Unit-1
(UNITS AND DIMENSIONS)

What is Science ?
The study and knowledge about the physical world and natural law.
What is physics ?
A science that deals with matter and energy and their interaction.
What is Scalar ?
Used about a measurement or quantity having size but no direction
What is vector ?
A measurment or a quantity that has both size and direction.
Dimension :—
Physical quantities that can be measurement.
What is unit ?
The quantity of a constant magnitude used to measurement the magnitudes of other quantities of an indentical type.
What is physical quantity ?
Any physical property of a material or system that can be quantified this is can be measurement using number.
Ex :- Length, mass, time etc.
What is fundamental physical quantity ?
The physical quantity which are independent of one another are, called " fundamental physical quantity."
Ex :- Length, mass, Time etc.
What is Derived physical quantity ?
The physical quantity which can be derived from the fundamenta physical quantities are called "Derived physical quantity"
Ex :- Area, volume, Speed etc.
What is a unit ? write the characteristics of unit.
The unit is defined as the standard of the measurement of the same kind.
Characteristics of unit :—
- It should be well defined without ambiguity.
- It should not very with respect to place, time, and temp
- It should be easily reproduced.
- It should be of Conveinient size.

(3) Define fundamental units and derived units.

Fundamental units :-

The units that are used measuremental physical quantities are called "fundamental units."

Ex:- Metre, Kilogram, second etc.

Derived units :-

The units that are used measure derived physical quantities are called "Derived units."

Ex:- Metre², metre, second' etc.

4. Define SI units and write the advantages of SI units.

SI units :-

Introduced a new system of unit called SI system. SI means international system units.

Advantages of SI units :-

The base and supplementary units covers all branches of science and engineering.

→ All the unit are well defined without any ambiguity.

→ All the derived units can be obtained by simple multiplication and or division of fundamental units.

→ Almost all countries in the world have adopted SI system.

Write the base (fundamental) and supplementary unit of SI along with their symbols.

→ There are seven base (fundamental) unit and two supplementary units.

S.NO	Quantity	unit	Symbol
	FUNDAMENTAL UNITS		
1	Length	Metre	M
2	mass	kilogram	kg
3	Time	second	s
4	Electric current	ampere	A
5	Thermodynamic Temp	kelvin	k
6	Luminous intensity	Candela	cd
7	Amount of Substance	mole	mol
	SUPPLEMENTARY UNITS		
1	Plane angle	radian	~~rad~~ rad
2	Solid Angle	steradian	Sr

6Q What are multiples and Submultiples of SI System ?

→ SI System established multiples and Sub multiples are arranged prefixes and symbol to express very large and small value which are lengthly in short form.

MULTIPLES			SUB-MULTIPLES		
Factor	Prefix	Symbol	Factor	Prefix	Symbol
10^1	deca	da	10^{-1}	deci	d
10^2	hecto	h	10^{-2}	Centi	c
10^3	kilo	k	10^{-3}	milli	m
10^6	mega	M	10^{-6}	micro	μ
10^9	giga	G	10^{-9}	~~pico~~ nano	n
10^{12}	tera	T	10^{-12}	Pico	p
10^{15}	Peta	P	10^{-15}	femto	F
10^{18}	exa	E	10^{-18}	atto	a

Q_7 What is dimension ?

The fundamental units is represented in the from of the mass (M), Lenght (L), Time (T) with is derive units is called dimension.

→ It is derive expenision in the from of

$[M^p L^q T^r]$

$$\boxed{\begin{aligned} &\text{If } p = -\text{or} + \text{or } 0 \\ &q = -\text{or} + \text{or } 0 \\ &r = -\text{or} + \text{or } 0 \end{aligned}}$$

Distance :- The movement of parth of a body from intial point to final is called distance.

Displacement :- The shoutes parth of a body from its intial to final point of position is called displacement.

NOTE :- Displacement is become distance but all distance are not displacement.

Q_1 What is physics. ?

→ A science that deals with matter and energy their interactions is called physics.

or

→ The process the Lambin about science is the process the Learning about natural world observation the experimentation is called science.

Units and measurement :-

Q2 What is measurement ? who types of measurement ?

→ Measurement is oppration by which we compare a physical quantities with a unit Chosunetor for that quantities. Thus measurement are nessesary for production and quantity control.

→ Two types of measurement :-

(i) Direct measurement.

(ii) indirect measurement

(1) Direct Measurement :-

When measurement are taken directly using tools instrument of othere coolibreated measuring dovia divice are called direct measurement.

For example :- Measurement of table by using meter scale.

(ii) Indirect Measurement :-

→ When the measurement of must be done through a formula of othere Calculation the measurement of indirect measurement.

→ For example :- (i) Distance of move

(ii) Distance of sun

(iii) Distance of light

(iv) Radiation path.

Unit :- The reference of standard used for of that physical is quantity is called are unit of that physical quantity.

For example :- Q = nu

Q = is physical quantity

n = numerical value.

u = unit of quantity.

Requarment of unit :-

(i) It should be of suitable size niethere too large non-small

(ii) It should be well defined.

(iii) It should not very place to place.

(iv) It should not be affected by change in physical condition.

(v) It should not change time.

(vi) It should be accepted internationally.

System of units :—

(i) C.G.S → In this system the unit of length is meter (M) and mass is kg / kilogram and time is second and it is also known as Forch System.

(ii) F.P.S → In this system the unit of length is foot (ft), mass is pound (Lb). Time is second it is also known as British system.

(iii) M.K.S → In this system the unit of length meter (M) in this System mass is kilogram (kg) and Time is second (s) it is also known matric system.

(iv) S.I system :—

In this year 1960 the Eleventh generally conference of weight of measure intraduced the international system of unit.

→ S.I system → International system of unit.

→ The international standard organization (I.S.O) and International electro chemical commision indoreed the system in 1962 in october 1971 a replacement of a matric system (M.K.S) system of unit was from it a new system called system intrnational unit.

Classification of physical Quantity and units :—

→ physical Quantity can be divided in two categories.

(i) Fundamental Quantity

(ii) Derive Quantity

(i) Fundamental Quantity :—

The physical quantity is which can not be derived from one another quantity that is the quanties which are absolute independent of each other are called fundamental quantity.

Example :- Mass, Length, Temp, time; Current, Luminoinlecity Distance.

(ii) Derived Quantity :—

→ All this physical quantity which can be derived from combination of two or more fundamental physical quanties their called derived physical quantities.

Example :- Force.

(i) Fundamental physical quanties :—

→ The fundamental quanties are mainly seventypes and two supplemetary fundamental quanties and their unit are called follows.

(i) Meter :—

It is the unit of length and it is represented by (M)

(ii) Kilogram :—

It is the unit of mass and it is represented by (kg)

(iii) Second :—

It is the unit of time it is represented by (T)

(iv) Ampere :—

It is the of current and it is represented by (A)

(v) kelvin :—

It is the unit of temperature and it is represented by (K)

(vi) Candela :—

It is the unit of luminous intensity and it is represented (cd)

(vii) Mole :—

It is the unit of amount of substance and it is represented by (mol^{-1})

(ii) Supplementary physical Quantity :—

i.e (i) Plane angle

(ii) Solid angle

→ Plane angle is unit radian. it is a syst symbol rad.

→ Solid angle is unit Steradian it is a symbol Sr.

DIMENSION :—

Dimension :—

The dimension of physical quantity may be defined as the power to which the fundamental quantities must be raised in order to represent it.

Ex:- (i) Area = Length x breath

$= l \times l$

$= l^2$

$= [M^0 L^2 T^0]$

(ii) Volume = Length x breadth x height

$= L \times L \times L$

$= [L^3]$

$[M^0L^3T^0]$

(iii) Density = $\frac{\text{mass}}{\text{Volume.}}$

$= \frac{[M]}{[M^0L^3T^0]}$

$= [M^1L^{-3}T^0]$

(iv) Force = mass x acceleration.

$= [M] \times [a] = kg \times LT^{-2}$

$= [M^1L^1T^{-2}]$

(v) Momentum = Mass x velocity

$= [M] \times [M^0L^{-1}T^{-1}]$

$= [M^1L^1T^{-2}]$

(vi) Power = $\frac{\text{work}}{\text{Time}} = \frac{[ML^2T^{-2}]}{[T]} = [M^1L^2T^{-3}]$

Dimensional formula :-

The formula which indicates the relationship between a derived physical quantity and fundamental quantities is known as dimensional formula

→ The general from dimensional is:

$[M^0L^0T^0]$

Dimensional Constants :-

→ The quantities which a constant value and posses dimension are called dimensional Constant.

Ex:- (i) Planck's Constant

(ii) Universal Gas constant.

Dimensionalless quantities :-

→ The quantities have not a dimesion is known as dimensionless quantities.

Ex:- Angle, Strain, refractive, index

Checking the dimensional correctness of physical quantities Relation :-

→ Accroding the principle of Homegenecity. If the dimension of each term both sides of equation are same then the physical quantity will connect.

Ex:- To check connectness of $v = u + at$ using dimension.

Dimensional formula of final velocity

$$v = [M^0 L^1 T^{-1}]$$

Initial velocity $u = [LT^{-1}] = [M^0 L^1 T^{-1}]$

Dimensional formula of Acceleration × Time.

$$= [L^1 T^{-2}][T^1]$$

$$= [M^0 L^1 T^{-1}]$$

The dimension of both sides of each same is term is same.

Hence, The equation is dimensionaly connect.

Unit-2

(SCALAR AND VECTOR QUANTITY)

Scalar Quantities :-

The quantities which have only magnitude and not direction is knows as Scalar quantities.

Ex:- Speed, Time, velocity, Distance etc.

Vector Quantities :-

The quantities which have both magnitude and direction and obey the addition of law parallelogram addition of triangle law.

Ex:- Force. Displacement, velocity. Acceleration, momentum.

Problem - 1 :-

* Surface tension :- $\frac{\text{Force}}{\text{Length}} = \frac{[M^1L^1T^{-2}]}{[L^1]} = [M^1L^0T^{-2}]$

* Momentum :- mass x velocity $= [M][M^0LT^{-1}]$
$= [M^1L^1T^{-2}]$

* Angular momentum :- momentum x Distance
$[M^1L^1T^{-2}] \times [L^1]$
$= [M^1L^2T^{-2}]$

* Planck's Constant = $\frac{\text{Energy}}{\text{Frequency}} = \frac{[ML^2T^{-2}]}{[T^1]}$
$= [ML^2T^{-3}]$

* Frequency :- $\frac{1}{Time} = \frac{1}{[T^1]} = [M^0L^0T^{-1}]$

* Rate of flow :- $\frac{Volume}{Time} = \frac{[M^0L^3T^0]}{[T^1]} = [M^0L^3T^{-1}]$

Q2 Check the correctness of the equation.

(i) $v^2 - u^2 = 2as$ (ii) $s = ut + \frac{1}{2}at^2$

Solution :- The dimensional formula of each term in the above equation is as follows.

(i) $v^2 - u^2 = 2as$

$\Rightarrow [M^0L^2T^{-2}]^2 - [M^0L^2T^2]^2 = [2[M^0LT^{-2}][L]]$

$\Rightarrow [M^0L^4T^{-4}] - [M^0L^4T^4] = [M^0L^2T^{-2}] = [L^2T^{-2}]$

Hence,

$v^2 = [LT^{-1}]^2 = [M^0L^2T^{-2}]$

$u^2 = [LT^{-1}]^2 = [M^0L^2T^{+2}]$

$2as = 2 \times$ acceleration $\times$ Distance.

$= 2 \times [M^0LT^{-2}][L]$

$= 2[M^0L^2T^{-2}]$ ($\because$ 2 has no dimension)

$= [L^2T^{-2}]$ Ans

The dimensional formula of each term in the given eq^n is same. Hence the given eq^n is correct according to principle of homogeneity of dimensions.

(ii) $s = ut + \frac{1}{2}at^2$

$\Rightarrow s = [L] = [M^0L^1T^0]$

$ut = [LT^{-1}] \times [T]$

$= [M^0L^1T^0]$

$\frac{1}{2}at^2 = [LT^{-2}] \times [T]^2$ $\because$ (as $\frac{1}{2}$ has no dimension)

$= [L] = [M^0L^1T^0]$

VECTOR :-

In physics, a quantity that has both magnitude and directions It is typically represented by an arrow whose direction is the same as that of quantity and whose length is proportional to the quantity's magnitude.

Types of vector :-

(i) Null vector	(ix) proper vector
(ii) Equal vector	(x) unit vector
(iii) Negative vector	(xi) line vector/co-direction vector
(v) Co-Linear vector	(xii) position vector.
(vi) Co-planer vector.	
(vii) Localised vector	
(viii) Non-localised vector	

(i) Null vector or (zero vector) :-

→ The vector having zero magnitude and orbitary direction is called Null vector.

→ properties of Null vector :- It has zero magnitude.

(2) It has orbitary direction

(3) It is represented by point

(4) When Null vector is added or substracted from a given vector is same as the resultant vector.

(5) Dot product of a null vector with any vector is always '0'

(6) Cross product of a non-vector if any othere vector is also null vector.

