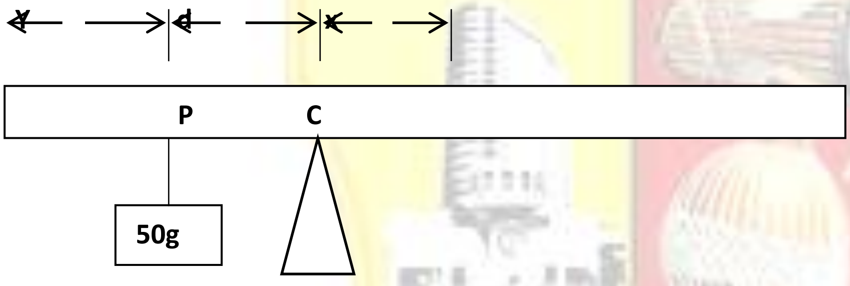
1. They can displace the weight of water equal to their own weight.
2. Their weights are in equilibrium with upthrust.

WEEK: Eight

PRACTICAL: **Verification of Principle of moment**

DETERMINATION OF MASS OF A METER RULE FROM PRINCIPLE OF MOMENT

APPARATUS: Meter rule, Knife edge, mass (50g), Thread, Knife edge



Balance a meter rule on the knife edge and record the scale mark **c**, corresponding to the distance of its center of gravity from the zero end of the rule. (ii) Suspend the given mass (50g) from the meter such the **y** = 2cm as shown in the diagram above. (iii) Balance the meter rule with the hanging mass on the knife edge. (iv)Read and record the position, **P**, of the pivot. Determine the value of d and x. (v) Repeat the experiment with **y**= 4, 6, 8, 10 1nd 12cm respectively. In each case, record the position **P** of the pivot and determine the corresponding value of d and x. (vii) tabulate your readings. (viii) Plot a graph of **d** against **x**. Determine the slope **S** of the graph and evaluate **k** = 50S. (ix) State two precautions taken to ensure accurate results.

WEEK: Nine

SIMPLE HARMONIC MOTION (SHM)

Simple harmonic motion can be defined as the periodic motion of a particle whose acceleration and restoring force are directed towards a fixed (equilibrium) point and are directly proportional to its displacement from the equilibrium position. Examples of simple harmonic motion are given as:

1. The motion of a simple pendulum swinging to and fro.
2. The motion of a weight moving up and down on one end of a spiral spring.
3. The motion of the prong of a tuning fork.
4. The up and down movement of a loaded test tube when pressed down and released in a liquid.
5. Vibration of electric and magnetic waves in electromagnetic field.
6. Vibration of atoms of a solid above their equilibrium position.

TERMS USED IN DESCRIBING SIMPLE HARMONIC MOTION

1. Amplitude (**A**): This is the maximum vertical displacement of a particle from mean or rest position. This is denoted by '**A**' and measured in meter '**m**'.
2. Wave Length (λ):This is the distance between two successive crests or troughs of the wave. It is measured in meter '**m**'.
3. Period (**T**):This is the time taken to make one complete oscillation. It is denoted by **T** and measure in seconds (**s**).

4. Frequency (**F**): The number of cycles which the wave completes in one second is called the frequency (**F**). Its S.I. unit is Hertz (**Hz**).
5. Cycle or oscillation or Vibration: This is to and fro movement of a particle from one extreme position to the other and back.

Period of a spiral spring with weight attached exhibiting simple harmonic motion is given as: T = 2π $\sqrt{\frac{m}{k}}$

.m = Mass of body attached
K= Force constant of the spring

Period of a simple pendulum exhibiting simple harmonic motion is given as: T = 2π $\sqrt{\frac{l}{g}}$

L= Length of pendulum
.g = Gravity

Period of a loaded test tube exhibiting simple harmonic is given as: T = 2π $\sqrt{\frac{m}{\rho g A}}$

.ρ = Density of liquid
.g = Gravity
A = Area

Example: The period of oscillation of a simple pendulum is 2.18seconds. Calculate:

a. The time taken for 50 oscillations
b. The length of the simple pendulum

(Take g = 10ms^{-2}; π = 3.142)

Solution:

T = $\frac{t}{n}$

2.18 = $\frac{t}{50}$

.t = 109seconds.

T = 2π $\sqrt{\frac{l}{g}}$

2.18 = 2 x 3.142 x $\sqrt{\frac{l}{10}}$

L = $\frac{10\ x\ 2.18^2}{2^2 x\ 3.142^2}$

L = 1.203m

SPEED AND ACCELERATION IN S.H.M.

Linear displacement (Ө): This is the angular distance (Ө) and the linear distance(s) covered when a particle is moving around a circle of radius (r).

It is given as **Ө =** $\frac{s}{t}$

The displacement of S.H.M. is thus given as **x = r sin wt**

Angular Velocity (w): This is the angle turned through per second of time rate of change of angular displacement. It is given as w =$\frac{\theta}{t}$. Its unit is $radsec^{-1}$

In relationship with linear velocity v = wr

The angular Velocity of S.H.M. is given as v = wrcoswt= $\pm w\sqrt{r^2 - x^2}$

V_{max} **= wr**

Angular Acceleration(a): This is the angle turned through per second squared or time rate of change in angular velocity. It is given as **α =** $\frac{w}{t}$

In relationship with linear acceleration: a = $\frac{v^2}{r}$ **=** w^2r

The angular acceleration of S.H.M. is given as a = -$w^2 r \sin wt$

a_{max} **=** w^2r

Example: A particle undergoes simple harmonic motion with amplitude of 5cm and angular velocity $12\pi rads^{-1}$ calculate:

a. The maximum velocity
b. The velocity when it is 2cm from the equilibrium position
c. The maximum acceleration of the particle
d. The period of oscillation

Solution:

a. V_{max} = **wr** = 12π x 0.05 = 0.6πm/s

b. V = $\pm w\sqrt{r^2 - x^2}$ = $\pm 12\pi\sqrt{0.05^2 - 0.02^2}$ = ±**0.55** πm/s²

c. $a_{max} = w^2r = (12\pi)^2$ x **0.05** = **7.2**π^2m/s²

d. T = $\frac{2\pi}{w} = \frac{2\pi}{12\pi}$ = **0.167s**

FREE, DAMPED AND FORCE VIBRATION

A vibration is said to be **free** if the total energy of a vibrating object is constant. No energy is lost by the object which makes the amplitude and frequency remain constant.

While a vibration is said to be **damped** if energy is continuously lost as the body vibrates. The energy loss makes its amplitude and frequency to decrease.

While a Force vibration is a vibration in which energy is constantly supplied to the vibrating body by an external periodic force e.g. Vibration of table surfaces when a sounding tuning fork is pressed on the tabletop, the vibration of a piston and the connecting rod in an engine.

RESONANCE AND ENERGY TRANSFORMATION IN S.H.M.

Resonance: This occurs when a body is set into vibration at its natural frequency by another vibrating body due to impulse received from that body such that they both vibrate at the same frequency e.g. shattering of a fragile glass by directing sound of high pitch to it, Barton's pendulum, and collapse of bridge when it is forced to vibrate at its natural frequency, Television and radio tuning circuits have capacitors and inductors which resonate at a frequency corresponding to the frequency of the transmitting station etc.

Natural frequency is the frequency at which a body tends to vibrate if left undisturbed.

The following occurs when a body is at resonance:

1. The frequency of the applied external force is equal to the natural frequency of the vibrating body.
2. The body vibrates with maximum amplitude with the gained energy replacing lost energy during the same interval.

Kinetic energy $E_k = ½ k (r^2 - x^2)$

Maximum K.E. is given as $E_k = ½ kr^2$

2^{ND} TERM

WEEK: ONE

LINEAR MOMENTUM

Momentum is defined as the product of mass and velocity of a body.

Momentum (P) = mass (m) x velocity (v).

Change in Momentum $\Delta P = mv - mu$

Impulse of a force is the product of a force and the time taken.

$I = F \times t$

$F \times t = mv - mu$

$I = \Delta P$ (impulse = change in momentum).

NEWTON's 1^{ST} LAW OF MOTION

It states that every object will continue in its state of rest or uniform motion in a straight line unless an impressed force act on it..

Inertia is the reluctance of a body to change its state of rest or motion in a straight line. It can also be defined as the tendency of a body to continue at rest or constant velocity in a straight line.

NEWTON's 2^{ST} LAW OF MOTION

It states that the change in momentum of a body per unit time is directly proportional to the force causing the change and takes place in the same direction of the straight line along the force act.

Force = $\frac{Change\ in\ momentum}{Time}$

Force = $\frac{mv-mu}{t} = \frac{m(v-u)}{t}$ = ma

Example: When a force is impressed on amass of 25kg for 5seconds, the velocity changes from 12m/s to 15m/s. calculate

a. Change in momentum.
b. Impulse.
c. Impact force on the body.

Solution:

a. $\Delta P = mv - mu = 0.25 \times 25 - 0 = 6.25$Kgm/s
b. Impulse = momentum change = 6.25Kgm/s
c. Force = $\frac{Change\ in\ momentum}{Time}$
   $= \frac{6.25}{0.01} = 625$N.

NEWTON's 3RD LAW OF MOTION

It statesthat to every action there is an equal and opposite reaction.

CONSERVATION OF LINEAR MOMENTUM

The principle of conservation of linear momentum states that when two or more bodies collide, the momentum before collision is equal to momentum after collision if no external force is impressed on them.

I.e. $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

COLLISION

This is when two or more bodies exert forces on each other for a relatively short time.

TYPES OF COLLISION

1. Elastic collision.
2. Inelastic collision.
1. **Elastic Collision:** This is the collision in which both the momentum and kinetic energy are conserved.
   I.e. $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$
   $\frac{1}{2} m_1u_1^2 + \frac{1}{2} m_2u_2^2 = \frac{1}{2} m_1v_1^2 + \frac{1}{2} m_1v_2^2$
2. **Inelastic Collision:** This is the collision in which momentum is conserved but kinetic energy is not conserved.
   I.e. $m_1u_1 + m_2u_2 = (m_1 + m_2)\ v$
   $\frac{1}{2} m_1u_1^2 + \frac{1}{2} m_2u_2^2 \geq \frac{1}{2}(m_1+m_1)v^2$

Example: A trolley of mass 2.5kg travelling at 3m/s collides with another trolley of mass 4.0kg travelling at 15m/s in the same direction. The impact lasted for 0.125seconds before the trolley continued to move with a velocity of 2m/s^2 in the same direction. Calculate:

a. Velocity of 4kg trolley after impact
b. Impulse
c. Kinetic energy loss

Solution:

(a) $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$
$2.5 \times 3 + 4 \times 1.5 = 2.5 \times 4v_2$
$13.5 = 4v_2 + 5$
$v_2 = 2.125m/s$

(b) **I**mpulse on 4kg trolley,
$= m_1v_1 - m_1u_1$
$=4 \times 2.125 - 4 \times 1.5$
$= 2.5Ns$
Impulse of 2kg $= m_2v_2 - m_2u_2$
$= 2.5 \times 2 - 2.5 \times 3$
$= -2.5Ns.$

(c) Kinetic energy before impact
$E_k = ½\, m_1u_1^2 + ½\, m_2u_2^2$
$= ½ \times 2.5 \times 3^2 + ½ \times 4 \times 1.5^2$
$= 15.57J$
Kinetic energy after impact
$E_k = ½\, m_1v + ½\, m_2v_2^2$
$= ½ \times 2.5 \times 2^2 + ½ \times 4 \times 2.125^2$
$= 14.03J$
Loss in Kinetic energy $= 15.75 - 14.03$
$= 1.72J.$

APPLICATION OF MOMENTUM

1. Rocket and Jets propulsion
2. Reduction of damaged to automobile during impact.
3. High jumpers and long jumpers flex their knees on landing to prolong impact and reduce impact forces on their knee and joints.

WEEK: Two

MACHINE

This is a device or piece of apparatus which enables a large resistance (load) applied at one point to be overcome by a small force (effort) at same other point.