(ii) Equal vector :-

Two vector as set to be equal vector if they process the Same magnitude and direction.

(1) Ex :- A ← Distance = D → B 5 kelometer

A ← Distance = D → B 5 kilometer

(ii)

A ← $\vec{u}$ → B

C ← $\vec{v}$ → D

$\vec{u} = \vec{v}$

(iii) Negative vector :-

→ The vector is said to be negative vector of one anothere

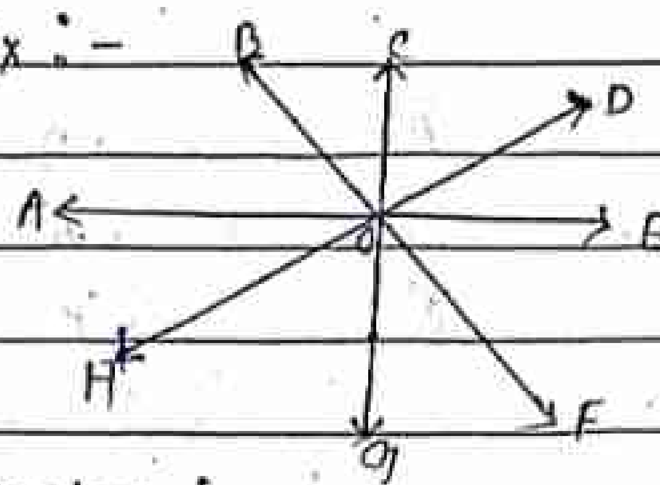
Ex (1) A $\vec{u}$ → B

A ← $-\vec{v}$ → B

(iv) Co-initial vector :-

The vector having same intial point irrespective their magnitude and direction are called co-intial vector.

For Ex :-

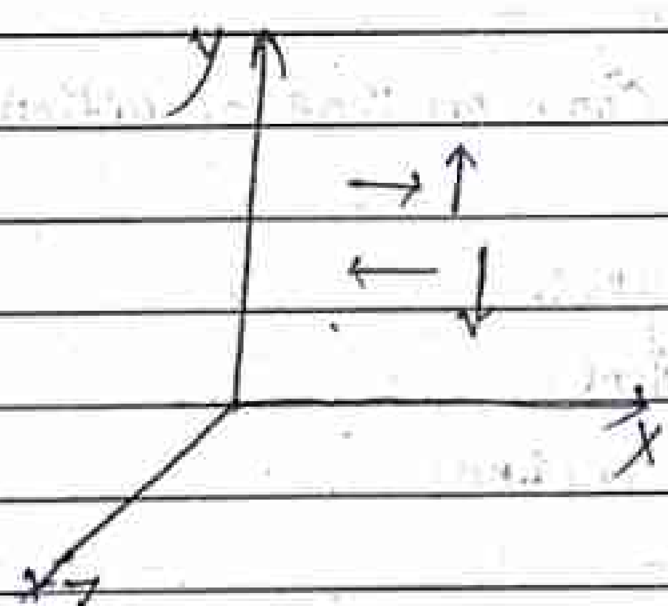


(v) Co-linear vector :-

(vi) Co-Planer vector :-

The vector lying is a same in the same plane magnitude irrespectiv their magnitude direction in intial point is called co-planer vector

Ex :-



(vii) Proper vector :-

→ The vector which magnitude is not equal to zero is called proper vector

Ex :- $\vec{A} \neq 0$

(viii) Unit vector :-

The vector is magnitude is unity is called unit vector

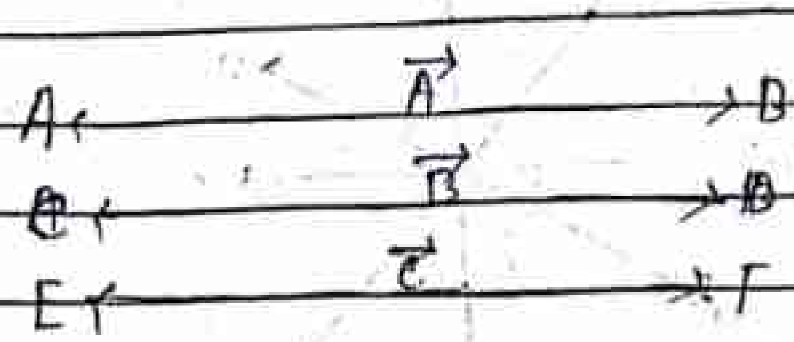
Ex :-

$$\hat{A} = \frac{\vec{A}}{|\vec{A}|} \quad (\because \hat{A} = 1)$$

(ix) Like vector on co-directional vector :—

The vector having same direction iniestive of their magnitude is called like vector on co-directional vector.

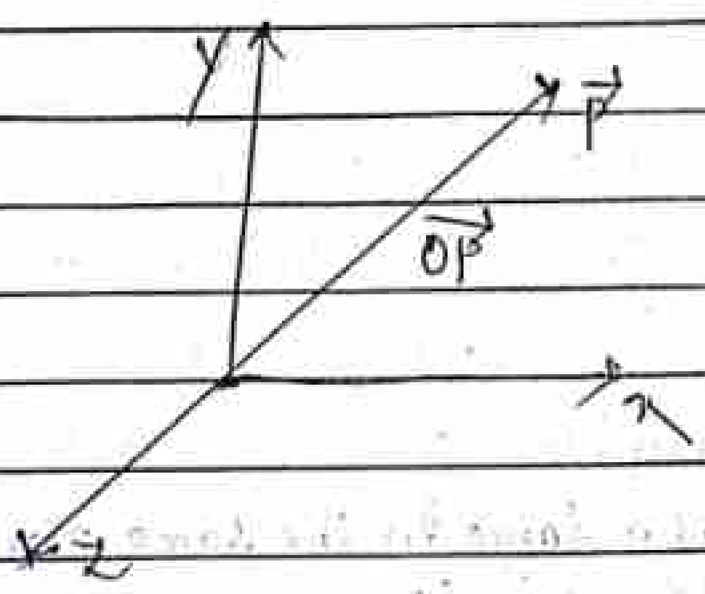
Ex :—



(x) possition vector :—

The vector which specified the possition of a point with respect to a fiexd point is called possition vector.

Ex :—



→ position vector is a fiexd vector.

(xi) Co-linear vector :—

The vector having a common line of action are called co-linear vector

→ There are two types.

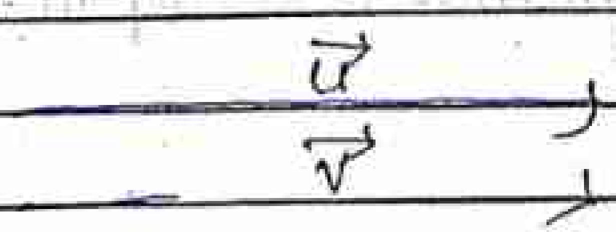
(1) parallel vectors

(ii) Anti parallel vectors

(1) parallel vector :—

→ Two vector acting along to same direction are called parallel vector

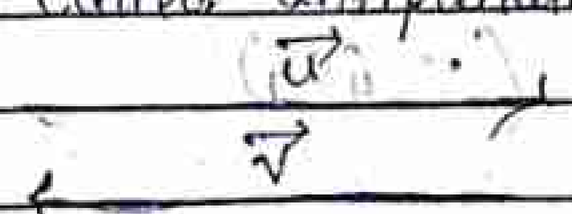
Ex :—



(ii) Anti parallel vector :—

→ Two vectors whose are direction directed in opposide direction are called antiparallal vectors.

Ex :—



(xii) Localised vector :—

→ The vector whose intial point is fiexd is called Localised vector.

Ex :-

(xiii) Non-localised vector :—

→ The vector whose intial point not fiexd is called non-localised vector

→ Example - Force.

Multiplication Vector :—

Scalar multiplication of vector :—

→ Consider a vector $\vec{u}$ when it is multiply by scalar (m). The result is another vector is $\vec{v} = m\vec{u}$

So, when evers a vector is multiplyied by scalar 'm' the result is another vector having magnitude 'm' times that of first and directed along the first vector.

Addition of vector or Composition of vector :—

→ The addition vector having five condition those are,

(i) The addition or Composition vector mines finding the resultance of number of vector action on a body.

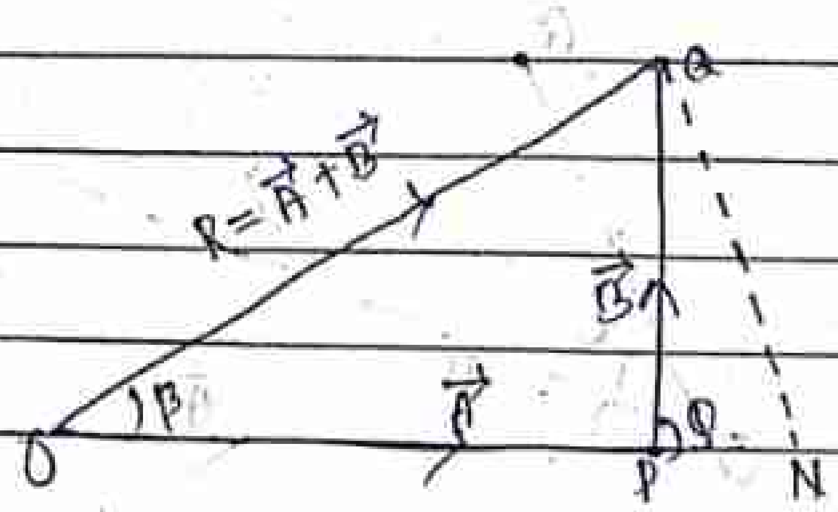
(ii) The vector can be added geometrically and not algebrical.

(iii) The vector whose resultance is to be calculated be have independent of each other.

(iv) The vector addition is commutative.

$$\rightarrow \vec{A} + \vec{B} = \vec{B} + \vec{A}$$

Triangles' Law of vector :—



Δ PQN

$\sin\theta = \frac{P}{h} = \frac{QN}{QP} = \frac{QN}{B}$

$B\sin\theta = QN \quad (i)$

$\cos\theta = \frac{B}{H} = \frac{PN}{PQ} = \frac{PN}{B}$

$B\cos\theta = PN \quad (ii)$

Δ OQN

$OQ^2 = ON^2 + QN^2$

$OQ^2 = (OP + PN)^2 + QN^2$

$= OP^2 + PN^2 + 2(OP)(PN) + QN^2$

$= A^2 + (B\cos\theta)^2 + 2AB\cos\theta + (B\sin\theta)^2$

$OQ^2 = A^2 + B^2\cos^2\theta + 2AB\cos\theta + B^2\sin^2\theta$

$= A^2 + B^2(\cos^2\theta + \sin^2\theta) + 2AB\cos\theta$

$= A^2 + B^2(1) + 2 \cdot AB\cos\theta$

$R^2 = A^2 + B^2 + 2AB\cos\theta \quad (\because OQ^2 = R^2)$

$\vec{R} = \sqrt{A^2 + B^2 + 2AB\cos\theta}$

$\tan\beta = OQN$

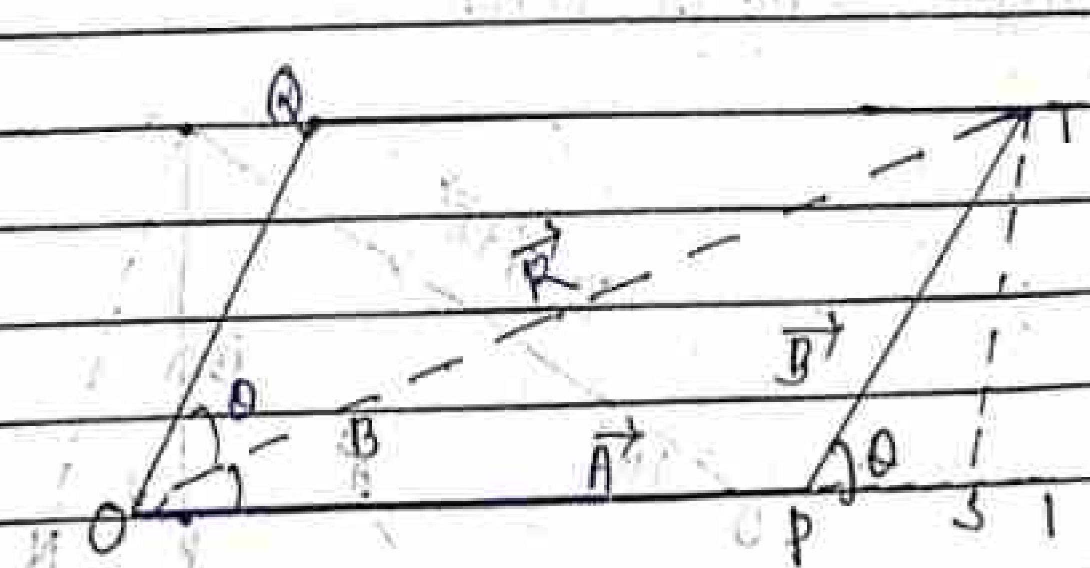
$\tan\beta = \frac{QN}{ON}$

$\tan\beta = \frac{QN}{(OP + PN)}$

$\tan\beta = \frac{B\sin\theta}{A + B\cos\theta}$

$$\boxed{\beta = \tan^{-1}\left(\frac{B\sin\theta}{A + B\cos\theta}\right)}$$

Parallelogram laws :—



In Δ PTS :-

$$\tan\beta = \frac{TS}{OS}$$

$$\sin\theta = \frac{TS}{PT} = \frac{TS}{B}$$

$$\Rightarrow B\sin\theta = TS \text{ ---- (1)}$$

$$\cos\theta = \frac{PS}{PT} = \frac{PS}{B}$$

$$\Rightarrow B\cos\theta = PS \text{ --- (11)}$$

In Δ OTS

$$OT^2 = OS^2 + TS^2$$

$$OT^2 = (OP+PS)^2 + TS^2$$

$$OT^2 = OP^2 + PS^2 + 2OP.PS + TS^2$$

$$OT^2 = A^2 + B^2\cos^2\theta + 2A.B\cos\theta + B^2\sin^2\theta.$$

$$R^2 = A^2 + B^2\cos^2\theta + 2AB\cos\theta + B^2\sin\theta \quad [\because OT^2 = R^2]$$

$$R^2 = A^2 + B^2(\cos^2\theta + \sin^2\theta) + 2AB\cos\theta$$

$$R^2 = A^2 + B^2 + 2AB\cos\theta$$

$$R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$$

$$B\sin\theta = TS \text{ ------- (1)}$$

$$B\cos\theta \; PS \text{ ------- (11)}$$

$$\tan\beta = \frac{B\sin\theta}{A + B\cos\theta}$$

$$\tan\theta = \frac{TS}{OS}$$

$$OS = OP + PS$$

$$= \vec{A} + B\cos\theta$$

$$\tan\beta = \frac{B\sin\theta}{A + B\cos\theta}$$

$$\beta = \tan^{-1}\left(\frac{B\sin\theta}{A + B\cos\theta}\right)$$

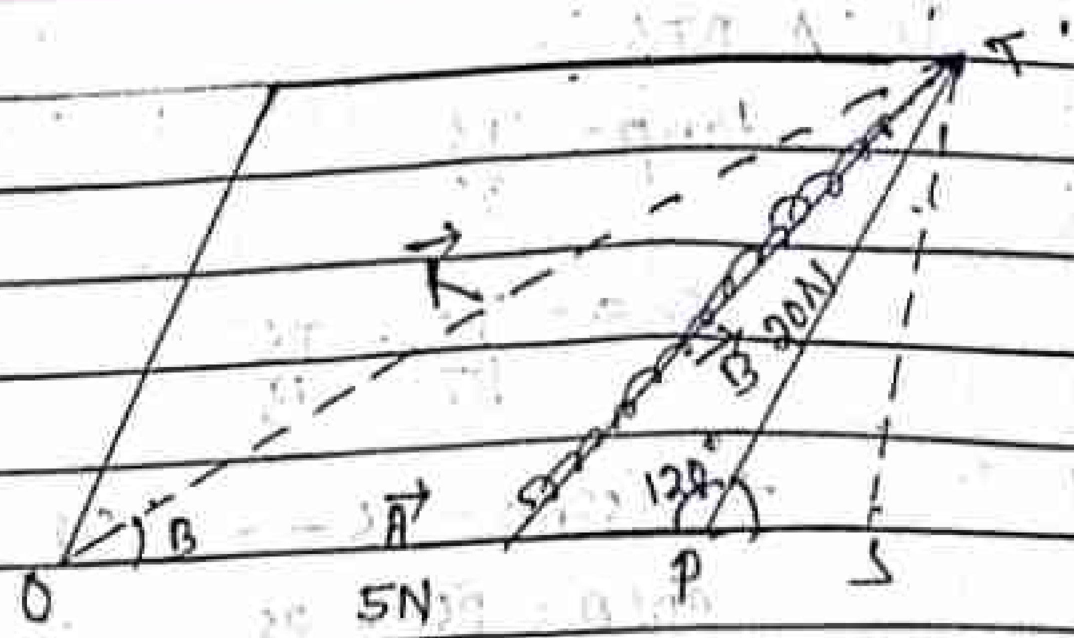
Q1 Two forces 5N and 20N are acting at angle of $120°$ between them find the resultances in magnitude and direction ?

Solution :-

Given, to forceses are,

$5N = \vec{A}$

$20N = \vec{B}$



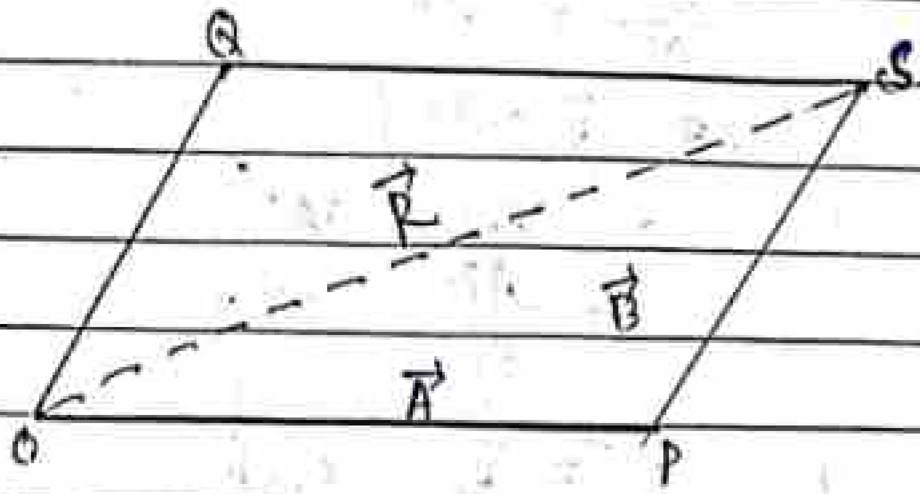
$$R = \sqrt{A^2+B^2+2AB\cos\theta}$$
$$= \sqrt{5^2+20^2+2\cdot 5\times 20\cos\theta}$$
$$= \sqrt{25+400+2\cdot 100\cos 120^\circ}$$
$$= \sqrt{25+400+2\times 100\times\left(-\frac{1}{2}\right)}$$
$$= \sqrt{425-100}$$
$$= \sqrt{325}$$
$$= 18.3$$

The resultance in magnitude are

$$\beta = \tan^{-1}\left(\frac{B\sin\theta}{A+B\cos\theta}\right)$$
$$= \tan^{-1}\left(\frac{20\times\frac{\sqrt{3}}{2}}{5+20\times\frac{-1}{2}}\right)$$
$$= \tan^{-1}\left(\frac{20\times\frac{\sqrt{3}}{2}}{5+10(-1)}\right)$$
$$= \tan^{-1}\left(\frac{20\times\frac{\sqrt{3}}{2}}{5(-10)}\right)$$
$$= \tan^{-1}\left(\frac{20\times\frac{\sqrt{3}}{2}}{-5}\right)$$
$$= \tan^{-1}\left(-4\times\frac{\sqrt{3}}{2}\right)$$
$$= \tan^{-1} -2\times 1\sqrt{3}$$
$$= \tan^{-1} -2\times 1.7$$
$$= \tan^{-1} -3.4$$
$$\beta = \tan^{-1}(-3.4)$$

Q2 Two force equalise magnitude have magnitude of their resultance equal to eithere find the an angle between them.

Solution :—



Let,

$\vec{A} = \vec{f_1}$

$\vec{B} = \vec{f_2}$

than, $f_1^2 = f_2^2 = R$

than,

According to parallelogram Laws

$\Rightarrow R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$

$\Rightarrow R = \sqrt{f_1^2 + f_2^2 + 2f_1^2 f_2^2 \cos\theta}$

$\Rightarrow R = \sqrt{2f^2 + 2f^2\cos\theta}$

$\Rightarrow F = \sqrt{2f^2 + 2f^2\cos\theta}$ $(\because R = F)$

$\Rightarrow F^2 = 2f^2 + 2f^2\cos\theta$

$\Rightarrow 1 = 2(1 + \cos\theta)$

$\Rightarrow \frac{1}{2} = 1 + \cos\theta$

$\Rightarrow \cos\theta = \frac{1}{2} - 1$

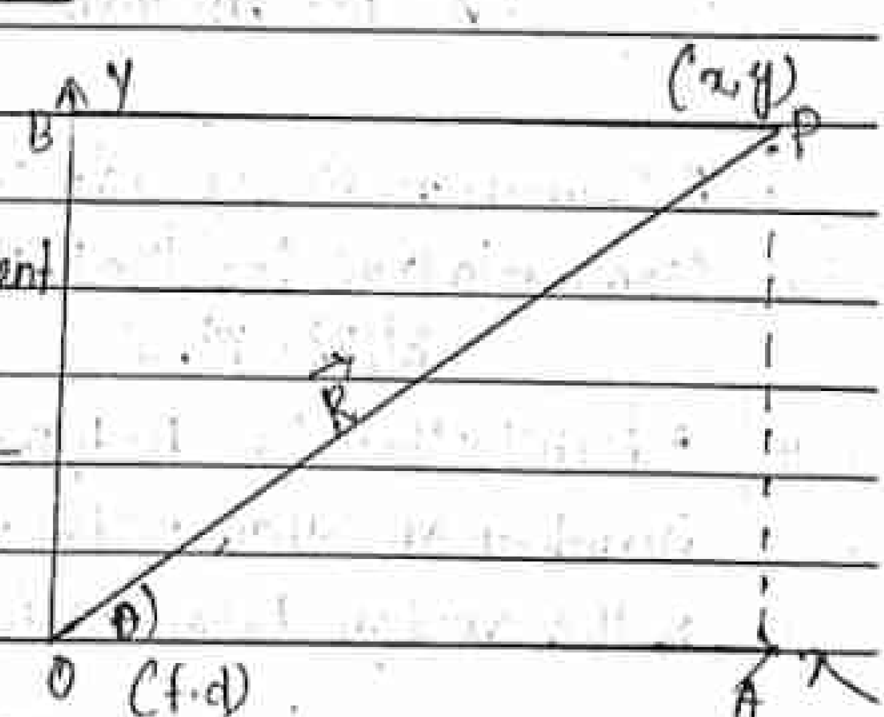
$\Rightarrow \theta = \cos^{-1}\left(-\frac{1}{2}\right)$

$\Rightarrow \theta = \cos^{-1}(120^\circ)$

$\Rightarrow \boxed{\theta = 120^\circ}$

Resolution of vector in a plane :—

$\vec{OP} = \vec{R}$ be the position vector of a point $P(x, y)$, from P, PA draw and PB $\perp$ an the x-axis and y-axis represent Where, $OA = x$ and $OB = y$



$\Rightarrow$ If $\hat{i}$ and $\hat{j}$ are unit vector, along x-axis and y-axis

$\vec{OA} = \hat{i}x = x$

$\vec{OB} = \hat{i}y$

* Applying triangles Law in ΔOAP Rectangular Components of vector.

$\vec{OP} = \vec{OA} + \vec{AP}$

$= \vec{OA} + \vec{AP}$

$\boxed{\vec{R} = x\hat{i} + y\hat{j}}$

In Δ OAP

$= \frac{OA}{OP} = \cos\theta$

$= \frac{x}{OP} = \cos\theta$

$\boxed{x = \vec{R}\cos\theta}$

In Δ OAP

$= \frac{AP}{OP} = \sin\theta$

$= \frac{y}{R} = \sin\theta$

$\boxed{y = \vec{R}\sin\theta}$

$\vec{R} = R\cos\theta + R\sin\theta$

$\boxed{\vec{R} = (R\cos\theta)\hat{i} + R\sin\theta\hat{j}}$

Product of two vector :—

(I) Dot product

(II) Cross product

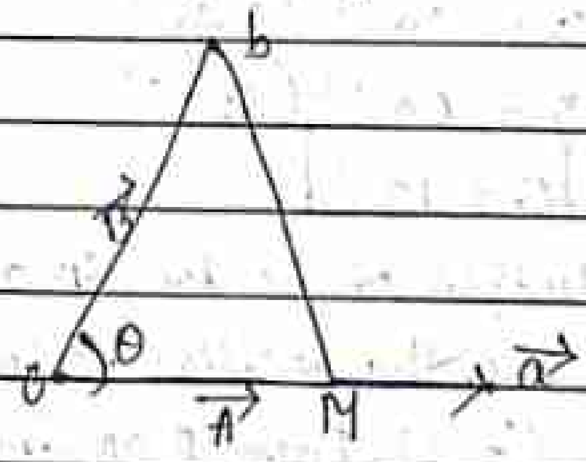
(i) DOT Product :—

Dot product of two vector is define as the product of their magnitude and the cossine of the smaller angle betn the two vector.

$\vec{A} = \vec{Oa}$

$\vec{B} = \vec{Ob}$

$\boxed{\vec{A}\cdot\vec{B} = AB\cos\theta}$



* Characteristic of dot product :—

(I) Commutative :— Dot product betn two vector is commutative.