BASIC TERMS AND DEFINITIONS

1. **Mechanical advantage (M.A)**: This is the ratio of load to effort.

   M.A $= \frac{load\ (l)}{effort\ (e)}$

   M.A. depends on friction, a good machine must have M.A<1.

2. **Velocity ratio (V.R.):** This is the ratio of the distance travelled by effort to the distance travelled by load.

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

M.A. = V.R. if the machine is frictionless, V.R. is independent of friction but depends on the working part of the machine.

3. Efficiency of a machine (E): This is the percentage of the ratio of work output to work input

E = $\frac{work\ output}{Work\ input}$x 100

E = $\frac{Load\ x\ distance\ moved\ by\ load}{Effort\ x\ distance\ moved\ by\ effort}$x 100

E = $\frac{Mechanical\ advantage}{Velocity\ ratio}$x 100

Efficiency E < 1

TYPES OF MACHINE

1. Lever.
2. Pulleys.
3. Wheel and axle.
4. Windless.
5. Inclined plane.
6. Screw jack.
7. Gear.
8. Hydraulic press.

WEEK: Three

VELOCITY RATIO OF SIMPLE MACHINES

1. **Velocity** ratio of Pulley system = Number of pulley
2. **Velocity** ratio of Wheel and axle = $\frac{2\pi R}{2\pi r}$ = $\frac{R}{r}$ where R= radius of wheel and r = radius of axle
3. **Velocity** ratio of Inclined plane = $\frac{1}{sin\theta}$ = $\frac{l}{h}$ where l = length of inclined plane, h = height of platform and ϴ = angle of inclination of plane.
4. **Velocity** ratio of screw jack = $\frac{2\pi r}{p}$ where r = length of effort arm = radius of circle formed on rotating screw handle and p = pitch.
5. **Velocity** ratio of Gear = $\frac{\text{number of teeth of the driven wheel}}{\text{number of teeth of the driving wheel}}$
6. **Velocity** ratio of Hydraulic press = $\frac{R^2}{r^2}$ where r = radius of effort piston and R = radius of load piston.

Example: A block and tackle system of 6 pulleys is used to raise a load of 300N steadily through a height of 30m.If work done against friction is 2000J. Calculate.

i. The work done by the effort.
ii. The efficiency of the system.
iii. The applied effort.

Solution:

i. Work done by effort = work done in raising load + work done against friction
= (300 x 30) + 2000
= 11000J.

ii. E = $\frac{work\ output}{Work\ input}$ x 100

E = $\frac{work\ done\ on\ load}{Work\ done\ by\ effort}$ x 100

E = $\frac{300\ x\ 30}{11000}$ x 100

= 81.8%

iii. E = $\frac{Mechanical\ advantage}{Velocity\ ratio}$ x 100

81.8 = $\frac{M.A.}{6}$ x 100

M.A. = 4.92

iv. M.A = $\frac{load\ (l)}{effort\ (e)}$

4.92 = $\frac{300}{effort\ (e)}$

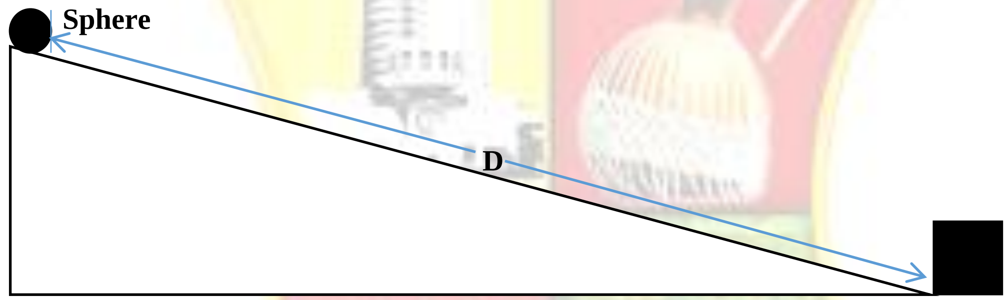
E = 61N

WEEK: Five

PRACTICAL

USE OF INCLINED PLANE AS A SIMPLE MACHINE AND DETERMINE ITS EFFICIENCY, V.R. AND M.A.

APPARATUS: Grooved plank (of about 150cm long), solid sphere, Pile of paper/ soft tissue paper, Stop watch.



(i) Place the pile of paper at the tail end of the inclined plane to stop the sphere from rolling off the table as shown in the above diagram. **(ii)** Release the sphere from a point at distance D = 140cm from the tail end of the inclined plane. **(iii)** Determine the average time t taken by the sphere to cover this distance. **(iv)** Evaluate W = D/t. **(v)** Calculate V = 2W. **(vi)**Repeat the procedure for D= 120cm, 100cm and 80cm respectively. **(vii)** Tabulate your readings **(viii)** Plot the graph of V on vertical axis and t on horizontal axis. **(ix)** Determine the slope, s, of the graph. **(x)** What is the significant of s? **(xi)** State two precautions taken to obtain accurate results.

WEEK: Six
HEAT ENERGY (I)
TEMPERATURE
This is the degree of hotness or coldness of a body. The instrument used in measuring **Temperature** is called **Thermometer. T**he types of thermometer are given below

1. Thermocouple thermometer.
2. Platinum resistance thermometer.
3. Gas thermometer.
4. Liquid-in-glass thermometer i.e. Laboratory, clinical and six's maximum and minimum thermometer.

	Names of Thermometer	Thermometric substance	Thermometric (Physical) properties	Advantage
1	Liquid-in-glass thermometer	Alcohol or Mercury	Changes in length of liquid thread in the stem of the thermometer as temperature changes.	It is portable and easy to use.
2	Gas thermometer	Gas	Change in the pressure of a gas at constant volume.	Accurate measurement of temperature and measures wider ranges of temperature.
3	Thermocouple thermometer	Two different metals	Changes in the e.m.f. between junctions of two different metals kept at different temperature.	Quick response to changes in temperature and wider ranges of temperature.
4	Resistance thermometer	Resistance wire	Changes in electrical Resistance of a wire due to rise in temperature.	It responds to small changes in temperature, very accurate and wider ranges in temperature.
5	Pyrometer		Color changes of radiation from hot bodies.	It measures temperature without being in contact with the hot body.
6	Bimetallic thermometer	Two different metals	Expansion of contraction of bimetallic strip as temperature changes.	

SPECIFIC HEAT CAPACITY OF A SUBSTANCE

This is the quantity of heat energy needed to change the temperature a unit mass by 1Kelvin.

C = $\frac{Q}{m\Delta\theta}$Its unit is $Jkg^{-1}k^{-1}$

While, **heat capacity** can be defined as the quantity of heat needed to change the temperature of any mass of a substance by 1Kelvin.

C = mc

Example: How much heat is needed to increase the temperature of 0.15kg of water from 30^0C to 50^0C, if the specific heat capacity of water is 4200J/kg/K.

Solution:

M = 0.15kg

.$\Delta\Theta = 50 – 30 = 20^0$

$Q = mc\Delta\Theta = 0.15 \times 4200 \times 20 = 12600$J.

Measurement of Specific heat capacity by method of mixture

$M_sC_s (\Theta_3 - \Theta_2) = M_wC_w (\Theta_2 - \Theta_1) + M_cC_c (\Theta_2 - \Theta_1)$

M_s and C_s= mass of solid and specific heat capacity of solid.

$M_w$and C_w= mass and specific heat capacity of water

$M_c$and C_c= mass and specific heat capacity of calorimeter

Θ_3= Initial Temperature of solid

Θ_2= Temperature of the mixture

Θ_1= temperature of water and calorimeter.

Measurement of Specific heat capacity by Electrical method

$IVt = M_sC_s (\Theta_2 - \Theta_1)$

M_s and C_s= mass of solid and specific heat capacity of solid.

I = current

V = voltage

Θ_2 = Initial Temperature of solid

Θ_1= Final temperature of solid

LATENT HEAT

This is the heat energy required to change the state of a body without temperature change. It can be in the following form

i. **Latent heat of fusion:** This is the heat energy needed to change 1kg of a solid to liquid at constant temperature
   Q = ml_f
ii. **Latent heat of vaporization:** This is the heat energy required to convert 1kg of a liquid to vapour at constant temperature.
   Q = ml_v

Example: An aluminium solid at 100^0c is dropped into a copper calorimeter of mass 60g containing 80g of water at 20^0c. Calculate the mass of the aluminium solids if the steady maximum temperature of the mixture is 30^0c. (S.H.C of copper = 400J/Kg/K, S.H.C. of aluminium = 900 J/Kg/K and S.H.C of water = 4200J/kg/K).

Solution:

M_w= 60g = 0.06kg

M_c= 80g = 0.08kg

$M_sC_s (\Theta_3 - \Theta_2) = M_wC_w (\Theta_2 - \Theta_1) + M_cC_c (\Theta_2 - \Theta_1)$

M_sx 900 x 70 = (0.06 x 400 x 10) + (0.08 x 4200 x 10)

63000M_s = 240 + 3360

M_s = 0.057Kg

THIRD TERM

WEEK: One

WAVES

A wave is disturbance which travels through a medium and transfer energy from one point to another without causing any permanent displacement of the medium itself.

WAVE MOTION

This is a process of transferring a disturbance (in form of kinetic energy) from one point to another in a medium without any transfer of the particles of the medium.

CLASS OF WAVES

Waves are generally classified into two, namely

1. Mechanical Waves
2. Electromagnetic Waves

1. **Mechanical Wave:** These are waves that require a material medium for their mode of propagation e.g. water waves, sound waves etc.
2. **Electromagnetic Wave:** These are waves that do not require or need a material medium for their propagation but they travel successfully in free space e.g. light waves, radio waves, x-rays etc.

WATER WAVES IN RIPPLE TANK SYSTEM

Ripple tank is an experimental setting used to study water waves. The wave is produced by the operating dipper which generates continuous pulses. These continuous waves can be made to appear stationary by the use of stroboscopes.

TYPES OF WAVES GENERATED FROM RIPPLE TANK

Two types of waves generated from ripple tank system are:

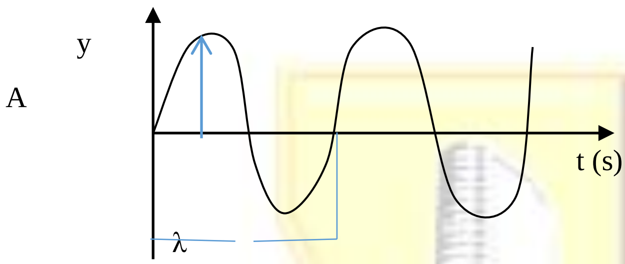
1. Plane wave.
2. The spherical or circular wave.

1. **The Plane wave:** When the dipper of the ripple tank is in form of a horizontal metal or wooden strip, parallel plane waves are produced.
2. **The Spherical Wave:** When the dipper is in form of sphere, spherical or circular waves are produced.

TYPES OF MECHANICAL WAVES

1. **Transverse Wave:** This is a wave which the vibration of the medium transmitting the wave is at right angles (perpendicular) to the direction the wave is travelling. Examples are water wave, waves generated by plucking a string fixed at both end and electromagnetic waves etc.

2. **Longitudinal Waves:** Tis is wave whose direction of propagation in a medium is parallel to the vibration of the particle of the medium transmitting it. E.g. sound waves, wave generated in rope.



WAVE REPRESENTATION

1. **Amplitude (A)**: This is the maximum displacement of a particle from the point of rest. This is denoted by 'A' and measured in meter 'M'.
2. **Wave Length (λ)**:This is the distance between two successive crests or troughs of the wave.
3. **Period (T)**: This is the time taken for one complete oscillation. It is denoted by T and measure in seconds.
4. **Frequency (F)**: The number of cycles which the wave completes in one second is called the frequency (F). Its S.I. unit is Hertz (HZ).
5. **Vibration**: This is to and fro movement of a particle from one extreme position to the other and back.
6. **Wave Speed (V)**: This is the distance travelled by the wave in one second. Its S.I. unit is meter per second.
7. **Wave front**: This is the line or curve which joins all the particles vibrating in phase.