$\vec{A}\cdot\vec{B} = \vec{B}\cdot\vec{A}$

(II) Distributive :— Dot product of a vector with the sum of a number of other vector is equal the sum of a the dot product of the vector taken with other vector separatly

$\vec{A}(\vec{B}+\vec{C}) = \vec{A}\cdot\vec{B} + \vec{A}\cdot\vec{C}$

(III) Perpendicular vector :— Two perpendicular vector $\vec{A}$ and $\vec{B}$.

$\theta = 90°$

$\vec{A}\cdot\vec{B} = AB\cos\theta$

$\boxed{\vec{A}\cdot\vec{B} = AB\cos 90°}$

The dot product of two non-zero vector $\theta = 90^\circ$ which are perpendicular to each other is always zero.

This statement is known as perpendicular condition so, $\hat{i}, \hat{j}, \hat{k}$ are mutually perpendicular.

$$\boxed{\hat{i}\cdot\hat{j} = \hat{j}\cdot\hat{k} = \hat{i}\cdot\hat{k} = 0}$$

(1) Write down the scale :-

(1) To construct a plaine scale to show meters and diameter when 1M is represented by 2.5cm and long enough to measure of to to 5m also mark 7dm and 3m 4dm on the scale.

(2) Draw a scale of 1:16 to show meter and decimeter and along enough to measure up to 5m. Show the length of 3.5m on the Scale.

Diagonal Scale :-

Construct a diagonal scale of RF is equal $\frac{1}{2.5 \times 10^6}$ to ready up to single km and long enough to measure 400KM marked a distance 254km and 322km on the scale.

* Construct a diagonal scale of 1:500 to show meters and decimeter and long enough to measure up to 80m so a distance of 64:8 m on it.

Distributive :-

Dot product between two vector with the some of a number of other vector each Distributive vector.

$$A + (B+C) = A \times B + A$$

$$\vec{A}\,(\vec{B}+\vec{C}+\ldots) = \vec{A}\cdot\vec{B} + \vec{A}\cdot\vec{C}$$

Perpendicular vector :-

Two vectors $\vec{A}$ & $\vec{B}$ $\theta = 90^\circ$

$$\vec{A}\cdot\vec{B} = AB\cos\theta$$

$$\boxed{\vec{A}\cdot\vec{B} = ABC\cos 90^\circ}$$

The Dot Product of two non-zero vector which are $\perp$ to each other is always zero.

This statement is known as $\perp$ condition, so $\hat{i}, \hat{j}, \& \hat{k}$ and mutualy $\perp$ $\hat{i}\cdot\hat{j} = \hat{j}\cdot\hat{k}$

$$= \hat{i}\cdot\hat{k} = \hat{j} = y = 0$$

(4) Collinear vector :-

(a) Parallel vector

in this $\cos\theta = 0°$

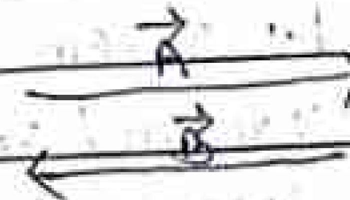
$$\vec{A}\cdot\vec{B} = AB\cos 0°$$

$$\vec{A}\cdot\vec{B} = AB \times 1$$

$$\Rightarrow \vec{A}\cdot\vec{B} = AB$$

(b) Anti Parallel vector

$$\vec{A}\cdot\vec{B} = AB\cos 180°$$



$$\vec{A}\cdot\vec{B} = AB(-1)$$

$$\boxed{\vec{A}\cdot\vec{B} = -AB}$$

(5) Equal vector :-

If vector are equal

$$\vec{A}\cdot\vec{A} = A \times A$$

$$\cos° = 1$$

$$\vec{A}\cdot\vec{A} = A^2$$

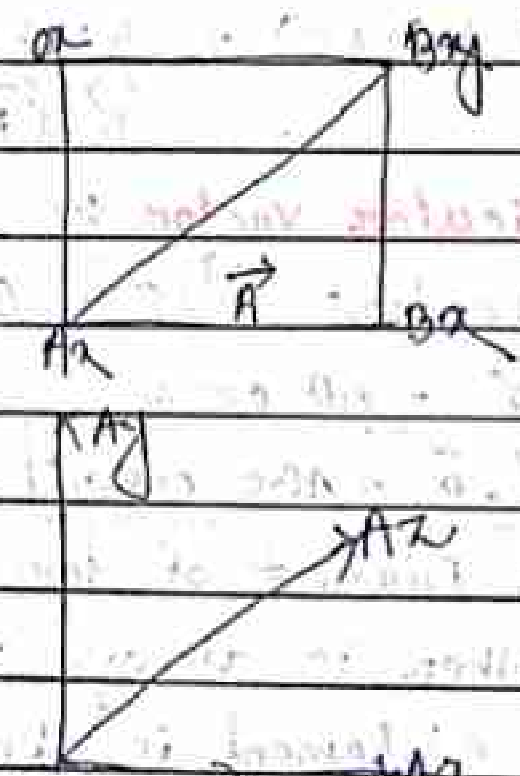
Dot product of two equal vector each equal to the squares of the magnitude of either

$$\hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k}$$

(6) Dot product of interm of Rectangular component :

Let $\vec{A_x}, \vec{A_y}, \vec{A_z}$ and $\vec{B_x}, \vec{B_y}, \vec{B_z}$ be the reactangular components of two vector $\vec{A}\cdot\vec{B}$

$$\boxed{\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}}$$



$$\vec{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$$

$$\vec{A}\cdot\vec{B} = (A_x\hat{i} + B_y\hat{j} + A_z\hat{k})\cdot(B_x\hat{i} + B_y\hat{j} + B_z\hat{k})$$

$\Rightarrow A_x B_x(\hat{i}.\hat{i}) + A_y B_y(\hat{j}.\hat{j}) + A_z B_z(\hat{k}.\hat{k})$

$= A_x B_x(\hat{i}.\hat{i}) + A_y . B_y(\hat{i}.\hat{i}) + A_z \hat{k} B_z \hat{k}(\hat{k}.\hat{k})$

$\vec{A}.\vec{B} = A_x B_x + A_y B_y + A_z B_z$

$\vec{A}.\vec{B} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$
$(B_x\hat{i} + B_y\hat{j} + B_z\hat{k})$

$= A_x B_x(\hat{i}\hat{i}) + A_y B_y(\hat{j}\hat{j}) + A_z B_z(\hat{k}\hat{k})$
$A_y B_y(\hat{j}\hat{j}) + A_x B_x(\hat{i}.\hat{i}) + A_z B_z(\hat{k}.\hat{k})$

condition

$$\boxed{\begin{array}{l} \hat{i}.\hat{i} = \hat{j}.\hat{j} = \hat{k}.\hat{k} = 1 \\ \hat{i}\hat{j} = \hat{j}.\hat{i} = 0 \\ \hat{i}.\hat{k} = \hat{k}.\hat{i} = 0 \\ \hat{j}.\hat{k} = \hat{k}.\hat{j} = 0 \end{array}}$$

$$\boxed{\vec{A}.\vec{B} = A_x B_x + A_y B_y + A_z B_z}$$

(PRODUCT)

EXAMPLE

Find the angle betn two vector $\hat{i} - 2\hat{j} - 5\hat{k}$ and $2\hat{i} + \hat{j} - 4\hat{k}$

$\vec{A} = A_x = 1$ $\qquad \vec{B} = B_x = 2$

$A_y = -2$ $\qquad B_y = 1$

$A_z = -5$ $\qquad B_z = -4$

$\vec{A} = \sqrt{A_x^2 + A_y^2 + A_z^2}$ $\qquad = \sqrt{2^4 + 1^2 + (-4^2)}$

$= \sqrt{-1^2 + -2^2 - 5^2}$ $\qquad = \sqrt{4+1+16}$

$= \sqrt{1+4+25}$ $\qquad \vec{B} = \sqrt{21}$

$= \sqrt{30}$

$$\boxed{\vec{A}.\vec{B} = A_x B_x + A_y B_y + A_z B_z}$$

$1\times2 + (-2)1 + (-5)(-4)$

$= 2 + (-2) + (20)$

$= \cancel{2} - \cancel{2} + 20$

$= 20$

$\vec{A}\cdot\vec{B} = 20$

$\vec{A}\cdot\vec{B} = AB\cos\theta$

$20 = \sqrt{30}\sqrt{21}$

$\cos\theta = \frac{20}{\sqrt{30}\sqrt{21}} = \frac{20}{\sqrt{630}} = \frac{20}{25.099}$

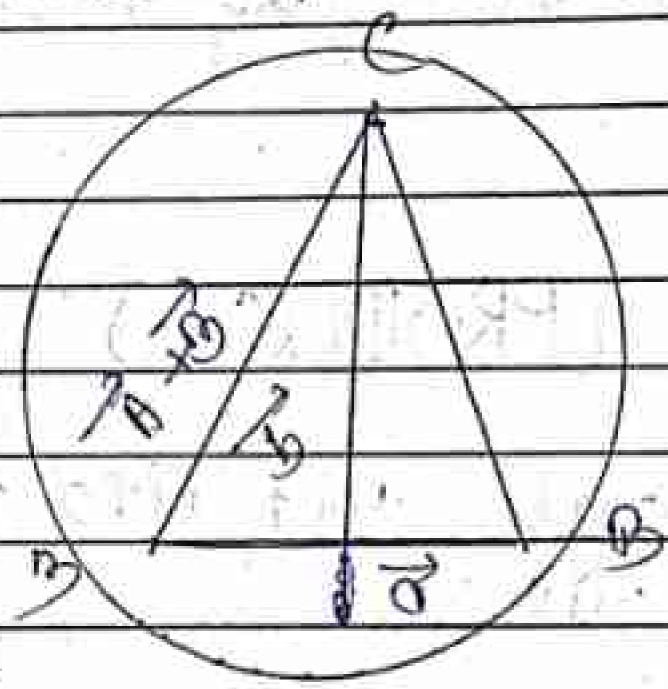
$(= 0.796)$

$\theta = \cos^{-1} 0.796$

$\theta = \cos^{-1} 0.796$

$\theta = 37^0$

(2) point 'C' is situated on the circumtance of a circle of dimetre AB provete the method of vector analylish that angle. ACB is and, right angle.



(crops Crush)

radius

let a be the circle

$\vec{AO} = \vec{OB} = \vec{a}$

$\vec{OC} \cdot \vec{b}$

From $\Delta \cdot \Delta OCA$

$\vec{AC} = \vec{AO} + \vec{OC}$

$\vec{AC} = \vec{a} + \vec{b}$

From Δ BOC

$\vec{CB} = \vec{OC} + \vec{OB}$ $\quad (\vec{a}\cdot\vec{a}) - \vec{a}\cdot\vec{b}^{\,0})$

$\vec{CB} = \vec{b} + \vec{a}$ $\quad (+\vec{b}\cdot\vec{a}^{\,0} - \vec{b}\cdot\vec{b}^{\,0})$

$\vec{BC} = \vec{CO} + \vec{OB}$ $\quad = (1-0) + (0-1)$

$= (-\vec{b}) + \vec{a}$ $\quad = 1 + (-1) = 1-1 = 0$

$\vec{a} - \vec{b}$

$\vec{AC} \cdot \vec{CB} = \vec{a} + \vec{b}\,(\vec{a} - \vec{b})$

(CROSS product)

cross product of a two vector $\vec{A}$ and $\vec{B}$ is defined as single $\vec{C}$, whose magnitude and is equal to the product of their individual magnitude and the sine of smaller angle between them and direct along the normal to the plane containing $\vec{A}$ and $\vec{B}$

$$\vec{A}\times\vec{B} = \vec{C} = AB \sin\theta \hat{n}$$

$\boxed{\text{where } \hat{n} \text{ is the unit vector}}$

(Characteristic cross product)