RELATIONSHP BETWEEN PERIOD, FREQUNECY, WAVE LENGTH AND VELOCITY

From the definition of frequency (F) and period (T).

$F = \frac{I}{T}$

The speed V, the wave length and frequency F are related by the equation $V = F\lambda$

WEEK: Two
WAVE (2)

PROGRESSIVE AND STATIONARY WAVES

All waves both transverse and longitudinal which spread out continuously are called travelling or progressive waves.

A stationary or standing waves is a wave obtained when two progressive wave of equal amplitude and frequency are traveling in opposite direction.
These can be expressed as follows:
Y = A Sin (wt$\pm$ kx)
Where Y = wave travelling in vertical direction
A = Amplitude or vertical displacement
W = Angular frequency
T = Time
λ = Wave number
From Y = A sin (wt$\pm$kx)
Since W = 2Πf and K = $\frac{2\pi x}{\lambda}$
Y = A sin (2πft$\pm\frac{2\pi x}{\lambda}$)

Example: A progressive transverse wave profile in a stretched rope given as:
Y = 2.5 sin (0.2πft$\pm 40\pi t$)
The units of x and y are in centimeters and t is time measured in seconds. Calculate the

a. Amplitude of the wave.
b. Wavelength of the wave.
c. Wave velocity.
d. Frequency of the wave.

Solution:

Y = A sin (2πft$\pm\frac{2\pi x}{\lambda}$)

a. A = 2.5cm

By comparing the equation above:

b. $\frac{2\pi x}{\lambda}$ = 0.2πx
$\frac{2}{\lambda}$ = 0.2
.$\lambda = 10cm$
c. 2πft = 40 πt
2f = 40
.f = 20Hz
d. V = f λ
V = 10 x 20
= 200cms^{-1}

PROPERTIES OF WAVES

The properties of waves are:

i. Reflection
ii. Refraction
iii. Diffraction
iv. Interference
v. Polarization

1. **Reflection:** This is a change in the direction of wave when they hit an obstacle. The type of wave formed depends on the type of obstacle they hit.
2. **Refraction:** This is the change in the speed and direction of the wave as they cross the boundaries between two media of different density.
3. **Diffraction:** This is the ability of waves to bend around obstacles in their path where travelling pass through narrow openings or move round obstacles to spread in different directions.
4. **Interference:** This is the effect produced when two waves of the same frequency amplitude and wave length travelling in the same direction in a medium are superposed.
5. **Polarization:** This is a phenomenon whereby a wave whose vibrations are only in one plane is produced. Only transverse waves can be plane polarized.

WEEK: Three

LIGHT WAVES

Light is a visible form of energy which is radiated outward from a source. Natural source of light are sun and stars while artificial source of light are electric lamp, touch, candle, incandescent etc.

1. **Luminous Source:** These sources that produce and emit light themselves e.g. sun, star, fire flies, glowing worms etc.
2. **Non-luminous source:** These sources is one that cannot produce its own light but reflects light falling on them e.g. Mirror, Moon, Paper, Wall etc.

Transparent Objects: These are bodies that allow large percentage of light to pass through them and objects can be seen clearly through them e.g. water, glass etc.

Translucence Objects: These are object that allow small amount of light to pass through them and objects cannot be seen through them e.g. tinted glass, frosted glass, tissue paper etc.

Opaque Objects: These are objects that do not allow light to pass through them and object cannot be seen at all through them e.g. wood, body, book etc.

RAYS AND BEAM

A ray of light is the direction or path through which light energy travels while a beam of light is the collection of rays of light.

TYPES OF BEAM

These are three types of beam:

i. **Parallel beam**: This is a beam of light with parallel rays.

ii. **Convergence beam**: This is a beam of light with its rays moving towards a common point.

iii. **Divergence beam**: This is a beam of light with its rays spreading out from common point.

THE RAY BOX

Rays of light are produced in the laboratory by means of ray box. A ray box consists of an electric lamp and a very narrow slit or slits arranged to produce a very narrow beam of light. Light travels in a straight line. The phenomenon of light travelling in a straight line is called rectilinear propagation of light.

SHADOWS

A shadow is produced by the obstruction of light by an opaque object. The types of shadow formed depend on the size of light source and the distance of the opaque object from light.

Types of shadow are:

1. **Umbra**: This is a region of complete darkness of a shadow.
2. **Penumbra**: This is a region around umbra; it has partial darkness of a shadow.

ECLIPSE

It can be described as a result of a shadow cast by one heavenly body on another one.

1. **Eclipse of the sun:** It occurs when moon is between the sun and the earth.
2. **Eclipse of the moon:** It occurs when the earth is in between the sun and the moon.
3. **Annular eclipse:** This occurs when the sun and the moon are in position where the ends rays intersect before reaching the sun.

PROPERTIES OF LIGHT

i. Light travels in a straight line.

ii. Light produces shadow when obstructed along its path.

iii. Light can be reflected.

iv. Light can be refracted.

v. Light can be diffracted.

vi. Light can be polarized.

PINHOLE CAMERA

The pinhole camera makes use of the fact that light travels in straight line. The pinhole camera consist of a light-tight box, one end of which has a small hole made with a pin or needle point.

Linear magnification is defined as the ratio of image size (distance) to object size (distance).

Mathematically,

Linear magnification (m): $\frac{Image\ size(h_i)}{Object\ size(h_0)} = \frac{Image\ distance\ (v\ )}{Object\ distance\ (u)}$

Example: A man 1.85m tall stands 5.35m in front of a pinhole camera of length 25cm. Find the magnification and the size of image formed.

Solution:

Linear magnification (m) =$\frac{Image\ distance\ (v\ )}{Object\ distance\ (u)} = \frac{0.25}{5.35}$ = 0.0467

Linear magnification (m) = $\frac{Image\ size(h_i)}{Object\ size(h_0)}$

0.0467 = $\frac{Image\ size(h_i)}{1.85}$

Image height = 0.0467 x 1.85 = 0.086m

PLANE MIRROR

A plane mirror is produced by coating one side of plane glass with silver. The silvered surface prevents light rays that strike the glass from passing through the glass.

LAWS OF REFLECTION

There are two laws associated with reflection

1. The incident ray, the reflected ray and the normal at the point of incident all lies on the same plane.
2. The angle of incident is equal to the angle of reflection.

CHARACTERISTICS OF IMAGES FORMED BY PLANE MIRROR

1. It is the same size as the object in front.
2. It is as far behind the mirror as the object in front.
3. It is laterally inverted.
4. It is Virtual.
5. It is upright.

REFLECTION BY CURVED MIRROR

These are two types of curved mirror; these are

1. Concave mirror.
2. Convex mirror.

1. **Concave Mirror:** This is a curved mirror that produces a real image and has the right hand side of its surface coated with silver.

2. **Convex Mirror:** Convex mirror at any point produces virtual images and has its left hand side inward coated.

IMAGES FORMED BY CONCAVE MIRROR

It depends of the position of the object from the pole of the mirror.

1. The object further than Centre of curvature.
   The properties of image formed are:
   i. The image formed is diminished.
   ii. The image is formed between the center of curvature and the focus of the mirror by real light interaction.
   iii. The image formed is inverted.
   iv. The image formed is real.

2. The object at Centre of curvature.
   The properties of image formed are:
   i. The image formed has the same size as the object.
   ii. The image is formed at the center of curvature of the mirror by real light interaction.
   iii. The image formed is inverted.
   v. The image formed is real.

3. Object between Centre of curvature and Focus.
   The properties of image formed are:
   i. The image formed is magnified.
   ii. The image is formed beyond the center of curvature of the mirror by real light intersection.
   iii. The image formed is inverted.
   iv. The image formed is real.

4. Object between Focus and Pole.
   The properties of image formed are:
   i. The image formed is magnified.
   ii. Image is formed behind the mirror by apparent light interaction.
   iii. The image is erect.
   iv. The image is Virtual.

5. Object at Focus.
   The properties of image formed are:
   i. The image formed is magnified.
   ii. The image is formed beyond the center of curvature of the mirror by real light intersection.
   iii. The image formed is real.
   iv. The image formed is inverted.

IMAGES FORMED BY CONVEX MIRROR

In a convex mirror, the image is formed behind the mirror irrespective of the position of the objects. It is always Virtual, Erect and diminished.

MIRROR'S FORMULA

Mirror formula is given by $\frac{I}{F} = \frac{I}{V} + \frac{I}{U}$

Where V = image distance

U = object distance

F = focal length

Example: A small pin is placed 10cm in front of a concave mirror of focal length 15cm.

i. Calculate the image distance formed and magnification of the image.
ii. What is the nature of the image?

Solution:

i. $\frac{I}{F} = \frac{I}{V} + \frac{I}{U}$

$\frac{I}{15} = \frac{I}{10} + \frac{I}{U}$

$\frac{I}{v} = \frac{I}{15} - \frac{I}{10} = - \frac{I}{30}$

V = - 30cm.

Magnification (m) $= \frac{v}{u} = - \frac{30}{10} = - 3.$

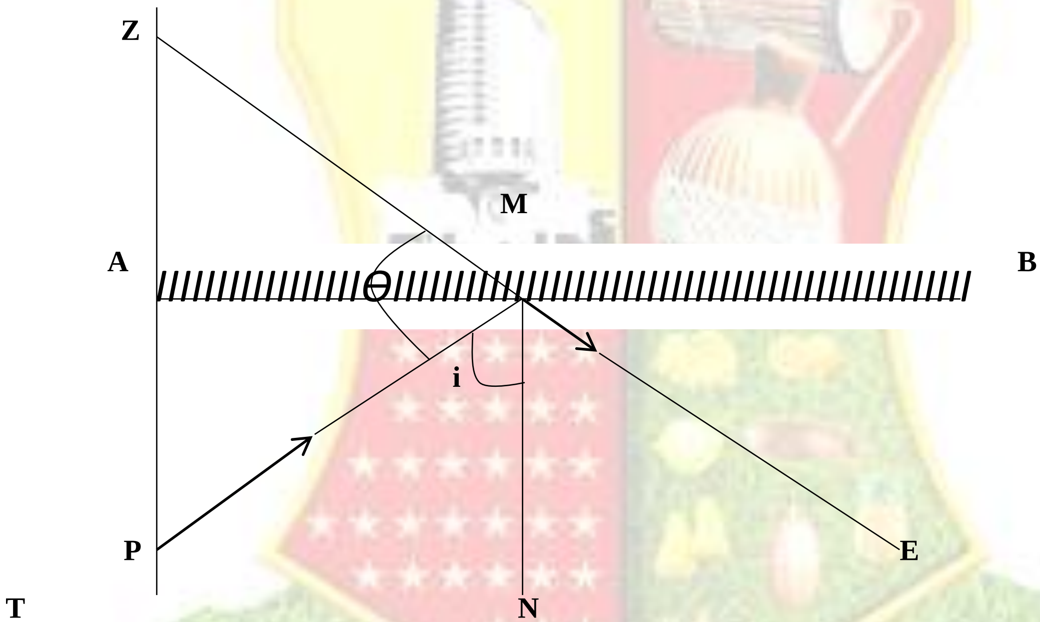
ii. The value of m and v indicates the nature of the image is an erect and virtual image, three times the size of the object is formed behind the mirror

WEEK: Four

PRACTICAL ON LIGHT WAVES

Verification of law of reflection

APPARATUS: (Vertically supported) Plane mirror, 3 optical pins, Drawing board, Drawing sheets, Drawing pins, Ruler and protractor.