① Not commutative

cross product of two vector is not commutative

$$\boxed{\vec{A}\times\vec{B} \neq \vec{B}\times\vec{A}}$$

② Distributive

$$\vec{A}\times(\vec{B}+\vec{C}) = \vec{A}\times\vec{B} + \vec{A}\times\vec{C}$$

③ collinear vector

(a) parallel vector

(b) Anti parallel vector

$\theta = 0^\circ \quad \sin\theta = 0$

$\vec{A}\times\vec{B} = AB \sin 0^\circ \hat{n}$

$\vec{A}\times\vec{B} = AB(0)\hat{n}$

$\boxed{\vec{A}\times\vec{B} = 0}$ null vector

an cas

$\theta = 180^\circ$

$\vec{A}\times\vec{B} = AB \cdot \sin\hat{n}$

$\vec{A}\times\vec{B} = AB \sin\theta \hat{n}$

$\vec{A}\times\vec{B} = 0$ null vector

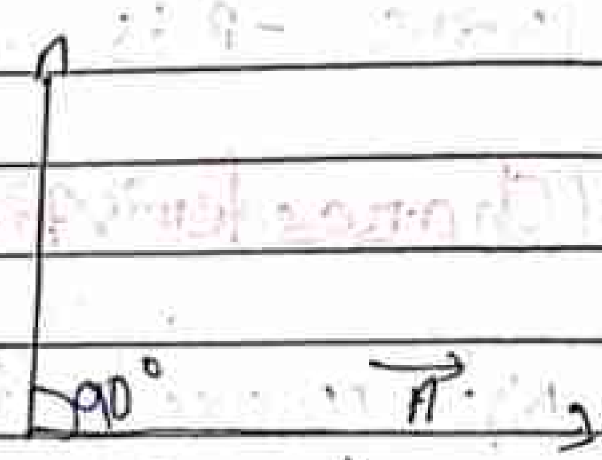
④ equal vector

if two vector are equal

$$\vec{A} \times \vec{A} = AB \sin 0^\circ \hat{n}$$
$$\theta = 0^\circ$$
$$\vec{A} \times \vec{A} = \vec{A}^2 \sin 0^\circ \hat{n}$$
$$= \vec{A} \cdot \vec{A} = A^2 \times (0)\hat{n}$$
$$\Rightarrow \vec{A} \cdot \vec{A} = 0 \text{ null vector}$$

⑤ (perpendicular)

$$\vec{A} \times \vec{B} = AB \sin 90^\circ \hat{n}$$
$$\vec{A} \times \vec{B} = AB(1)\hat{n}$$
$$\boxed{\vec{A} \times \vec{B} = AB}$$



$\theta = 90^\circ$
$\sin 90^\circ = 1$

(orthogonal unit of vector)

$$\boxed{\begin{array}{l} \hat{i} \times \hat{j} = \hat{k} \\ \hat{j} \times \hat{k} = \hat{i} \\ \hat{k} \times \hat{i} = \hat{j} \\ \hat{j} \times \hat{i} = -\hat{k} \\ \hat{k} \times \hat{j} = -\hat{i} \\ \hat{i} \times \hat{k} = -\hat{j} \end{array}}$$

cross product of in terms of rectangular components.,

let A_x, A_y, A_z and B_x, B_y, B_z are rectangular component of $\vec{A}$ and $\vec{B}$

$$\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$$
$$\vec{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$$

$$\vec{A} \times \vec{B} = (A_x\hat{i} + A_y\hat{j} + A_z\hat{k}) \times (B_x\hat{i} + B_y\hat{j} + B_z\hat{k})$$

$= A_x B_x (\hat{i} \cdot \hat{i}) + A_y B_y (\hat{j} \cdot \hat{j}) + A_z B_z (\hat{k} \cdot \hat{k})$

$=$

Date 21.11.2023 Tuesday

① Find the dot product of two vectors $\vec{A} = 2\hat{i} + 5\hat{j} + 7\hat{k}$ and $\vec{B} = 3\hat{i} + 8\hat{j} + -4\hat{k}$

$\vec{A} = A_x = 2$ $\vec{B} = B_x = 3$

$A_y = 5$ $B_y = 8$

$A_z = 7$ $B_z = -4$

$\sqrt{A_x^2 + A_y^2 + A_z^2}$ $\sqrt{B_x^2 + B_y^2 + B_z^2}$

$= \sqrt{2^2 + 5^2 + 7^2}$ $= \sqrt{3^2 + 8^2 + (-4^2)}$

$= \sqrt{4 + 25 + 49}$ $= \sqrt{9 + 64 + (-16)}$

$\vec{A} = \sqrt{78}$ $\sqrt{62}$

$\vec{A} \cdot \vec{B}$

$A_x B_x + A_y B_y + A_z B_z$

① $\vec{A} \cdot \vec{B} = (2\hat{i} + 5\hat{j} + 7\hat{k}) \cdot (3\hat{i} + 8\hat{j} + -4\hat{k})$

$= (2 \times 3)\, \hat{i} \cdot \hat{i} + (2 \times 8)\, \hat{i} \cdot \hat{j} + (2 \times (-4))\, \hat{k} \cdot \hat{k}$

$+ (5 \times 3)\, \hat{j} \cdot \hat{i} + (5 \times 8)\, \hat{j} \cdot \hat{j} + (5 \times (-4))$

$\hat{j} \cdot \hat{k} + (7 \times 3)\, \hat{k} \cdot \hat{i} + (7 \times 8)\, \hat{k} \cdot \hat{j} + 7 \times (-4)\, \hat{k} \cdot \hat{k}$

② A force $6\hat{i} + 2\hat{j} + 8\hat{k}$ produce a displacement of $2\hat{i} + 3\hat{i} + 3\hat{k}$ find the work done. (W)

Ans $= W\ \vec{F} \cdot \vec{S} = \left(\underset{A_x}{6\hat{i}} + \underset{A_y}{12\hat{j}} + \underset{A_z}{8\hat{k}}\right)$

$\left(\underset{A_x}{2\hat{i}} + \underset{B_y}{3\hat{j}} + \underset{B_z}{5\hat{k}}\right)$

$= (6\hat{i} \cdot 2\hat{i})\, \hat{i} \cdot \hat{i}\ (12 + 3)\, \hat{j} \cdot \hat{j} + (8 + 5)\, \hat{k} \cdot \hat{k}$

$= 8 + 15 + 13$

$= 36$

③ Break are apply a train travelling at $72 \, Km^{h-1}$ After passing over 200m. It's velocity is reduce to $36 \, Km^{h-1}$ and the same rate of retard assum how much further with it go before it is brought to rest.

→ $u = 72 \, Km^{h-1}$

$\boxed{v^2 - u^2 = as}$

$v = 36 Km^{h-1}$

$s = 200m.$

$36^2 - 72^2 = 200$

$= 1296 - 5184$

$u^2 = 72 \times \frac{5}{18} = 20 ms^{-1}$

$v^2 = 36 \times \frac{5}{18} = 10 ms^{-1}$

$s = 200$

$a = -0.75$

$1296 - 5184$

$0.75 \quad \frac{v^2 - u^2}{s} \quad 1.5 \quad ms^{-2}$

$2 \left(\frac{-3}{4}\right) \times x$

$-x = \frac{100 \times 4}{0.75 \times 200}$

$\boxed{v^2 - u^2 = 2as}$

$10^2 - 20^2 = -0 - 10 ms^{-1}$

$a = -3/4 \, ms^{-2} = 0^2 - 10^2 = 2 \times -3/4 \times s$

$= -100 = -3/2 \times s$

(I) A body projected in to space & is longer being produced by is called project motion.

ex -(I) Bullete fire from a rifle.

(II) A cricket ball a through into space.

Projectile fired

Projectise fired vertically up word

Motion under gavity.

At a initial velocity.

(A) $= u$

A+B final velocity $B(v) = 0$

Distance.

(I) Maximum height (h)

Applying Kinematic equation.

$v^2 - u^2 = 2as$

$v^2 - u^2 = 2(-g)h$

So, $-u^2 = -2gh$

$= u^2 = 2gh$

$\boxed{h = \frac{u^2}{2g}}$

(II) Time of asend (t)

$v = u + at \quad v - u = at$

$0 = u + (-gt)$

$0 = u - gt \quad , gt = u$

$\Rightarrow gt = u$

$\Rightarrow \boxed{t = \frac{u}{g}}$

(III) Speed on reaching ground:—

$v^2 = u^2 = 2as$

$v^2 - 0^2 = 2as$

$v^2 = 2as$

$v^2 = 2(-g) \cdot h$

$v^2 = 2gh$

$v^2 = \cancel{2g} \times \frac{u^2}{\cancel{2g}} \quad \boxed{v^2 = u^2} \Rightarrow v = -u$

* A body is through vertically up words with velocity of $19.6 ms^{-1}$, calculate.

(I) Time of ascent
(II) Time of descent
(III) Spend on reaching the ground.

$u = 19.6 ms^{-1}$
$a = -9.8 ms^{-2}$
$S = 0$
$h = 0$
$\Rightarrow -19.6 = -ght = t = \frac{19.06}{9.8} = 2s$

(II) $u = 19.6 ms^{-1}$
$a = -9.8 ms^{-2}$
$S = 0$
$S = ut + \frac{1}{2} at^2$
$0 = 19.6 \times T - \frac{1}{2} \times 9.8 \, T^2$
$T(19.6 - 4.9T) = 0$
$4.9T = 19.6$
$T = \frac{19.6}{4.9} = 4s$

(III) v = Speed on reaching the ground back
Again consider motion from A, back to

$u = 19.6 ms^{-1}$
$u = v, a = -9.8 ms^{-2}$
$S = 0$
$v^2 - u^2 = 2as$
$v^2 - (19.6) = 2a \times 0 = 0$
$v^2 = (19.6)^2$
$v = -19.6 ms^{-1}$

$$\boxed{\begin{aligned} v^2 &= (19.6)^2 \\ v &= \pm 19.6 ms^{-1} \end{aligned}}$$

15/ A ball thrown up by a player is caught by him 4s after the throw.

(i). What was the speed when the ball was thrown.

(ii) How high did it go,

(iii) Where was the ball after.

(a) 1.5s

(b) 3s after the start.

Solution;

Total time

$$t = 4s$$

$$t = \frac{t}{2} = \frac{4}{2} = 2s$$

(i) Time ascent $t = \frac{u}{g}$

$$= 2 = \frac{4}{9.8}$$

$$u = 19.6 ms^{-1}$$

(ii) Maximum height

$$h = \frac{u^2}{2g} = \frac{(19.6)^2}{2 \times 9.8} = 19.6 m$$

(iii) Instantaneous height of the ball is.

$$y = ut - \frac{1}{2} gt^2$$

(a) $t = 1.5$

$y = y,$ $\quad y = 19.6 \times 1.5 - \frac{1}{2} \times 9.8 (1.5)^2 = 29.4 - 11.05 = 18.35 m$

(b) $t = 3s$ $\quad y_2 = 19.6 \times 3 - \frac{1}{2} \times 9.8 \times (3)^2$

$$= 58.8 - 44.1$$

$$= 14.7 m$$

No-16

A Aeroplane is flying horizontally a height of 490 m with a velocity of 360 kmh^{-1}, A bag containing ration is to be dropped to the jawans on the ground. How far from there should the bag be released so that it falls over them.

$y = -490 m \cdot g = -9.8 ms^{-2}$

$y = \frac{1}{2} g t^2$

$-490 = \frac{1}{2} \times (-9.8) \times t^2$

$\Rightarrow t^2 = \frac{490}{4.9} = 100$

$t = 10s$

Velocity of plane,

$u = 360 kmh^{-1} = 360 \times \frac{5}{18} ms^{-1}$

$= 100 ms^{-1}$

$x = ut = 100 \times 10 = 1000 m = 1 km.$

No-17

A body is thrown horizontally from the top of a tower and strikes the ground after 3s at an angle of 45° with the horizontal, find the height of the tower and the speed with which the body was projected.

Soln :-

$\tan 45^\circ = \frac{v}{u}$

$1 = \frac{v}{u}$

$v = u$

initial vertical velocity = 0

$a = 9.8 ms^{-2}, t = 3s \; v_y = ?$

$v = u + at$

$v = 0 - 9.8 \times 3 = -29.4 ms^{-1}$

From (i) and (ii)

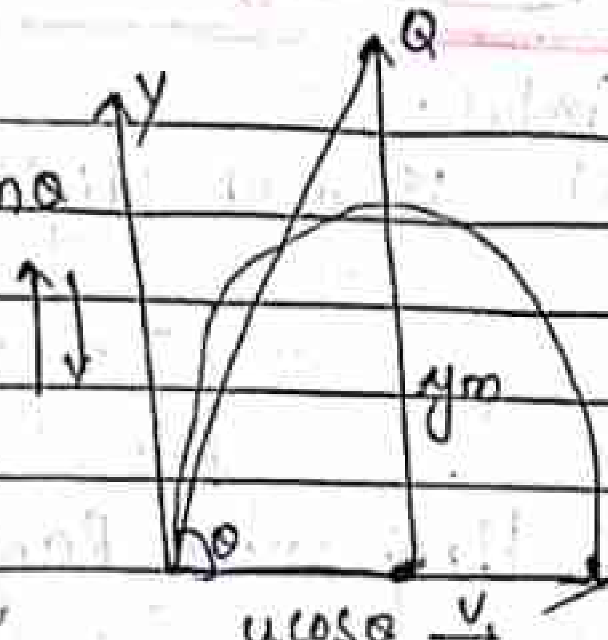
$u = 29.4 ms^{-1}$

h = height of the tower

$h = 0 \times 3 - \frac{1}{2} \times 9.8 (3)^2$

$= -\frac{1}{2} \times 9.8 \times 9 = -44.1 m.$

No-18 ~~A body is th~~



(1) $u\cos\theta$ along horizontal
(ii) $u\sin\theta$ along vertically
(iii) Eq^n of ~~traceition~~ trajectory.

x = velocity × time x = Distance

$$x = (u\cos\theta) \times t \quad \text{---} (i)$$

$$y = u\sin\theta\, t - \tfrac{1}{2} g t^2$$

$$\left(S = ut + \tfrac{1}{2} a t^2\right)$$

From eq^n --- (i)

$$x (u\cos\theta) t$$

$$\Rightarrow t = \frac{x}{u\cos\theta} \quad \text{---} (iii)$$

Put the value of eq^n $x \; \frac{x}{u\cos\theta} - \frac{1}{2} g \left(\frac{x}{u\cos\theta}\right)$

$$y = \frac{u\sin\theta}{u\cos\theta} - \frac{1}{2} g \frac{x^2}{u^2\cos^2\theta}$$

$$\boxed{y = \tan\theta = -\frac{g}{2u^2\cos^2\theta} x^2}$$

(ii) Maximum height (y) velocity direction.
Lets.