(i) Measure and record the length L of the mirror provided and draw a line AB = L on a sheet of drawing paper. (ii) Mark a point M at the mid-point of AB. Draw normal MN and AT at M and A respectively as shown in the diagram above. (iii) Draw a line MQ making angle I = 30^0 with MN and produce it to meet AT at P. (iv) Now, place the mirror with its length along AB and its reflecting plane vertical. (v) Erect one pin P and another at Q. (vi) Look through the mirror from position E and erect a pin at R such that the three pins appear to be in a straight line. (vii) Produce RM to meet TA produce at Z. Measure and record PZ. Determine and record the values Θ, $\frac{\theta}{2}$and tan $\frac{\theta}{2}$. (viii) Repeat the experiment with i = 40^0, 50^0, 60^0, 70^0 in turns and record Θ, $\frac{\theta}{2}$and tan $\frac{\theta}{2}$and PZ in each case. Tabulate your readings. (ix) Plot a graph with PZ against tan$\frac{\theta}{2}$on the horizontal axis. (x) Determine the slope s of the graph. (xi) From your graph, determine the value of PZ when I = 45^0. (xii) State two precautions taken to ensure accurate results.

WEEK: Five

LIGHT WAVES (2)

REFRACTION OF LIGHT

Refraction is defined as the property of a change in the direction of light when its passes from one medium to another.

LAWS OF REFRACTION

1. The incident ray, normal at the point of incidence and the refracted ray all lie on the same point on the plane
2. The ration of sine of angle of incident to the sine of angle of refraction is constant for all rays passing through the medium.

   $$\eta = \frac{\sin i}{\sin r}$$

   This is called Snell's law

$$\eta = \frac{\sin i}{\sin r} = \frac{\text{Speed of light in air}}{\text{Speed of light in glass}} = \frac{\text{Real depth}}{\text{Apparent depth}}$$

CRITICAL ANGLE

This is the angle of incident in the denser medium when the angle of refraction in the less dense medium is 90°. It is denoted by C

$${}_a\eta_g = \frac{\sin i}{\sin r}$$

$${}_g\eta_a = \frac{\sin r}{\sin i}$$

At critical angle i = 90° and i = C

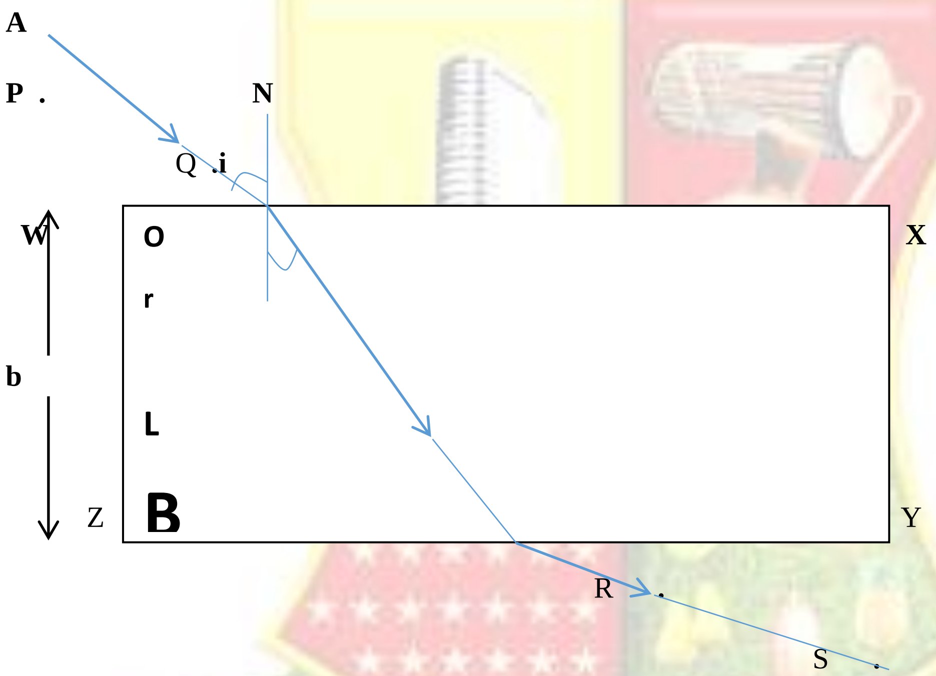
$${}_g\eta_a = \frac{\sin 90}{\sin C}$$

$${}_g\eta_a = \frac{1}{\sin C}$$

WEEK: Six

PRACTICAL ON LIGHT WAVES (2)

Experimental verification of Snell's Law



(i), Measure and record the thickness, b of the glass block provided in the diagram above. (ii) Place the rectangular glass block on the drawing paper and draw the outline WXYZ. Remove the block. (iii) Mark a point O along WX as shown and draw NO perpendicular to WX. (iv) Draw AO such that the angle of incidence, I = 200. Fix one pin at P and another at Q along AO. (v) Replace the block. Fix one pin at R and another at S so that they are in a straight line with the pins at P and Q when viewed through the glass block. (vi). Remove the glass block and the pins. Join SR and produce it to meet ZY at B. Also join OB and measure the angle r. (vii) Repeat the experiment for i = 30^0, 40^0, 45^0 and 50^0. Measureand record the corresponding values of r. (viii) Evaluate Sine **i** and Sine **r.** Tabulate your readings. (ix) Plot the graph of Sine **i** against Sine **r** and find slope **m.** (x) State two precautions taken to ensure accurate results (Attach your traces to your answer booklet).

WEEK: Six

APPLICATION OF LIGHT WAVES

LENS

A lens is a portion of a transparent medium bounded by two spherical surfaces or by a plane and a spherical surface.

TYPES OF LENSES

There are two major types of lenses

i. Concave lens.
ii. Convex lens
i. CONVEX LENS: A convex lens is a converging lens i.e. It converges ray of light falling on it.
ii. CONCAVE LENS: There are bi-concave, Plano concave and diverging meniscus

NATURE OF IMAGES FORMED BY CONVEX LENSES

i. Object beyond 2F
The properties of image formed are:
a. The image formed is diminished.
b. The image is formed at the focus.
c. The image is inverted.
d. The image is real.

ii. Object at 2F
The properties of image formed are:
a. The image size is the same as object.
b. The image is formed at 2F
c. The image is inverted.
d. The image is real.

iii. Object between F and 2F
The properties of image formed are:
i. The image is magnified.
ii. The image formed is beyond 2F.
iii. The image is inverted.
iv. The image is real.

iv. Object at F
The image is formed at infinity.

v. Object between lens and F
The properties of image formed are:
a. The image formed is magnified.
b. The image formed is behind the object.
c. The image is erect.
d. The image is Virtual.

vi. Object at infinity

The properties of image formed are:

a. The image formed is diminished.
b. The image is formed at the focus.
c. The image is inverted.
d. The image is real.

NATURE OF IMAGES FORMED BY CONCAVE LENSES

The properties of image formed are:

a. The image formed is diminished.
b. The image formed is between focus (F) and the optical center (C).
c. The image formed is erect.
d. The image formed is Virtual.

POWER OF LENS

The power of a lens is the reciprocal of the focal length. The power of lens is given by P = $\frac{1}{F}$.

It is expressed in meter (m). Its S.I unit of power of lens is the dioptre (D).

SPECTRUM OF WHITE LIGHT

This is the pattern or array of colors obtained on the white screen after dispersion of white light.**Dispersion** is the splitting of white light into seven pure colors i.e. red, orange, yellow, green, blue, indigo and violet. The red has longest wavelength and has the highest speed while violet has the shortest wavelength and travels with the lowest speed. There are two types of spectrum, which are:

1. **Pure Spectrum:** This is formed when colors of white light are completely separated
2. **Impure Spectrum:** This is formed when colors of white light overlap.

RAINBOW

Rainbows are formed when sun white light disperse when it passes through rain droplets.

TYPES OF RAINBOW

1. **Primary Rainbow:** This occur when the light ray undergo one internal reflection

2. **Secondary Rainbow:** This is due to light rays which undergo two internal reflections.

FORMS OF COLOUR

There are three forms of colors namely

1. **Primary Colors:** These are colors that can be mixed or blend together to form other colors. E.g. Red, Green and Blue.
2. **Secondary Colors:** These are colors obtained by mixing two primary colors. E.g. Red + Green = Yellow, Red + Blue = Magenta, Blue +Green = Cyan
3. **Complimentary/Tertiary Colors**: There are colors which mix to produce white light. E.g. Cyan is a complementary of Red to form White, yellow is a complementary of Blue to form White and Magenta is a complementary of Green to form White.

APPLICATION OF LIGHT WAVES

1. Film projector
2. Telescope
3. Binoculars
4. Lens camera etc.

THE HUMAN EYE

The human eyes is a pair located in the eyes socket of the brain which is held in position by some muscles that connect the blood vessels with the nerve cells.

EYE DEFECT AND CORRRECTION

Some defects are:

1. Myopia (Short sightedness).
2. Hypermetropia (Long sightedness).
3. Presbyopia.
4. Astigmatism.
5. Color blindness.

(1) **<u>Myopia (Short sightedness):</u>** This is an eye defect in which one can only see short distance objects clearly but cannot see long distance objects.

<u>Correction of Myopia</u>

This can be corrected by using concave lens or diverging lens which diverge the rays of light entering the eye so that the ray is bought to focus.

(2) **<u>Hypermetropia:</u>** This is an eye defect in which one can only see a long distance object clearly and not short distance object. It is caused by shortness of the eyeball.

<u>Correction of Hypermetropia</u>

This can be corrected using convex lens or converging lens which converges rays of light entering the eye so that the rays are brought into focus.

(3) **<u>Astigmatism:</u>** This defect is caused by the cornea, when the ray of an object reaches the cornea, they are reflected at different rate because of the roughness and thickness of the cornea and the lens.

(4) **Presbyopia:** This is an eye defect in which the eye is unable to accommodate. It is used by inelasticity of eye lens due to old age. Bifocal lens is used to correct this.

SIMPLE MICROSCOPE

The simple microscope or magnifying glass is a convex lens which is used to produce magnified images of small objects.

THE COMPOUND MICROSCOPE

These have higher magnification when compared to simple microscope. It consist of two converging lens of small focal length. The lens closer to the object is called the objective lens and the other lens through which final image is seen is called eye piece.

TELESCOPE

This is an instrument used mostly for viewing distance objects. It is extensively used in war, by sailors and astronauts.

There are different types of telescope.

1. Astronomical telescope
2. Galilean telescope
3. Terrestrial telescope
4. Prism telescope
5. Gregorian telescope
6. Newtonian telescope

WEEK: Eight

SOUND WAVES

Sound is a form of energy which is propagated as longitudinal wave. Sound can be propagated in a solid, liquid, gas and its speed depends on the density and elasticity of the medium.

REFLECTION OF SOUND (ECHO)

Echoes are produced by the reflection of sound from hard surface or wall. If the reflecting surface is very close to the source, the echo joins up with the original sound which then seems to be prolonged. This phenomenon is called reverberation.

APPLICATION OF SOUNDWAVE

1. It is used in determining the speed of wind in air.
2. It is applied in the exploration of oil and gas.
3. To determine the depth of sea bed.

MUSICAL NOTES AND NOISE

Musical note are sound that are pleasant to the ear. They are produced by regular and periodic vibration of objects.

A noise is an unpleasant, harsh sound. It is produced by sudden, irregular and non-periodic vibration of objects.

CHARACTERISTICS OF MUSICAL NOTES

1. **Pitch:** It depends on frequency.
2. **Loudness:** It depends on intensity.
3. **Quality:** It depends on overtone.

RESONANCE

This is an effect caused by vibrating body setting another body into vibration and both vibrating in the same frequency.

VIBRATION OF AIR IN PIPE

The study of modes of vibration in pipes is important because musical instrument such as flutes, drums etc. are either opened or closed pipe.

MUSICAL INSTRUMENTS

Musical instruments are classified into:

1. String Instrument e.g. Sonometer, Guitar, Piano, Violin, Harp, etc.
2. Wind Instrument e.g. Flutes, Trumpets, Saxophone, etc.
3. Percussion Instrument e.g. Bells, Drums, Turning Fork, etc.

WEEK: Nine

COMPARISON OF SPEED OF SOUND IN VARIOUS MEDIA; RESONANCE, HARMONICS AND OVERTONES

Resonance is a phenomenon which occurs whenever a particular body or system is set in oscillation at its own natural frequency as a result of impulses of signals received from some other system or body which is vibrating with the same frequency.

VIBRATIONS IN STRINGS

When a wire is stretched between two points, a transverse wave is formed and the wave length is λ. The velocity of wave propagated along a fixed wire or string is given by $V = \sqrt{\frac{T}{M}}$ where T = Tension, M = Mass.

VIBRATION IN A CLOSED PIPE

The wavelength is given by

$$l = \frac{\lambda}{4}$$

$\lambda = 4l$

For fundamental frequency $fo = \frac{V}{\lambda} = \frac{V}{4l}$

VIBRATION IN OPEN PIPE

The wavelength is given by

$$.l = \frac{\lambda}{2}$$

$\lambda = 2l$ Fundamental frequency $f_o = \frac{V}{\lambda} = \frac{V}{2l}$

HARMONICS AND OVERTONES

The lowest frequency obtained from a plucked string when the string vibrates in one loop is called the fundamental frequency, f_o. Higher frequencies which are integral or whole number multiplies of the fundamental frequency can also be produced in the spring. These are called the Harmonics or overtones e.g. $2f_o$, $3f_o$ etc.

The note produced in this mode is called the first overtone or second harmonic and the frequency f_1 of this overtone is then given by;

$$f1 = \frac{V}{\lambda} = \frac{V}{l}$$

This produces the next higher note called the second overtone or 3rd harmonics.

$$l = \frac{3\lambda}{2}$$

From V = fλ

$$f2 = \frac{3V}{3l}$$

Thus, $f0 = \frac{V}{2l}$; fundamental frequency or 1st overtone

$f1 = \frac{V}{l} = 2fo$; 2nd harmonic or 1st overtone

$f2 = \frac{3V}{2l} = 3fo$; 3rd harmonic or 2nd overtone

SS3

WEEK: One

ELECTROMAGNETIC WAVES (E-M WAVES)

Electromagnetic waves are the types of wave that do not require a material medium for their propagation. They arise from the vibrations of electric field (E)and magnetic field (M). The Electric and the magnetic fields are mutually at right angles to one another and to the direction of motion of the wave. E-M waves arranged in order of increasing wave length are Gamma rays, x-rays, Ultra-violet rays, Visible light, infra-red rays, micro waves and radio waves. These constitute the Electromagnetic spectrum.

Uses of Electromagnetic Waves

I. Radio Waves in radio transmission and radar
II. X-rays in radiography and in x-ray diffraction
III. Gamma rays in medical fields for sterilization of medical equipment and in the treatment of cancers & tumors.

WEEK: Two

GRAVITATIONAL FIELD

Definition: A gravitational field is a region or space around a mass in which the gravitational force of the mass can be felt.

NEWTON'S LAW OFUNIVERSAL GRAVITATION:

It states that the gravitational force of attraction between any two masses M_1, M_2 is directly proportional to the product of the masses and inversely proportional to the square of the distance 'r' between them i.e.

$$F = \frac{G\, M_1 M_2}{r^2}$$

Where M_1 & M_2 = masses of the two particles (kg)

G = gravitational constant ($G=6.67 \times 10^{-11}\ NM^2Kg^{-2}$)

r = separation distance (m)

GRAVITATIONAL POTENTIAL (V):

This is defined as the work done in taking unit mass from infinity to the point. S.I unit i.e. JKg^1

$$V = \frac{G\,M}{r}$$

Where G= Gravitational constant

M= mass producing the gravitational field

r= distance

ESCAPE VELOCITY 'Ve':
This is the minimum velocity required for an object to just escape from the gravitational influence of the earth. S.I unit is ms^{-1}. I.e.

$$\text{Escape velocity,} Ve = \sqrt{2gR}$$

Where R= radius of the earth

G= acceleration due to gravity ($g=9.8ms^{-2}$)

ACCELERAION DUE TO GRAVITY 'g':
This is the force per Unit mass on the earth's surface i.e.

$$G=\frac{f}{m} \text{or} = \frac{GM_e}{r_e^2}$$

Where M_e= mass of the earth

r_e= earth's radius

WEEK: Three

<u>ELECTRIC FORCE</u>
COULOM'S LAW:
States that the electric force between two point charges q_1 and $q_2$separated by a distance 'r' is directly proportional to the product of the charges and inversely proportional to the square of the distance between the charges i.e

$F=\frac{Kq_1q_2}{r^2}$, $K=\frac{1}{4\pi\varepsilon_0}$ = $9.0x10^9NM^2C^{-2}$

Where F= electric force (N)

q_1& q_2 = charges (C)

r= distance (m)

ELECTRIC FIELD INTENSITY:
This is defined as the force per Unit charge (q) at that point. i.e. F= qE

$E=\frac{f}{q}$

S.I Unit is NC^{-1}

Where F= force (N)

.q= charge (C)

It is a vector field.

ELECTRIC POTENTIAL (V):
This is defined as the total work done or energy transformed in an electric field to bring a unit positive charge from a point at infinity to a point in the electric field of another charge.

Electric potential $= \frac{Work\ done}{Charge}$

Electric potential $= \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$

The unit is JC^{-1} or Volt

CAPACITOR

This is an electrical component that store electric charges. **Capacitance of a Capacitor** is the charge stored per unit voltage

Q = CV. Its unit is Farads (f).

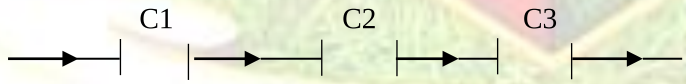
Capacitance of a capacitor depends on the following factors:

- **i.** Area of the plate (A)
- **ii.** Nature of plate (ε)
- **iii.** Distance between plate (d)

$C = \frac{\varepsilon A}{d}$

<u>ARRANGEMENT OF CAPACITOR</u>

SERIES ARRANGEMENT:
When the Capacitor are connected end to end as shown, they are said to be in **series connection**



For series connection, each Capacitor (C) has different Voltage (V) but the same Charge (Q)

The total Voltage in the Circuit is given as

$V = V_1+V_2+V_3\ldots\ldots$ xx
From Q = CV

So, $V = \frac{Q}{C}$

Which gives, $\frac{Q}{C} = (\frac{Q}{C_1} + \frac{Q}{C_2}+\frac{Q}{C_3})$

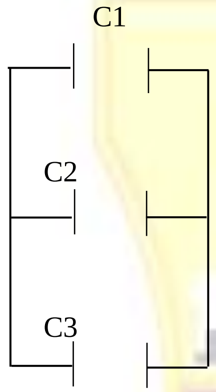
$\frac{Q}{C} = Q(\frac{1}{C_1} + \frac{1}{C_2}+\frac{1}{C_3})$

Therefore the equivalent capacitance of the combination is given by

$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}+ \frac{1}{C_3}$

PARALLEL ARRANGEMENT

When Capacitor are arranged side by side such that their corresponding ends join together at two common junctions, the arrangement known as **parallel arrangement.**
The combined or equivalent Capacitor (C) is given by



For parallel connection, each Capacitor (C) has different Charge (Q) but the same Voltage (V)
The total Current in the Circuit is given as

$Q = Q_1+Q_2+Q_3$……… (x)

From $Q = CV$

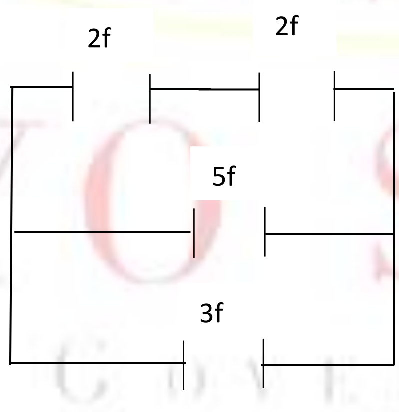
Which gives, $VC = VC_1+VC_2+VC_3$

$VC = V (C_1+C_2+C_3)$

Therefore the equivalent capacitance of the combination is given by

$C = C_1+C_2+C_3$

Example: Find the equivalent Capacitance in the Circuit below



Solution:

Two 2f Capacitors are connected in series with 3f and 5f Capacitor.

Calculating the two parallel connected capacitor:

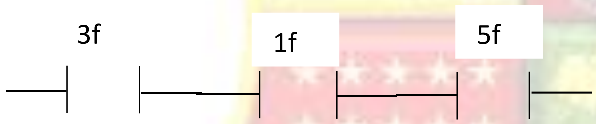
$C_1 = 2f$ and $C_2 = 2f$

$\frac{1}{C} = \frac{1}{2} + \frac{1}{2}$

$\frac{1}{C} = \frac{1}{1}$

C = 1f

The circuit diagram becomes,



Now calculating the series connection of the capacitor:

.$C = C_1 + C_2 + C_3$

.C = 3 + 1 + 5

.C = 9f

WEEK: Four

<u>CURRENT ELECTRICITY</u>

Electric Current (I) is defined as the ratio of flow of electric charge to time along a conductor.

I.e. I = $\frac{Q}{t}$

PRODUCTION OF CURRENT

Electric current or a continuous flow of charge can be generated from

a) Chemical energy
b) Heat energy
c) Mechanical energy
d) Solar energy

MEASUREMENT OF CURRENT

The ammeter is an instrument for measuring current. Millimeters measure smaller currents. Very small currents are detected by sensitive instruments called Galvanometer.

POTENTIAL DIFFERENCE:
This is defined as the work done in moving a positive charge of one (1) coulomb from one point to the electric field to another S.I Unit is Volt (V).

ELECTROMOTIVE FORC (E.M.F):
This is defined as the potential difference (p.d) between the terminals of a cell when it is not delivering any current in an external circuit. S.I Unit is Volt (V).

RESISTANCE (R):
These can be defined as the opposition to the flow of charges or current. S.I Unit is Ohms (Ω)

FACTORS AFFECTING ELECTRICAL RESISTANCE OF A WIRE

These are;

(v) Length of conductor
(vi) Area of conductor
(vii) Temperature
(viii) Type or substance of material

R $\alpha \frac{L}{A}$

R = $\frac{\rho L}{A}$ where R = Resistance, L = Length of wire, A = Cross sectional area of wire, ρ = Resistivity

Example: The resistance of a wire of length 2.0m is 5.4 x 10^{-7}Ωm. If the cross-sectional area of wire is 9.5 x $10^{-3} cm^2$. Calculate the resistance of the wire.

Solution:

A = 9.5 x $10^{-3} cm^2$ = 9.5 x $10^{-7} m^2$

L = 2m

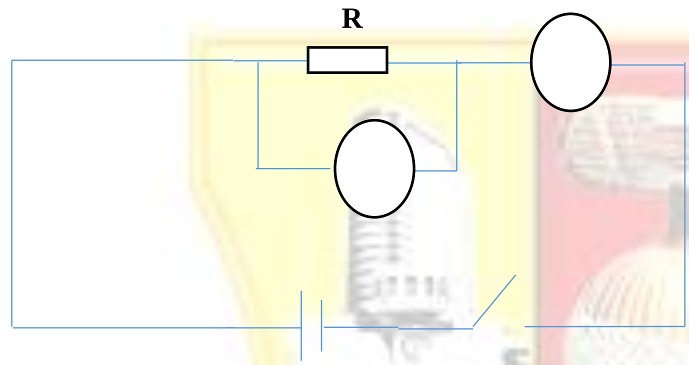
R = $\frac{\rho L}{A} = \frac{5.4 \text{ x } 10^{-7} \text{ x } 2}{9.5 \text{ x } 10^{-7}}$ = 1.77Ω

MEASUREMENT OF RESISTANCE

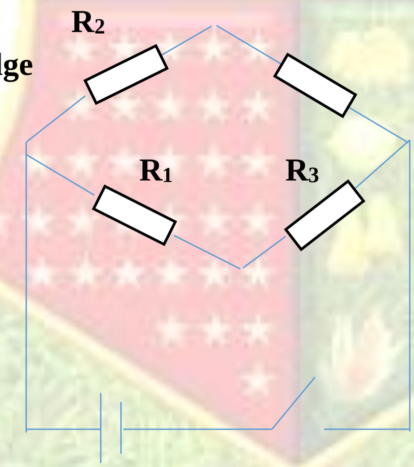
The following methods is used to determine resistance (R)