AB θ initial velocity = $u\sin\theta$
At 'P' final velocity = 0
Acceleration (a) = $-g$
vertically distance ($S = y_0$)

$$v^2 - u^2 = 2as$$

$$= 0 - u\sin\theta = 2(-g) y_0$$

$$= u^2\sin^2\theta = 2g y_0$$

$$\boxed{y_0 = \frac{u^2\sin^2\theta}{2g}} \quad \text{~~x~~} \quad \boxed{v - u = at}$$

(iii) ~~A~~ time of ascent (t) = a

$$\boxed{t = \frac{u\sin\theta}{g}}$$

Total

(iv) Time of flight (T)

$$\boxed{T = \frac{2u\sin\theta}{g}}$$

(v). Horizontal Range :-

$$\boxed{(x) = \frac{u^2\sin 2\theta}{g}}$$

(1) Intial speed of a shell is $392ms^{-1}$ what angle must the gun the fired if the projectile is to strain the Haiget but same level as thegune & at a distance ~~8~~ 8140m, from gf

$u = 392ms^{-1}$

$x = 7840m$

$g = 9.8ms^{-2}$

$$x = \frac{u^2\sin 2\theta}{g}$$

$v^2 - u^2 = 2as.$

$$\sin 2\theta = \frac{392 \times 9.8}{(392)^2}$$

$\sin 2\theta = 0.5$

$2.\theta = \sin^{-1}(0.5)$

$2\theta = \cancel{30}/2 = 15$

$\theta = 15^0$

Unit-3
(KINEMATICS)

State of Rest :-
A body is said to be at rest if it doesn't changes its position with respect to its sorrounding.

Absolute rest or Absolute motion :-
The rest or motion is said to be absolute if the reference point is fixed point.

Non - Absolute Rest :-
On the earth surface no fixed point is available because the earth surface rotates around the sun. So all the earthly bodies are also in motion. So absolute rest and absolute motion are only hypothetical concept. The rest or motion which we come across in our day to day life are relative in nature.

Linear Motion or Rectilinear Motion :-
If a body particle moving in a straight line path. then the motion of the body is said to be linear motion or rectilinear motion.

Mechanics :-
It is the branches of physics which deals with the study of rest or motion of the material body is called Mechanics.
→ It is of 2 types :-
(1) Kinematics (2) Dynamics.

(1) Kinematics :-
The branches of mechanics which deals with study of motion of the material bodies without going into its cause is called Kinematics.

Ex :- It deals with the study of distance, speed, displacement, velocity and acceleration etc.

(2) Dynamics :-

It is the branch of mechanics which deals with the study of motion of the material bodies along with its cause is called Dynamics.

Ex :- It deals with the study of force, Impulse, momentum etc.

Displacement :-

The shortest distance between two points is called displacement.

→ It is a vector.

Unit :-

C.G.S - Cm
M.K.S - Meter
F.P.S - Foot
S.I - Meter

Dimension - $[M^0L^1T^0]$

Speed (v) :-

The distance covered by the body unit time is called its speed.

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

$$\boxed{V = \frac{S}{T}}$$

→ It is a scalar.

Unit :-

M.K.S - m/s
C.G.S - Cm/s
F.P.S - foot/s
S.I - m/s

Dimension - $[M^0L^1T^{-1}]$

Velocity ($\vec{v}$) -

The time rate of change of displacement is Called velocity.

→ It is a vector.

Velocity = $\frac{\text{Displacement}}{\text{Time}}$

$$\boxed{\vec{v} = \frac{\vec{s}}{T}}$$

Unit :-

C.G.S - Cm/s

M.K.S - m/s

F.P.S - foot/s

S.I - m/s

Dimension - $[M^0 L^1 T^{-1}]$

Acceleration :-

The time rate of change of velocity is Called acceleration.

→ It is a vector.

Acceleration = $\frac{\text{Velocity}}{\text{Time}}$

$$\boxed{a = \frac{\vec{v}}{t}}$$

$$a = \frac{\Delta\vec{v}}{\Delta t} = \frac{\vec{v_2} - \vec{v_1}}{t_2 - t_1}$$

Unit :-

C.G.S - Cm/s^2

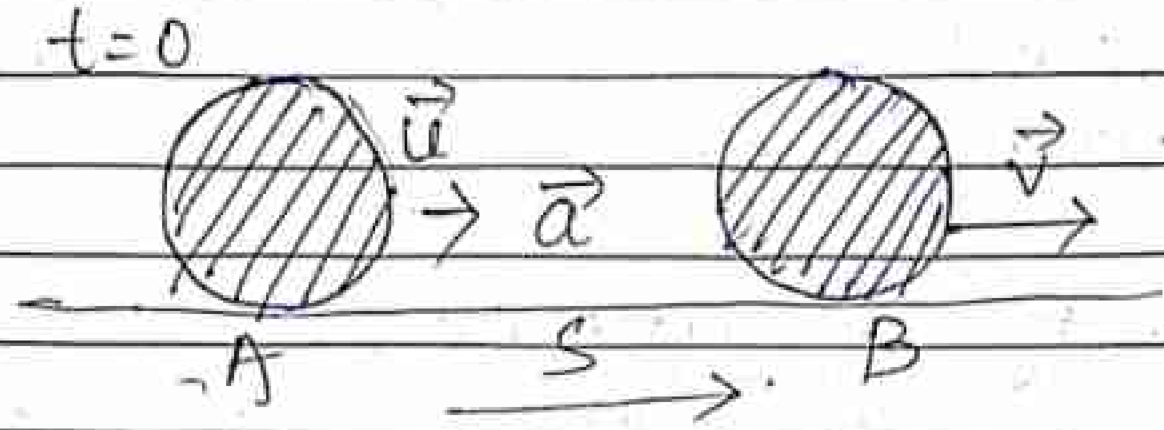
M.K.S - m/s^2

F.P.S - $foot/s^2$

S.I - m/s^2

Dimension - $[M^0 L^1 T^{-2}]$

Equation of Motion :-

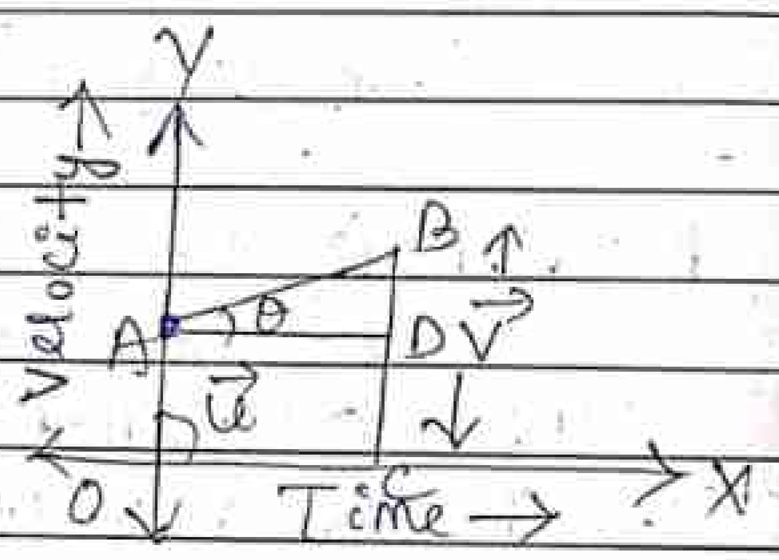


Equations connecting u, v, a, s and t are known as equations of motion.

(Equations of motion)

By graphical method — By analytical method

(I) $v = u + at$



Let, $OC = OD = t$ (say)

$OA = CD = u$

$BC = v$

$BD = BC - DC$

$= v - u$

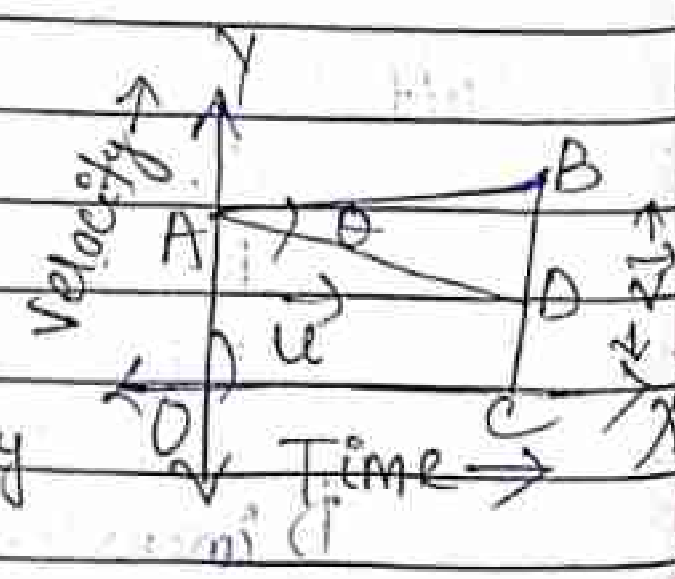
We know,

$$a = \tan\theta = \frac{BD}{AD} = \frac{v-u}{t}$$

$\Rightarrow at = v - u$

$\Rightarrow \boxed{v = u + at}$ (Proved)

(II) $S = ut + \frac{1}{2}at^2$



We know,

The distance covered by the body (S) = Area below velocity ~ Time graph.

= Area of OABC Quadrilateral

= Area of OADC Rectangle + Area of ΔABD

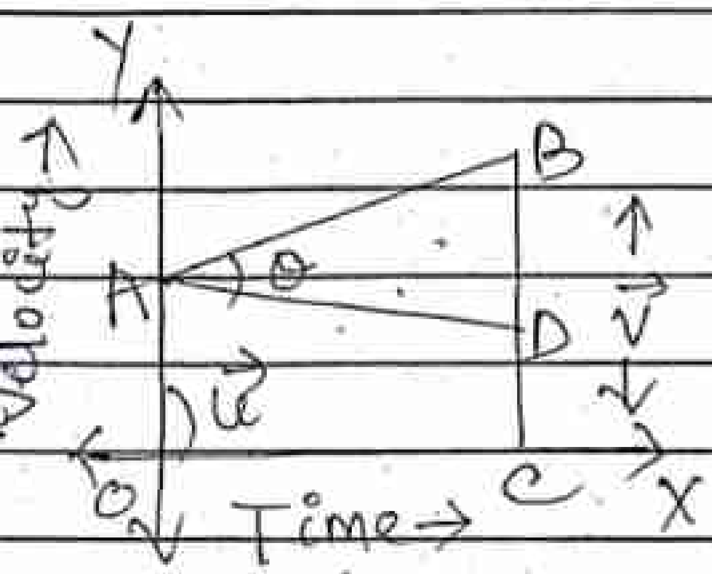
$= (OA)(OC) + \frac{1}{2}(AD)(BD)$

$= ut + \frac{1}{2} t (v-u)$ $\left[\because v = u+at \Rightarrow v-u = at\right]$

$= ut + \frac{1}{2} t \cdot at$

$$\boxed{S = ut + \frac{1}{2} at^2}$$ (Proved)

(III) $v^2 = u^2 + 2as$



We know,
The distance covered by the body (S)
= Area of below velocity ~ Time graph
= Area of OABC trapezium

$= \frac{1}{2} \times$ [Sum of two parallel sides]

$= \frac{1}{2}[OA + BC]\ AD$

$= \frac{1}{2}[u+v] \cdot t$

$\Rightarrow S = \frac{1}{2}[v+u]\left[\frac{v-u}{a}\right]$ $\left[\because v = u+at,\ v-u = at,\ \frac{v-u}{a} = t\right]$

$\Rightarrow 2as = v^2 - u^2$

$$\Rightarrow \boxed{v^2 = u^2 + 2as}$$

(Proved)

Equations of motion by analytical method :-

(a) $V = u + at$

Let us consider a particle moving in a straight line with constant acceleration $\vec{a}$.