1. Voltmeter – Ammeter method
2. Substitution method
3. Using Wheatstone bridge
4. Using Meter bridge
5. Using potentiometer

1. **Voltmeter – Ammeter method**
   With the circuit diagram shown above, the ammeter and voltmeter values are obtained.If the Variable Resistor is varied. The slope obtained is Resistance

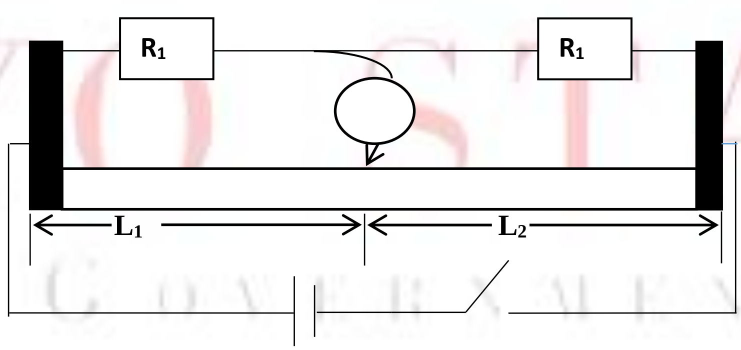


2. **Substitution method:** This method can only be used to measure resistances of 100Ω and more.**R**
3. **Wheatstone bridge**



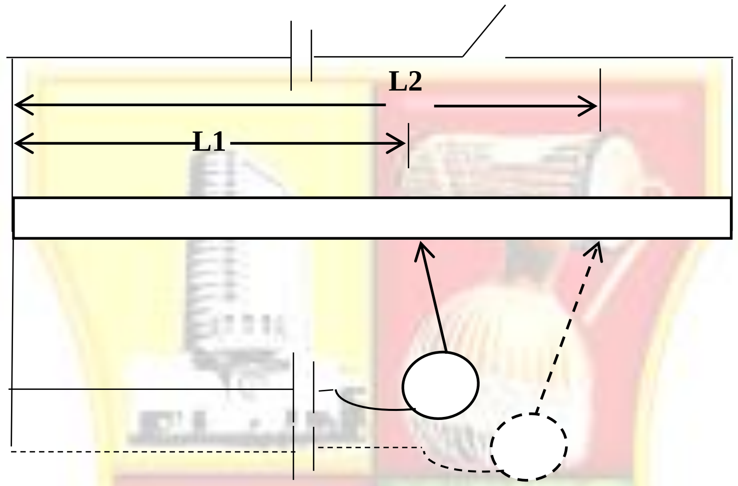
$\frac{R}{R_3} = \frac{R_1}{R_2}$

4. **Meter bridge**



$\frac{R_1}{R_2} = \frac{L_1}{L_2}$

5. Potentiometer



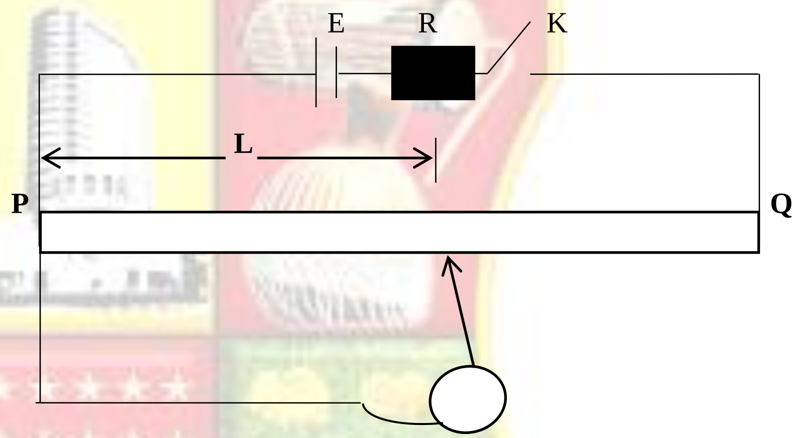
$$\frac{Known\ e.m.f.of\ cell\ (E_1)}{Unknown\ e.m.f.of\ cell\ (E_2)} = \frac{L_1}{L_2}$$

WEEK: Five

PRACTICAL

Uses of Meter Bridge& potentiometer

APPARATUS: Resistor (2Ω), Cell, Key, Potentiometer, Voltmeter, Jockey and connecting wires



(i), Connect the circuit in the diagram above (ii) Close the key and use the jockey to make contact with the potentiometer wire PQ such that L = 10cm. (iii) Read and record the value of the potential difference V. (iv) Evaluate L^{-1} and V^{-1}. (v) Repeat the experiment with L = 20cm, 30cm, 40cm and 50cm. In each case read and record the corresponding values of V, L^{-1} and V^{-1}. (vi)Tabulate your readings. (vii) Plot the graph of L^{-1} against V^{-1}starting both axes from origin. (viii) Determine the slope m, of the graph. (ix) State two precautions taken to ensure accurate result.

WEEK: Six

MAGNETIC FIELD

Definition: The magnetic field is a region around a magnet in which the influence of the magnetic effect can be felt or detected. It is a vector field.

Properties of Magnet and Magnetic Material

Soft iron is pure iron while steel is an alloy iron & carbon. Steel is a much harder and stronger material than soft iron, steel & iron have two different magnetic properties.

i. Iron is more easily magnetized than steel but it also losses its magnetism more quickly than steel.
ii. Iron produces a stronger magnet than steel.
iii. Steel is used for making permanent magnet while iron is used for making temporary magnets.

MAGNETIC MATERIALS: These are materials that are capable of being magnetized. E.g. Iron, Steel, Cobalt, Nickel, Manganese. These are also known as ferromagnetic substances.

Classes of magnet are given as:

1. **Diamagnetic material:** They resist being attracted by a magnet. It they are positioned in a strong magnetic field, they move towards the weak part of the field.
2. **Paramagnetic material:** They have less resistance to magnetic field compared to diamagnetic materials. If they are placed in a strong magnetic field, they become weak magnet and are attracted weakly toward the magnet.
3. **Ferromagnetic material:** The molecules of ferromagnetic materials are small magnets. If they are brought in a field of a strong magnetic field, their atomic molecules align in one direction; therefore, they become strongly attracted toward the magnet.

MAGNETIZATION: This is a process of making a metal e.g. steel, copper and iron etc. to possess a magnetic property. The ability of a magnet to attract magnetic substances is called the **magnetism**.

DEMAGNETIZATION: This is a process where by a magnet is made to lose its magnetism. Demagnetization can be achieved by; Electrical method, Mechanical method and Heating method.

CONCEPT OF MAGNETIC FIELD:

The area around a magnet in which it can attract or repel objects or in which a magnetic force can be detected is called the magnetic field of the magnet. Magnetic field patterns can conveniently be observed using iron fillings.

WEEK: Seven

FORCE AND FIELD PATTERN OF TWO PARALLEL CURRENT CARRYING CONDUCTOR

THE EARTH'S MAGNETIC FIELD: The Earth's magnetic field occur due to the presence of an imaginary bar-magnet situated at the center of the earth's and inclined at a small angle to the earth's axis of rotation.

USES OF ELECTROMAGNET

1. They are used for lifting & transporting heavy pieces of iron and steel e.g. steel plates.
2. They can be used to separate iron from mixtures containing non-magnetic substances.
3. They are used in the construction of such electromagnetic devices as the electric bell & telephone earpiece.

MAGNETIC FORCE ON A MOVING CHARGE

The magnetic force on a charged particle moving across a magnetic field is given by $F = QVB\sin\theta$

S.I Unit is Newton (N)

Where, Q = charge (C)

V = average velocity of the charge.

B = flux density, S.I Unit Tesla (T).

.θ = angle of inclination

WEEK: Eight

ELECTROMAGNETIC FIELD

APPLICATION OF FLEMING'S LEFT HAND RULES:

If the thumb, fore-finger and middle finger are held mutually at right angles to one another with the fore-finger pointing in the direction of magnetic field, and the second finger in the direction of current, then the thumb will point in the direction of motion.

FARADAY'S LAW: It states that current or voltages are induced in a coil anytime the magnetic flux linking it is changed. The magnitude of the induced current/voltage is directly proportional to the rate of change in magnetic flux.

$E = N\frac{d\phi}{dt}$

Where, E = Induced Voltage or E.M.F., N =Length or Number of turns of wire. $\frac{d\phi}{dt}$ = Rate of change of flux

LENZ'S AND MOTOR RULES:

LENZ'S LAW: states that the induced E.M.F. is in such a direction as to oppose the motion or change producing it.

WEEK: Nine

MOTOR-GENERATOR EFFECT

Explanation of the Equation ($E=EoSin\omega t$)

The E.M.F. generated by the A.C. generator and whose waveform can be represented by the equation

$E = EoSin\omega t$

Let the coil of area A rotate in a magnetic field of strength B.

Flux Ø through the coil is given by

$Ø = ABCos\theta$

$E = \frac{-dØ}{dt} = \frac{d}{dt}(NABCos\theta)$

$= -NAB\frac{d}{dt}(Cos\theta)$

$= NABSin\theta\frac{d\theta}{dt}$

$= w = \frac{d\theta}{dt}$

$\therefore E = NABwSin\theta$

$E = NAB\omega = Eo$

$E = EoSin\theta$

But $w = \frac{\theta}{t}$

$E = EoSin\omega t$

INDUCTANCE – SELF AND MUTUAL:
This is the flow of induced current or voltage in a coil due to an alternating or varying current in a neighboring coil.

EDDY CURRENT:
These currents are produced by the varying flux cutting the iron core; reduce efficiency because they consume power from the primary. Energy is lost in the form of heat in the iron core due to eddy current.

POWER TRANSMISSION AND DISTRIBUTION
Power generated at power stations are distributed over large distances to consumers through metal cables. Power is given by P=IV and can thus be transmitted either at low current and high voltage or at high current and low voltage.

INDUCTION COIL:
This is electrical device that is capable of producing a very high intermittent E.M.F. by electromagnetic induction from a low voltage D.C. source e.g. a battery.

THE TRANSFORMER
A transformer is an electrical device for changing the size of an A.C. voltage. It acts to increase or decrease the E.M.F. of an alternating current.
An important transformer equation is given by:

$$\frac{Es}{Ep} = \frac{Ns}{Np} = \frac{Ip}{Is}$$

Where, Es = Secondary E.M.F.
Ep = Primary E.M.F.
Ns = No of turns in Secondary Coil
Np = No of turns in Primary Coil
Is &Ip = Secondary & Primary Currents

Efficiency (E) $\frac{Power\ output}{Power\ input}\ x\ 100$

Efficiency (E) = $\frac{I_s V_s}{I_p V_p}\ x\ 100$

Example: A step down transformer has 500 turns in a secondary coil and 10000 turns in the primary coil. When connected to a video player it draws a current of 5A, calculate the current flowing in the primary coil if the transformer is 90% and it step up 240V supply to 6000V.

Solution:

= $\frac{Ns}{Np} = \frac{Ip}{Is}, \frac{I_p}{5} = \frac{500}{10000}$, I_p = 0.25A

E = $\frac{I_s V_s}{I_p V_p}\ x\ 100$

90 = $\frac{I_s\ x\ 6000}{0.25\ x\ 240}\ x\ 100$

$= I_s$ = 0.009A

How to reduce energy loss in a transformer

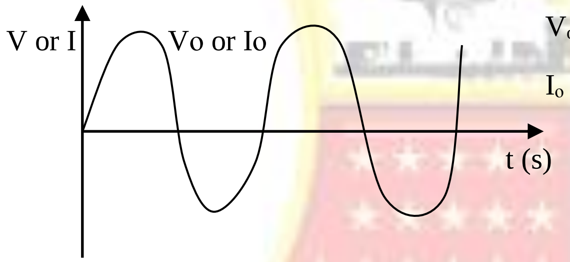
1. Using low resistance copper coil in the coil winding.
2. Laminating soft core.
3. Ensuring that the core is made of soft magnetic material
4. Ensuring that the primary flux links completely with the secondary circuit.

WEEK: Ten

SIMPLE A.C. CIRCUIT

GRAPHICAL REPRESENTATION OF A.C. & E.M.F.

An Alternating Current (or Voltage) varies sinusoidally as shown in (fig.1) which is a sine waveform. The amplitude or peak value of the current Io, is the maximum numerical value of the current



V_o= Peak or Maximum Voltage (V)

I_o = Peak or Maximum Current (A)

PEAK AND ROOT-MEAN-SQUARE VALUES (R.M.S.): This is defined as the steady or direct current which produces the same heating effect per second in a given resistor.

R.M.S. Value = $\frac{PeakValue}{\sqrt{2}}$

Peak or Maximum value of current is given by

$I_{r.m.s.} = \frac{Io}{\sqrt{2}}$ Io = Peak or Max. Current Value

$I_{r.m.s.}$ = Current root mean Square value

Similarly,

Peak or Max.value of voltages is given by

$V_{r.m.s.} = \frac{Vo}{\sqrt{2}}$

TERMS IN AN A.C. CIRCUIT

DEFINITIONS:

REACTANCE (X): This is the opposition to the flow of an alternating current from an inductor (L) or a capacitor (C). S.I. Unit is Ohm (Ω). When inductor only opposes the flow of current it is called **Inductive reactance (X_L).** When capacitor only opposes the flow of current it is called **capacitive reactance (Xc)**

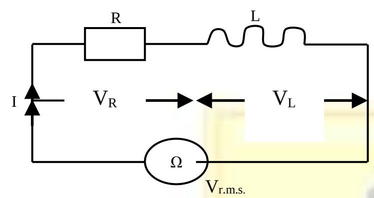
$X_c = \frac{1}{2\pi fc}$ while $X_L = 2\pi fL$

INDUCTANCE (L): This is a property of the circuit which opposes a change of current. The unit of inductance L is called 'Henry' (H).

IMPEDANCE (Z): This is the total opposition to the flow of alternating current in a mixed circuit consisting of either inductor (L) and Resistor (R). Resistor & Capacitor (C) or L, C, R in series S.I. Unit is Ohm (Ω).

A.C. CIRCUIT WITH RESISTOR & INDUCTOR IN SERIES (RL CIRCUIT)

(a)



The Impedance expression for RL Circuit is given

$Z = \sqrt{R^2 + X_L^2}$

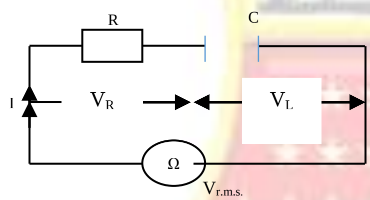
Also, current through

$I = \frac{V}{Z}$

Phase angle Ø for RL Circuit

is tan Ø = $\frac{X_C}{R}$ or $\frac{V_C}{V_R}$

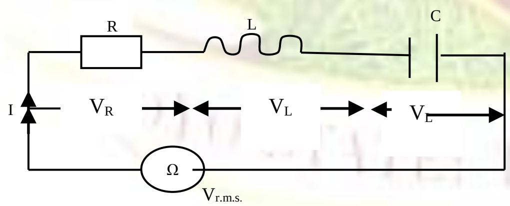
(b) **A.C. CIRCUIT WITH RESISTOR & CAPACITORIN SERIES (RC CIRCUIT)**



The Impedance is given by $Z = \sqrt{R^2 + X_C^2}$

$.I = \frac{V}{Z}$

A.C. CIRCUIT CONTAINING RESISTOR, CAPACITOR AND INDUCTOR RLC CIRCUIT



The Impedance is given by

$Z = \sqrt{R^2 + (X_L - X_C)^2}$

Also the current is given

$I = \frac{V}{Z}$

Phase angle is tan Ø = $\frac{V_L - V_C}{V_R}$ or $\frac{X_L - X_C}{R}$

RESONANCE IN RLC SERIES CIRCUIT

Resonance is said to occur in an A.C. series circuit when the maximum current is obtained from such a circuit. The frequency at which this resonance occurs is called the resonance frequency (f_o) i.e.

$f_o = \frac{1}{2\pi\sqrt{LC}}$ where, L = Inductance (H)

C = Capacitance (F)

S.I. Unit is Hertz (Hz)

Maximum A.C. current at resonance is given by

$$Io = \frac{Vo}{Z}$$

POWER IN A.C. CIRCUIT

The average power in an A.C. circuit is given by

Power, P = IVCosØ

The quantity CosØ is known as the power factor of the device. Power can also expressed as

P = IV (But V = IR)

$P = I^2R$

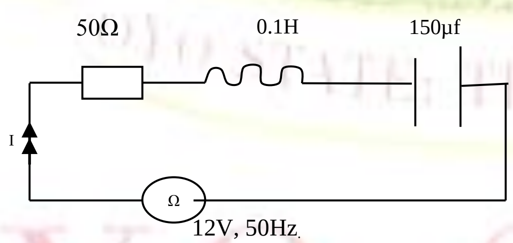
Power factor, $\text{Cos}Ø = \frac{Resistance}{Impedance} = \frac{R}{Z}$

$$\text{Cos}Ø = \frac{R}{Z}$$

Example: A capacitor of 150μf, an inductor of 0.1H and a resistor of 50Ω are connected in series to a 12V; 50Hz power supply. Calculate:

(a) Impedance of the a.c. circuit
(b) The current flowing through the cicuit

Solution:



a. $X_c = \frac{1}{2\pi fc} = \frac{1}{2\pi fc} = \frac{1}{2 \times \pi \times 50 \times 150 \times 10^{-6}} = 21.2\Omega$

$X_L = 2\pi fL = 2 \times \pi \times 50 \times 0.1 = 31.4\Omega$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$Z = \sqrt{50^2 + (31.4 - 21.2)^2}$$

$$Z = \sqrt{2604.04} = 51\Omega$$

b. $I = = \frac{V}{Z} = = \frac{12}{51} = 0.24A$

SECOND TERM SS3 PHYSICS

WEEK: One

RADIOACTIVITY

This is the process by which the atom of a natural occurring substance emits particles or radiation as a result of spontaneous disintegration or break of its atomic nucleus.

TYPES OF RADIATION

1. Alpha (α) particle
2. Beta (β) particle
3. Gamma (γ) ray

S/N		Alpha (α) particle	Beta (β) particle	Gamma (γ) ray
1	**Nature**	It has helium nucleus (^4_2He)	It is an electron	They are electromagnetic wave
2	**Type of charge**	Positively charged	Negatively charged	No charge
3	**Type of trail**	It makes a thick cloud trail	It makes a wave cloud trail	It produces faint trail
4	**Mass unit**	It has a unit mass of 4	Has a mass of 1/1840	Negligible mass
5	**Speed**	Emission speed of $\frac{1}{20}$ of the velocity of light	Speed range 3 x 10^6 – 9.9 x 10^7m/s	Speed is equivalent to that of light
6	**Penetrating power**	It has low penetrating power	It has more penetration than alpha particle	High penetration power
7	**Absorbing medium**	It is absorbed by thin paper (0.03mm)	It is absorbed by metal plate (3.75mm) like aluminum	Can be absorbed by thick lead block or concrete

ADVANTAGES OF RADIOACTIVE SUBSTANCES

1. They are used in medical practice in treating malignant growth in the same way the x-ray is used.
2. They form main source of nuclear fuel used in generating nuclear energy.
3. Radioactive isotopes are used in tracer technique.
4. They are used in estimating age of archaeological findings.

DISADVANTAGES OF RADIOACTIVE SUBSTANCES

1. Emitted radiation destroys tissue cell exposed to it.
2. It upsets chemical reaction taking place in blood cells which undoubtedly lead to death.

BINDING ENERGY: This is the amount of energy required to split the nucleus of an atom i.e.
$E = \Delta MC^2$
E = Energy in Joules (J)
Δm = Mass defects (kg)
C = Velocity or speed of light (ms^{-1})

Example: Calculate in joules the binding energy for $^{59}_{27}Co$. (Atomic no of $^{59}_{27}Co$ = 58.9332u, mass of proton = 1.00783u, mass of neutron = 1.00867u, 1u = 931MeV, 1eV = 1.6×10^{-19}, 1Mev = 1.6×10^{-16}, 1Me = 9.11×10^{-31}J) also calculate the wavelength.

Solution: From the cobalt nucleus $^{59}_{27}Co$implies that

Number of nucleons = 59

Number of Protons = 27

Number of neutron = 59 – 27 = 32

.$^{59}_{27}Co$ = 27 protons + 32 nucleons

27 protons + 32 nucleons = (27 x 1.00783) + (32 x 1.00867)

27 protons + 32 nucleons = 59.48885u.

.$^{59}_{27}Co$ = 58.9332u

Then the binding energy

Binding energy = $^{59}_{27}Co$ – (27 protons + 32 nucleons)

= (59.48885 – 58.9332)u

Binding energy = 0.55565u

= $0.55565 \times 931 \times 1.6 \times 10^{-13}$J

= 8.25×10^{-11}J

$\lambda = \frac{hc}{E} = \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{8.28 \times 10^{-11}} = 2.391 \times 10^{-15}$m

NUCLEAR FUSSION: This is a process in which two or more light nuclei combine or fuse to form a heavier nucleus with the release of a large amount of energy. E.g.
$^{2}_{1}H + {}^{2}_{1}H \longrightarrow {}^{3}_{2}He + {}^{1}_{0}\cap + Energy$

NUCLEAR FISSION: This is the splitting-up of the nucleus of a heavy element into two approximate equal parts with the release of a large amount of energy and neutrons. E.g.
$^{235}_{92}U + {}^{1}_{0}\cap \longrightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3\,({}^{1}_{0}\cap)$

WEEK: Two

HALF LIFE

Half-life of a radioactive element is the time taken for half of the atoms initially present in the element to decay. S.I. Unit is seconds (s). It is denoted by $T_{½}$ i.e.

$T_{½} = \frac{ln2}{\lambda} = \frac{0.693}{\lambda}$

DECAY CONSTANT (λ): This is defined as the instantaneous rate of decay per unit atom of a substance.**Radioactive decay** is defined as the process by which the nucleus of heavy radioactive element disintegrates and emits α or β with a γ **ray.**

$T_{½} = \frac{0.693}{\lambda}$

$= \frac{N}{N_o} = \left(\frac{1}{2}\right)^{\frac{t}{T}}$

Where $T_{½} = T$ = half life

..t = period

N = Initial sample

N_o = Final sample

Examples: (1) A radioactive element has a half- life of 30secs and a decay constant λ. Calculate the value of λ.

Solution:

But $T_{½}$= 30secs, λ =?

Using, $T_{½} = \frac{0.693}{\lambda} = \frac{0.693}{30}$

$\lambda = 0.0231s^{-1}$

Example: The half- life of a radioactive element is 3 days. In what time will the activity of the specimen decay to $\frac{1}{32}$ of its original value?

Solution:

T = 3 days

$N_o = x$

$N = \frac{1}{32}x$

$= \frac{N}{N_o} = \left(\frac{1}{2}\right)^{\frac{t}{T}}$

$= \frac{\frac{1}{32}x}{x} = \left(\frac{1}{2}\right)^{\frac{t}{3}}$

$= \frac{1}{32} = \left(\frac{1}{2}\right)^{\frac{t}{3}}$

$= \left(\frac{1}{2}\right)^{5} = \left(\frac{1}{2}\right)^{\frac{t}{3}}$

$5 = \frac{t}{3}$

.t = 15 days.

APPLICATION OF RADIOACTIVITY

i. They are used in agriculture as radioactive tracers.
ii. They are used to treat cancer, patients & to sterilize surgical equipment.
iii. They are used in industry to study the defects in metals and welded joints & to check metal fatigue.

WEEK: Three

ATOMIC PHYSICS

Einstein Photo Electric Theory: The theory states that the energy of incident of a photon is equal to the algebraic sum of the maximum kinetic energy of the electrons and the work function i.e.