Let $\vec{u}$ = Initial velocity
$\vec{v}$ = Final velocity
T = Time interval

According to the definition of acceleration

$$\vec{a} = \frac{d\vec{v}}{dt}$$

$$d\vec{v} = \vec{a}\,dt \quad \text{——— (1)}$$

Integrating both sides with proper limits we get

$$\int_{\vec{u}}^{\vec{v}} d\vec{v} = \int_0^t \vec{a}\,dt = \vec{a}\int_0^t dt$$

$$\left[v\right]_{\vec{u}}^{\vec{v}} = \vec{a}\left[t\right]_0^t$$

$$\Rightarrow \vec{v} = \vec{u} + \vec{a}t \quad \text{(Proved)}$$

(b) $S = ut + \frac{1}{2}at^2$

Let us consider a particle moving in a straight line with constant acceleration $\vec{a}$,

Let $\vec{u}$ = Initial velocity
$\vec{v}$ = final velocity
t = Time Interval
$\vec{s}$ = Distance covered by the body

According to the definition of velocity

$$\vec{v} = \frac{d\vec{s}}{dt}$$

$$\Rightarrow d\vec{s} = \vec{v}\,dt$$

$$d\vec{s} = (\vec{u} + \vec{a}t) \quad \text{——— (1)}$$

$$(\because \vec{v} = \vec{u} + \vec{a}t)$$

Integrating both sides with proper limits we get,

$$\int_0^{\vec{s}} d\vec{s} = \int_0^t (\vec{u} + \vec{a}t)\, dt$$

$$= \int_0^t \vec{u}\, dt + \int_0^t \vec{a}t.dt$$

$$= \vec{u} \int_0^t dt + \vec{a} \int_0^t t\, dt$$

$$\Rightarrow \left[\vec{s}\right]_0^{\vec{s}} = \vec{u}\left[t\right]_0^t + \vec{a}\left[\frac{t^2}{2}\right]_0^t$$

$$\Rightarrow \vec{s} - 0 = \vec{u}(t-0) + \frac{\vec{u}}{2}(t^2 - 0)$$

$$\Rightarrow \vec{s} = \vec{u}t + \frac{1}{2}at^2 \quad \text{(proved)}$$

(c) $v^2 = u^2 + 2as$

Let us consider a particle moving in a straight line with constant acceleration $\vec{a}$.

Let $\vec{u}$ = Initial velocity
$\vec{v}$ = final velocity
t = Time Interval
$\vec{s}$ = Distance covered by the body

According to the definition of acceleration $\vec{a}$.

$$\vec{a} = \frac{d\vec{v}}{dt} \Rightarrow \vec{a} = \frac{d\vec{s}}{dt} \cdot \frac{d\vec{v}}{ds}$$

$$\Rightarrow \vec{a} = \vec{v} \cdot \frac{d\vec{v}}{ds}$$

$$\Rightarrow a\,ds = v\,dv \quad \text{——— (1)}$$

Integrating both sides with proper limits we get,

$$\int_0^s a\,ds = \int_u^v v\,dv$$

$$\Rightarrow \int_0^s ds = \left[\frac{v^2}{2}\right]_u^v$$

$$\Rightarrow a\,[s]_0^s = \frac{1}{2}\left[v^2 - u^2\right]$$

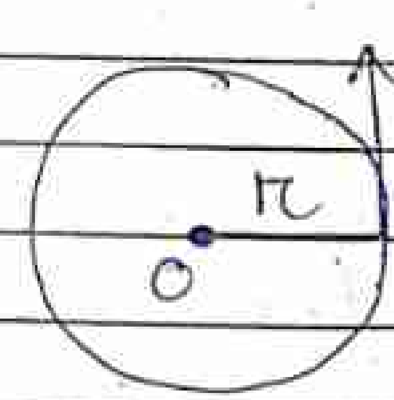
$$\Rightarrow a\,[s - 0] = \frac{v^2 - u^2}{2}$$

$$\Rightarrow 2as = v^2 - u^2$$

$$\Rightarrow \boxed{v^2 = u^2 + 2as} \quad \text{(Proved)}$$

Circular Motion :-

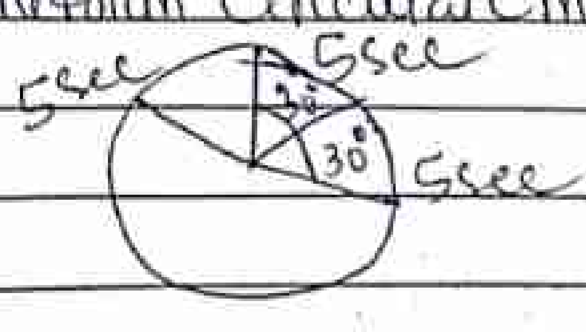
If a body resolves around a fixed point with fixed distance from that point, then the motion is said to be circular motion.

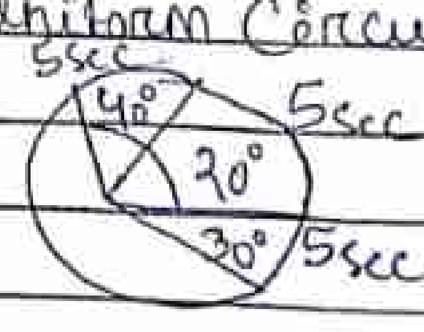


Circular motion

↓ Uniform Circular motion

↓ Non-Uniform Circular motion

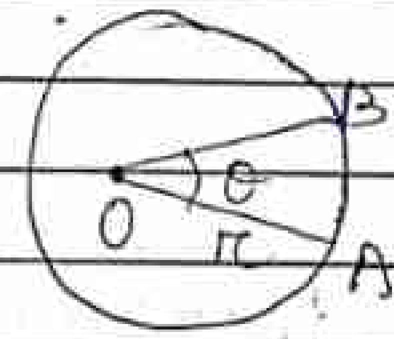




Angular Displacement :-

The angle turned by the radius vector is called angular Displacement.

→ It is denoted by θ or $\Delta\theta$.



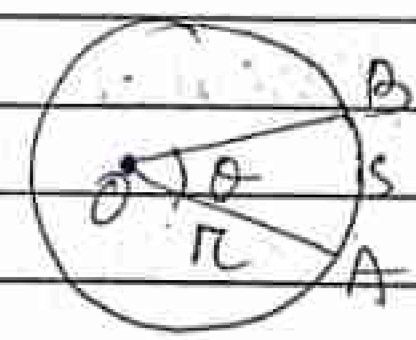
Unit of θ

Degree - Radian

Dimension - $[M^0 L^0 T^0]$

Relation between S and θ :-

from the fig,



$$\sin\theta = \theta = \frac{S}{r}$$

$$\boxed{S = r\theta}$$

$$\boxed{\Delta S = r\Delta\theta}$$

In vector form :-

$$\Delta\vec{S} = \Delta\vec{\theta} \times \vec{r}$$

$$\vec{S} = \vec{\theta} \times \vec{r}$$

Angular Velocity (ω)

The time rate of change of angular displacement is called Angular velocity.

$$\omega = \frac{\theta}{t}$$

$$\Rightarrow \omega = \frac{\Delta\theta}{\Delta t} = \frac{\theta_2 - \theta_1}{t_2 - t_1}$$

$$\Rightarrow \omega = \frac{d\theta}{dt}$$

Unit of ω :-

Degree/sec or Radian/sec

Dimension of $\omega = [M^0 L^0 T^{-1}]$

($\vec{v} \times \vec{\omega}$

Relation between v and ω :-

We know $v = \frac{ds}{dt}$

$$= \frac{d}{dt}(r\theta) = r\frac{d\theta}{dt}$$

$$\Rightarrow \boxed{v = r\omega}$$

In vector form :-

$$\vec{v} = \vec{\omega} \times \vec{r}$$

Angular Acceleration (α)

The time rate of change of angular velocity is called Angular Acceleration.

Mathematically,

$$\alpha = \frac{\omega}{t}$$

$$\alpha = \frac{\Delta\omega}{\Delta t} = \frac{\omega_2 - \omega_1}{t_2 - t_1}$$

$$\Rightarrow \alpha = \frac{d\omega}{dt}$$

Unit :-

Degree/sec^2 or Radian/sec^2

Dimension = $[M^0 L^0 T^{-2}]$

Relation between a and α :-

We know,

$$a = \frac{dv}{dt} = \frac{d}{dt}(r\omega)$$

$$= r\frac{d\omega}{dt}$$

$$\Rightarrow \boxed{a = r\alpha}$$

In vector form :- $\vec{a} = \frac{d\vec{v}}{dt} = \frac{d}{dt}(\vec{\omega} \times \vec{r})$

$$= \frac{d\omega}{dt} \times \vec{r} + \vec{\omega} \times \frac{d\vec{r}}{dt}$$

$$\Rightarrow \boxed{\vec{a} = \vec{\alpha} \times \vec{r} + \vec{\omega} \times \vec{v}}$$

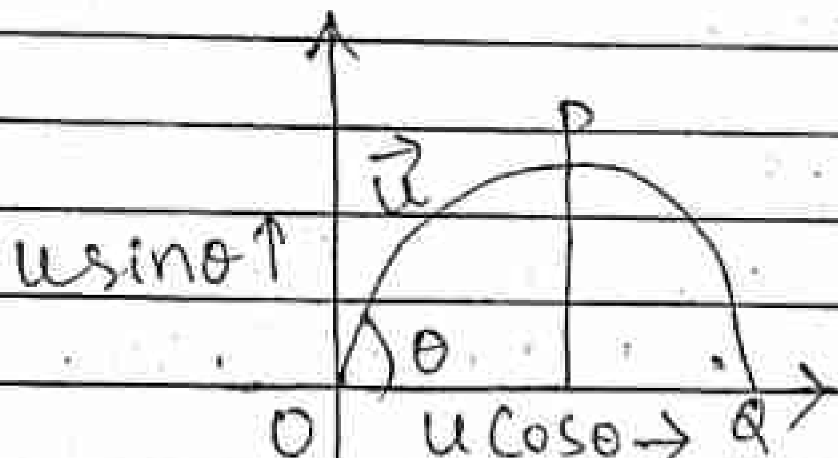
Projectile Motion :-

Projectile :-

An object thrown into space and moves under the action of gravity without any motive power of its own is called projectile.

Examples :- (1) A cricket ball thrown into space.
(2) Javelline Throw
(3) A bullet fired from a rifle etc.

Projectile fired at an angle θ with the horizontal :-



Let us consider a projectile fired with a velocity $\vec{u}$ which makes an angle θ with the horizontal.

The velocity $\vec{u}$ is resolved into two components.

(I) Horizontal component $= u\cos\theta$ which is uniform

(II) Vertical component $= u\sin\theta$ which is non-uniform.

Then we can derive the following results.

(1) Eqn of Trajectory :-

It is an equation connecting both horizontal and vertical distances covered by the projectile.

For horizontal equation of motion

$$x = (u\cos\theta)t \quad \text{———} (1)$$

For vertical equation of motion using the equation of motion.

$S = ut + \frac{1}{2}at^2$ we can write

$$y = (u\sin\theta)\frac{x}{u\cos\theta} - \frac{1}{2}g\frac{x^2}{u^2\cos^2\theta}$$

$$\boxed{y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}} \qquad \left[t = \frac{x}{u\cos\theta} \text{ from eq}^n(1) \right]$$

This is the equation of trajectory and Parabollic in nature.

(II) Maximum Height :-

It is the distance covered by the Projectile in the vertically upward direction.

Now using equation of motion

$$v^2 = u^2 + 2as$$

From O to P

$$0 = (u\sin\theta)^2 - 2gy_m$$

$$\Rightarrow 2gy_m = u^2\sin^2\theta$$

$$\Rightarrow \boxed{y_m = \frac{u^2\sin^2\theta}{2g}} \qquad \left[\begin{aligned} &\because v = 0 \text{ at } P \\ &u = u\sin\theta \\ &s = y_m \\ &a = -g \end{aligned} \right]$$

(III) Total time of Light :- (T)

It is the time taken by the Projectile from Starting point to the final Point.
We know time of ascent = Time of descent,
So, Total time of Light (T) = 2t

$$\boxed{T = \frac{2u\sin\theta}{g}}$$

OR, Using equation of motion

$$S = ut + \frac{1}{2}at^2$$

from O to Q in the vertically upward direction we can write,

$$0 = u\sin\theta . T - \frac{gT^2}{2}$$

$$0 = \left(u\sin\theta - \frac{gT}{2}\right)T$$

$$0 = u\sin\theta - \frac{gT}{2}$$

$$\Rightarrow \frac{gT}{2} = u\sin\theta$$

$$\Rightarrow \boxed{T = \frac{2u\sin\theta}{g}}$$

(IV) Horizontal Range (x) :-

It is the distance travelled by the projectile in the horizontal direction.

$\therefore$ Horizontal Range $(x) = (u\cos\theta).T$

$$= u\cos\theta . \frac{2u\sin\theta}{g}$$

$$x = \frac{u^2 . 2\sin\theta . \cos\theta}{g}$$

$$\boxed{x = \frac{u^2 . \sin 2\theta}{g}}$$

Condition for Maximum Range :-

Range will be maximum if $\sin 2\theta = 1 = \sin 90°$

$$2\theta = 90° \Rightarrow \theta = 45°$$

Maximum Range, $\boxed{X_{max} = \frac{u^2}{g}}$

Unit-4
(WORK AND FRICTION)

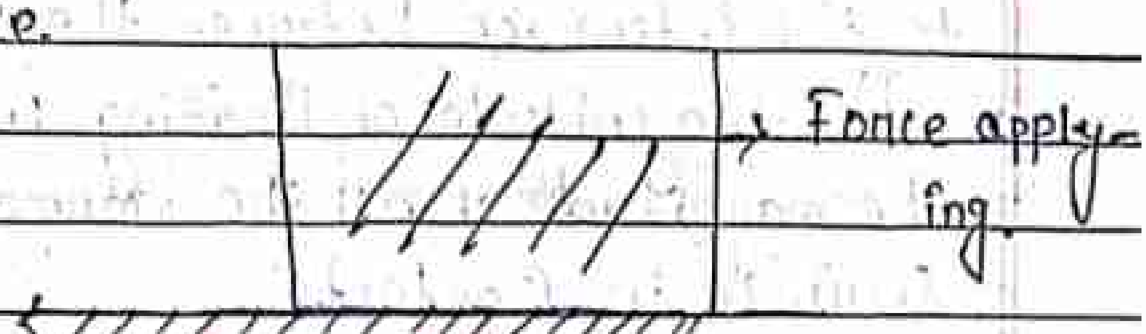
Date-30-11-2023

Works Friction :-

→ Capability of Smallest using work is called work friction.

$W = F.S \cos\theta$

Friction of Force :- The force which oppose or tend to tend and opposing the relative motion between the to surface in contac each called as friction force.



Types of friction :-

(1) Static friction

(ii) Dynamic friction. (kinematic motion)

(iii) Rolling friction.

(iv) Fluid friction. (viscocity friction)

(1) Static friction :-

The friction is opposing force exist between a surface and object at rest is called as static friction.

Ex :- a book on the table

a duster on the table.

(ii) Dynamic friction :-

The friction of force is opposing force created when to solid surface slide or move over one another is called dynamic friction.

Ex :- Writing on a paper

walking on the road.

(3) Rolling friction :-

The friction is opposing force create a between moving surface when rolls over another is called as rolling friction.

Ex :-

(4) Fluid friction :-

Fluid friction is the opposing force created when something tries to move on or through the gas liquid is called fluid friction

Ex :-

Law of ~~friction~~ limiting friction :-

→ The direction force of friction is always direction opposite to the direction of motion.

→ The force of limiting friction depend of the nature and stand of polish of the surface in contact and tangentially to the interface between the two surface.

→ The magnitude of limiting friction is directly proportional to the magnitude of all the normal reaction between two the surface in contact.

$$\boxed{F \propto R}$$

→ The magnitud of the limiting friction between two surface is independ of the area and shape of the surface in contact show ~~the surface in contact~~ long are the normal reaction remain the same.

Co-efficient of friction :-

Co-effient of friction of a air of surface in contact is defined as the ratio betn the limiting friction force (F) to the the narmal recn. It is denoted as μ.

$$\boxed{\mu = \frac{F}{R}} \quad R = \text{Narmal rec}^n$$

~~Methoad of Reducing friction~~ :-

~~By moving and pulishing are~~

~~By rubbing and pulishing~~

1 ~~A Force at 3kg weight force saficient to full~~ black 1kg weight ~~overal class~~ surface. Find out the co-efficient friction

Ans:-

METHOD OF REDUCING FRICTION :-

(a) by rubbing and polishing

(b) by Lubricands

(c) by Converting Sliding into Rolling friction,

(d) By Straining meaning

Problem-1

Find the Horizontal for required to move a body when weighting 200 on a rough horizontal Surface having co-efficient of friction. 0.35.

Weight = 200kg

Friction - 0.35

$M = 0.35$

Mass = 200kg

$\Rightarrow F = MR$

$0.35 \cdot 1960$

$F = 686$ kg

$R = mg = \frac{200 \times 9.8}{0.35}$

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

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

$\Rightarrow R =$ mass $\times A$

$\Rightarrow R = 200kg \times 9.8$

NO-3.

3kg wt is a block of 4kg wt over a flat Surface find out the co-efficient of friction.

$\boxed{M = \frac{F}{R}}$ → Co-efficient of friction

$w = 3kg$

over flat = 4kg

$\mu = \frac{F}{R} \frac{3}{4} = 0.75$

$\boxed{\Rightarrow \mu = 0.75}$

$\mu = 0.75 \times 4 = 3$

Angle of friction :-

$\boxed{\mu = \tan\theta}$

$\mu = \tan\theta$

$\theta = \tan^{-1}(\mu)$

$0.75 \tan^{-1}$

$= 36°$

Long - quitation

1 State and explain newton's Law of gravitation ?

Newton's Laws of gravitation.

Each body in the universal attracts every everother body with is free which is directly perportional to the product of the their masses and inversaly proportional to the square of the distance betⁿ them.

Let $m_1 m_2$ be the masses of two point objects and the distance betⁿ them be "r.

Then. $F \propto m_1 m_2$

$\propto \frac{1}{r^2}$

$\Rightarrow F = G \frac{m_1 m_2}{r^2}$ (1)

Where G = universal gravitation Constant = 6.67×10^{-19} Newton $m^2 kg^{-2}$

Hence with the increase in mass of one of both object the force of attraction increase and with increasing distance betⁿ them, the force attraction decrease.

2 State the explain kirchhoff's law and wheatstone bridge !

2 State Laws of limiting friction ?

→ The force of friction is proportional to the normal force the maximum frictional force is directly propentional to the normal Force acting on the object.

→ The direction of friction is opposite to the direction of motion or impending motion. Friction acts to resists the relative motion or the tendency of motion betⁿ two surface.

3 Explain diffⁿ method's to reduce friction ?

Certainly : Here are diffⁿ methods to reduce friction

1 Lubrication :- Explanation introducing betⁿ Surface reduce direct contact minimizing friction this method is commonly used in machinery and engines.

2 Smoothing surface :- Explanation : polishing or Smoothing Surface reduces rough decreasing the friction betⁿ them, this can involve using smooth materials or surface tretmeant.

3 Ball Bearings :-

Explanation using ball bearings or roller bearing betn air resistance indirectly minimizing friction. This is often Common in wheels and rotating machinery.

4 Steamlining :-

Explanation : Desing objects with Steatmlined Shapes reduces air resistance to vehicles and aerodynamics Structures.

5. Reducing Contact Area :-

Explain :- Reducing the contact area betn surface decreses the overall frictional force. This is utilized in specific application where minimizing contact is feasible.

6. Uses of Anti-friction materials :-

Explanation :- Incorporating materials with low friction cofficient such as PTFE helps reduce friction specific application.

(4) Write down the properties of ultrasonic ?

→ Here are some properties on ultrasonic waves.

1 Frequency :- ultrasonic waves have frequency above the audible focused range. typically greater than 20,000 hertz (Hz)

2. Directionality :- They exhibit highly directional properties and Can be focused in to narrow beam.

3. Wave Nature :- ultrasonic behave as mechanical waves with properties like reflection, refraction diffraction and interference.

4. Penetration :- They can penetrate Solids and liquid making useful for various application like medical imaging and industrial testing.

5 Speed of Propagation :- ultrasonic waves travel higher speed than audible sound waves.

6. Attenuation :- The intensity of ultrasonic waves decreases with distance due to factors like absorption and Scattering.

7. Energy Conversion :- ultrasonic waves can be converted into other froms of energy, such as heat making them useful for application like ultrasonic cleaning.

8. Application :- ultrasonic find application in medical diagnostics, cleaning, distance measurement (Sonar) material testing and more

(5) Check the connetness of the physical eqn $s = ut + \frac{1}{2}at^2$

(ii) $s = ut + 1/2\, at^2$

$\Rightarrow s = [L] = [M^0L^1T^0]$

$ut = [LT^{-1}] \times [T]$

$= [M^0L^1T^0]$

$\frac{1}{2}at^2 = [LT^{-2}] \times [T]^2$

$= [L]$ ($\because$ as 1/2 has no dimension)

$= [M^0L^1T^0]$

6) Compare Fleming Left-hand rule and Right hand rule?

Let's compare Fleming Left-hand rule and Right hand rule.

Fleming Left-hand Rule :-

Application used for electric generators to determine the direction of induced current or electromotive force (EMF)

Hand positioning :- fore finger point in the direction of the magnetic field, middle finger points in the direction of motion and the thumb gives the direction in induced current or (EMF)

Fleming Right Hand Rule :-

Application used for electric motors to find the direction of force of motion

Hand positioning :- Fore finger points in the direction of the magnetic middle finger points in the direction of current and the thumb gives the direction of force or motion

Usage :- Primarily applied in electric motors

(7) Writ down perporties of magnetic lines of force?

Here are properties of magnetic line of force.

1) Direction :- Magnetic lines of force travel from the north Pole to the South pole outside the magnetic and from the South Pole to the north pole inside the magnetic.

2 Non - intersecting :- Magnetic lines do not intersecting eachother if they did it would imply a point having more than one direction for the magnetic field, while ~~more spaced~~ is not Possible

3. Density indicates Strength :-

The density of magnetic line indicate the strength of the magnetic field. Closer lines represent stronger fields, while more spaced out lines indicate weaker fields.

4. Closed loops :— Magnetic lines form closed loops. they enter from the north pole and exist from the south pole creating continuous loops outside the magnetic.

5.) Tangential to field :— The magnetic field at any point is tangential to the line of force at that representing the direction a small compass would align.

6) External field indicator :— The pattern formed by iron fillings placed near a magnet outlines the magnetic field lines providing a visual representation of the magnetic field.

7. No Beginning on End :— Magnetic lines neither start nor end, indicating the continuous nature of the magnetic field.

8) State kirchoff's laws derive the condition of balanced in a wheatstone bridge ?

→ Let's briefly state kirchoff's laws and then derive the condition for balance in a wheatstone Bridge.

Kirchhoff's Laws :—

1. kirchhoff's law current law (KCL) the total current entering a junction is equal to the total currence leaving the junction.
2. Kirchhoff's voltage law (KVL) : The sum of the electromotive forces (EMFs) and the product of the currents and resistances in any closed loop is equal to the sum of the potential drop's in that loop.

Condition for Balance in a wheatstone Bridge :—

A wheatstone Bridge consist of four resistors arranged in a dimond shape. Let's denote the resistor's as R_1, R_2, R_3 and R_4

The bridge is considered balanced when the ratio of the resistances on one side is equal to the ratio on the other side.

$$\frac{R_1}{R_2} = \frac{R_3}{R_4}$$

This condition ensures that no current flows through the galvometer, indicating a balanced state, it can be derived by applying kirchhoff's law and analyzing the potential differences and currents in the bridge circuit.

(9) State kelper's Law of planetary motion ?

→ kelpers laws of planetary motion.

1) Law of orbits :— planets move in elliptical a planet and the sun at one of the foci.

2) Law of Areas :— A line segment joining a planet and the sun sweeps out equal areas during equal intervals ~~of the~~ semimajor axis ~~of it's orbit~~ of time.

(3) Law of periods :— The square of the orbital period of a plannet is directly propotional to the cube of the semimajor axis of its orbit

(10) State faraday's laws of electromagnetic induction ?

→ faraday's first law :—

Statement: the induced electromotive force (EMF) in a closed circuit is directly proportional to the rate of change of magnetic flux through the circuit

(2) Explanation :— If the magnetic field experienced by a based loop changes an EMF is induced in the loop the greater the rate of change of magnetic flux. the higher the induced EMF

* Faraday's Second Law :—

Statement :— The direction of the induced EMF is such that it opposes the change in magnetic flux that product it.

Explanation :— The induced current will create a magnetic field opposing the change in the original magnetic field. This is based on the conversation of energy and Lenz's Law.

11) State and explain Coloumb's Law of electrostation ?
Coloumb' Law
→ Coloumb's Law decribedes the force betn two charged objects
Explanation :—
① Magnitude of force :— The force betn two charges is directly proportional to the product of their charges ($q_1 \& q_2$)
② inverse square law :—
The force is inversarily proportional to the square of the distance (r) betn the charges.
③ Constant factor :— Coloumb's Constant (k) is a proportional constant.
Mathmatically :— Coloumb Law is expressed as :

$$F = k \frac{q_1 q_2}{r^2}$$

So the force increase with the magnitude of charges and decreases with the square of the distance betn them.

(12) Define lines of force and write down its propenties ?
→ Lines of force represent the ~~point~~ path's along which a small positive test charge would move in an electric field
Propenties ?—
① Direction :— lines of force indicate the direction of the electric field at any Point.
② Closer together :— where lines are closer, the electric field is strong.
③ Parallel Near charges :— line emerge from Positive charged and enter negative charges. They are perpendicular to surfaces of conductors.
④ Never Cross :— lines of force never cross each other in an electric field.

Short note :-

① Properties of LASER

→ LASER (~~light application~~ Amplification by stimulated Emission of Radiation properties include:

1- Monochromatic :- Produces light of single color or wavelength.

2- Coherent :- light waves are in phase, maintaining a fixed relationship.

3. Collimated :- light beams are parallel and spread minimally

④ High intensity :- Concentrated energy in a small area.

⑤ Directionality :- Emits a focused, narrow beam.

⑥ Temporal Stability :- light output is suitable over time.