$E = W_o + K.E$ ---------- (1)

$$\left.\begin{array}{l} \text{But } E = hf \\ W_o = hf_o \\ K.E = \tfrac{1}{2}mv^2 \end{array}\right\} \text{---------- (2)}$$

Subt. (2) into (1) above, we have

$.hf = hf_o + \tfrac{1}{2}mv^2$

Where, E = Photon Energy

W_o = Work function

K.E. = Kinetic Energy

.h = Planck's constant ($h = 6.63 \times 10^{-34}$Js)

$.f_o$ = Threshold frequency (Hz)

THRESHOLD FREQUENCY (f_o): This is the minimum or lowest frequency that can cause photo emission from a metallic surface. S.I. Unit is Hertz (Hz).

WORK FUNCTION (W_o): This is the minimum energy required to liberate an electron from a metal surface. S.I. Unit is Joule (J) i.e.

$W_o = hf_o$

H = Planck's constant ($h = 6.63 \times 10^{-34}$Js)

F_o = Threshold frequency (Hz)

STOPPING POTENCIAL (Vs): This is the potential difference obtained across the electrode when no electron reaches anode collector and when the current in the circuit becomes zero.

$E_{max} = K.E = eV_S$

$E = W_o + eV_S$

$.hf = hf_o + eV_S$

Example: An x-ray tube operates at a potential of 50kv of the heat generated in the target is the target is at the rate of 800w. Determine:

i. The current passing into the tube
ii. The number of electron striking the target the targets per seconds
iii. The velocity of the electron striking the target.

Solution:

i. Electric power = IV
800 = I x 50000
I = 0.016A

ii. Number of electron striking per seconds = $\frac{Current\ input}{Electric\ charge}$
$= \frac{1.6\ x\ 10^{-2}}{1.6\ x\ 10^{-19}}$
= 1 x $10^{17}s^{-1}$

iii. The speed is obtained by
½mv^2 = eV_s
½ x 9.11 x 10^{-31} x V^2 = 1.6 x 10^{-19} x 50000
V = 1.32 x 10^8m/s

Example: A metal has a work function of 1.8eV. Find the stopping potential when the incident light on it is of wavelength 5 x 10^{-7}m. (take h = 6.6 x 10^{-34}Js, C = 3 x 10^8m/s, e = 1.6 x 10^{-19}C, 1eV = 1.6 x 10^{-19}J)

Solution:

E = K.E + Wo

E = $\frac{hc}{\lambda} = \frac{6.6\ x\ 10^{-34}\ x\ 3\ x\ 10^8}{5\ x\ 10^{-7}}$ = 3.96 x 10^{-19}J

Wo = 1.8 x 1.6 x 10^{-19} = 2.88 x 10^{-19}J

Therefore,

E = eV_S + Wo

3.96 x 10^{-19} = 1.6 x 10^{-19}Vs +2.88 x 10^{-19}

Vs = 0.68V.

PHOTO ELECTRIC EFFECT: This is the process whereby electrons are emitted from the surface of a metal when radiation of appropriate frequency or wavelength falls on it.

APPLICATION / USES OF PHOTOCELLS
(i) Photometer (ii) Burglar Alarm (iii) Automatic doors (iv) Cathode ray tube

Examples:
Calculate the work function for Lithium whose threshold frequency is 5.5 x 10^{14}Hz (h = 6.63 x 10^{-34}Js)
Solution:
Bur, $W_o = hf_o$
W_o = 6.63 x 10^{-34} x 5.5 x 10^{14}
W_o = 36.47 x 10^{-20}J

WEEK: Four

ENERGY QUANTIZATION

An electron has a well-defined state of energy level in an atom. The lowest energy level is called the ground state (E_o) while the higher energy levels (E_1, E_2, E_3etc) are known as the excited states. i.e.

$\Delta E = hf$

$\Delta E = changeinenergylevel$

F = frequency of emitted radiation

H = Planck's constant

1. **GROUND STATE ENERGY:** This is the stable state of an atom corresponding to its minimum energy. Atoms are most stable in the ground state.
2. **EXCITATION STATE ENERGY:** This is the energy required to raise the state of an atom from its ground state to any other allowed state.

DE-BROGLIE EQUATION

Louis-de-Broglie postulated that moving particles exhibit wave properties is given by

$\lambda = \frac{h}{p}$ ----------- (1)

But, p = mv

$\lambda = \frac{h}{mv}$ where, P = momentum of particle

m = mass of particle (kg)

v = velocity (ms^{-1})

λ = de-Broglie wavelength (m)

h = Planck's constant

WAVE PARTICLE DUALITY

The dual nature of matter is known as the wave particle paradox. The wave particle duality explains that light and matter have both wave properties (such as diffraction, reflection & refraction of light, etc.) as well as particle properties (such as emission, absorption of light, photo electric effect, black body radiation etc.).

Heisenberg Uncertainty Principle States that the product of uncertainty in the measurements of the position(Δx) and momentum($\Delta \rho$) of a particle is equal to or greater than the plank's constant (h).

$\Delta x \Delta \rho \geq h$

Heisenberg uncertainty principle is true for simultaneous measurements of energy of particle and time

$\Delta E \Delta t \geq h$

Example: Calculate the uncertainty in the measurement of momentum if the uncertainty in the measurement of its position is 2.2 x 10^{-10}m (h = 6.6 x 10^{-34}Js)

Solution:

$\Delta x \Delta \rho \geq h$

$2.2 \times 10^{-10} \times \Delta \rho \geq 6.6 \times 10^{-34}$

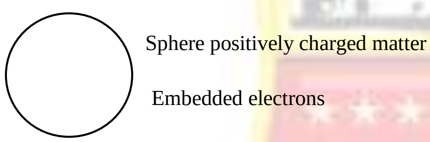
$$\Delta \rho \geq \frac{h}{\Delta x} = \frac{6.6 \times 10^{-34}}{2.2 \times 10^{-10}} = 3 \times 10^{-24} \text{Ns}$$

WEEK: Five

MODELS OF ATOM AND THEIR LIMITATIONS

J.J. THOMPSON MODEL:

Sir J.J. Thompson proposed an atomic model which visualized the atom as a homogeneous sphere of positive charge inside of which are embedded negatively charge electron.



It also determined the ration of the charge to mass $^{e}/_{m}$ of electrons. Thompson's model explains that:

1. A normal atom is electrically neutral.
2. Ions are formed by atom gaining or loosing electron.

Limitation of Thompson's model

1. The scattering of alpha- particle by gold foil in Geiger and Marsden experiment.
2. The existence of line spectra of hydrogen atom and other complex gases.

RUTHERFORD MODEL: Visualized an atom which consists of a positively charged heavy core called the nucleus around which negatively charged electrons circle in orbits much as planets move round the sun. The model was created to explain the back-scattering of alpha particles from thin metal foils. The postulates are stated as:

1. The diameter of the atom is about $10^{-10}m$.
2. The diameter of the nucleus of an atom is $10^{-14}m$.
3. The region around the nucleus is large compare to the space occupied by the nucleus.
4. The electrons are located around the nucleus.
5. The mass of an atom is concentrated at the nucleus.

Limitations of Rutherford model

1. The assumed nature of the orbit not could be said to be fixed due to the electrostatic attraction of the electrons towards the nucleus by the positively charged protons.
2. The electrostatic force that is supposed to maintain the electrons in their respective orbits are weak due to emission of photon when accelerating electrons fall into the nucleus or from one orbit to the other.
3. The model was unable to explain some observations behind the line of spectrum emitted by incandescent objects.

BOHR MODEL: Bohr's model proposed an atomic model in which:

i. The electrons in such stationary statements no radiation

ii. If an electron jumps to a lower state, it emits a photon whose energy equals the difference in energy between the two states.

iii. The angular momentum 'L' of the atomic electron is quantized by the rule $L = \frac{nti}{2\pi}$ (Where n = 1, 2, 3 etc.).

iv. The chemical and physical properties of an element depend on the number of electrons in the outermost shell.

v. The chemical properties of element depend on the number of electrons in the outermost shell.

Limitations of Bohr's model

1. It does not explain how fixed orbits for electrons are chosen when they are not radiating energy.
2. The model is not applicable to the atom with more than one electron in the outermost shell.
3. The model cannot be used to predict energy level for complex atoms with many electrons.

WEEK: Six

ELECTRICAL CONDUCTION THROUGH LIQUID AND GASES

CONDITIONS UNDER WHICH GASES CONDUCT ELECTRICITY:

Experiments with discharge tube show that gases conduct electricity under low pressure and high potential difference (>100V)

NATURE AND PROPERTIES OF CATHODE RAY

1. They cause glass and other materials to fluoresce.
2. They can ionize a gas.
3. They travel on a straight line.
4. They can affect photographic plate

SIMILARITIES AND DIFFERENCES BETWEEN THERMONIC EMISSION AND LIQUID VAPOURIZATION

SIMILARITIES:

1. Heat is involved in both processes.
2. Both occur at the surface of the material
3. In both cases, rate of phenomenon (low pressure and high p.d.) increases with temperatures.

DIFFERENCES:

1. Vaporization takes place from liquid surfaces while Thermionic emission takes place from metal surfaces.
2. Water molecules are released in vaporization while electrons are emitted in Thermionic emission.

ELECTROLYSIS: This is the chemical change in a liquid due to the flow of electric current through the liquid. Examples are: Electrolysis of acidulated water, electrolysis of copper sulphate solution with copper electrodes etc.

LAWS OF FARADAY'S

FARADAY'S 1ST LAW: states that the mass (M) of a substance liberated in electrolysis is directly proportional to the quantity of electricity Q which is passed through the electrolyte.

FARADAY'S 2ND LAW: states that the masses of different substance deposited or liberated by the same quantity of electricity are directly proportional to their chemical equivalents of the substance.

From,1st Law of Electrolysis i.e.

.$M \propto Q$

$M = ZQ$

But, Q = It

M = ZIt

Where, Q = Quantity of electricity (C)

I = Current (A)

T = Time (s)

Z = Constant of proportionality known as the electro chemical equivalent (e.c.e)

APPLICATIONS OF ELECTROLYSIS

i. Electroplating.
ii. Calibration of an Ammeter.
iii. Extraction of metal.
iv. Manufacturing of electrolytic capacitors.

WEEK: Seven

FUNDERMENTALS OF ELECTRONICS

SEMICONDUCTORS

These are materials whose ability to conduct electric current is between those of conductors and insulators. E.g. Silicon (Sand), Germanium, Arsenide, Carbon, Gallium, Selenium and some compunds like Lead Sulphide etc.

Properties of semiconductors

1. They are insulators at low temperature.
2. Their resistance decreases with increase with temperature.
3. Their electrical conductivity can be improved by adding other substances (impurities). This is called**Doping.**

Types of Semiconductors

1. **Intrinsic Semiconductors**: These are pure semiconductors. Their valence is completely filled and the conduction band is empty at low temperature. They conduct electricity by the movement of electrons in the conduction band or movement of positive hole in the valence band.

2. **Extrinsic semiconductors**: Theses are semiconductors produced by doping. Their electrical conductivities are improved by addition of impurities.

   Types of Extrinsic semiconductors

   i. **P-type semiconductor**: This type of semiconductor is one with surplus holes than free electrons. It is formed by adding a trivalent impurity such as indium, boron etc.

   ii. .**n-type semiconductor:** This type of semiconductor is one without surplus hole. The semiconductors are doped by pentavalent atoms e.g. phosphorus, arsenic etc. The five electrons in the outermost shell of the impurities causes more electrons than holes are freed, thus causing a large increase in conductivity.

<u>Forward and reverse bias of semiconductor diodes</u>

A p-n junction is **forward biased** if an appreciable current is obtained when small p.d. is set across, while**reverse biased** is when the negative terminals are connected to p- material and the positive terminal to the n- material with a very small current generated.

<u>Advantages of Junction diode over the diode value</u>

i. It requires low voltage source for it to function.
ii. It doesnot require warm up time.
iii. It is portable
iv. It is Cheaper and can be manufactured easily.
v. It cannot be broken easily.