BASIC CONCEPT OF PHYSICS

ALGEBRA :

Common formula

(i) $(a+b)^2 = a^2 + b^2 + 2ab$

(ii) $(a-b)^2 = a^2 + b^2 - 2ab$

(iii) $(a+b+c)^2 = a^2 + b^2 + c^2 + 2ab + 2bc + 2ca$

(iv) $(a+b)(a-b) = a^2 - b^2$

QUADRATIC EQUATION :

- An equation of second degree is called a quadratic equation.
- A standard quadratic equation is of the form $ax^2 + bx + c = 0$
  where a is co-efficient of x^2, b is co-efficient of x and c is a constant term.
- By the quadratic equation measure the variable (x).

and, $x = \frac{-(\text{coeff. of } x) \pm \sqrt{(\text{coeff. of } x)^2 - 4(\text{coeff. of } x^2) x \text{ const. term}}}{2(\text{coeff. of } x^2)}$ i.e. $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$.

Illustration* 1:** ***Solve $4x^2 - 10x + 6 = 0$

Solution :

Here, a = 4 ; b = –10 and c = 6

$\therefore \quad x = \frac{b \pm \sqrt{b^2 - 4ac}}{2a}$

so, $x = \frac{+10 \pm \sqrt{100 - 4 \times 4 \times 6}}{2 \times 4}$

$x = \frac{+10 \pm \sqrt{100 - 96}}{8}$

$x = \frac{10 \pm 2}{8}$

so, $x = \frac{3}{2}$ or $x = 1$

TRIGONOMETRY :

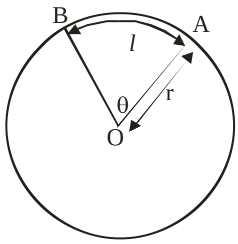
MEASUREMENT OF AN ANGLE

Radian: It is the S.I. unit of plane angle.

One radian: The angle subtended at the Centre of a circle by an arc equal in length of the radius of the circle

AB = ℓ = length of arc

OA = OB = r = radius of the circle



If ℓ = r then $\angle$ AOB = θ = 1 radian, A radian is a constant angle,

2π radian = 360°

or, 1 radian = $\frac{360}{2\pi} = 57.27°$

Some Important Equations

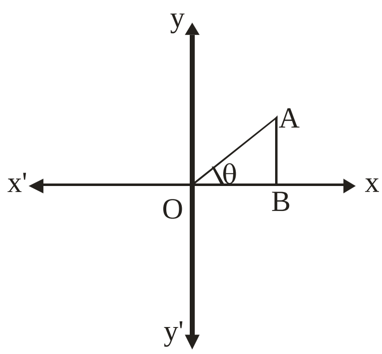
Angle = $\frac{\text{arc}}{\text{radius}}$

⇒ 1 right angle = 90 degrees (90°)

⇒ 1 degree = 60 minutes (60′)

⇒ 1 minutes = 60 seconds (60″)

Some Important Terms



OB = base = b; AB = perpendicular = p; OA = Hypotenuse = h

i. $\sin\theta = \frac{\text{perpendicular}}{\text{Hypotenuse}}$ ii. $\cos\theta = \frac{\text{Base}}{\text{Hypotenuse}}$

iii. $\tan\theta = \frac{\text{perpendicular}}{\text{base}}$

$\tan\theta = \frac{p}{b} = \frac{AB}{OB}$

iv. $\sec\theta = \frac{1}{\cos\theta} = \frac{h}{b}$ v. $\text{cosec}\theta = \frac{1}{\sin\theta} = \frac{h}{p}$

vi. $\cot\theta = \frac{1}{\tan\theta} = \frac{b}{p}$ vii. $\tan\theta = \frac{\sin\theta}{\cos\theta}$

viii. $\sin^2\theta + \cos^2\theta = 1$ ix. $\sin^2\theta = 1 - \cos^2\theta$

VALUE OF TRIGONOMETRICAL RATIO OF SOME ANGLE

Angle (a)	sin θ	cos θ	Tan θ
0°	0	1	0
30°	$\frac{1}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{3}}$
45°	$\frac{1}{\sqrt{2}}$	$\frac{1}{\sqrt{2}}$	1
60°	$\frac{\sqrt{3}}{2}$	$\frac{1}{2}$	$\sqrt{3}$
90°	1	0	∞
120°	$\frac{\sqrt{3}}{2}$	$-\frac{1}{2}$	$-\sqrt{3}$

Trigonometrical Ratios Of Allied Angles

- When the sum of two angles is equal to 90º, they are called complementary angles.
- When the sum of two angles is equal to 180º, they are called supplementary angles.
- The angle whose sum or difference with angle θ is zero or a multiple of 90º are called allied angle to θ.

Some Allied Angles, Which Are Commonly Used

1. $\sin(-\theta) = -\sin\theta$

   $\text{cosec}(-\theta) = -\text{cosec}\,\theta$

   $\cos(-\theta) = \cos\theta$

   $\sec(-\theta) = \sec\theta$

   $\tan(-\theta) = -\tan\theta$

   $\cot(-\theta) = -\cot\theta$

2. $\sin(90-\theta) = \cos\theta$

   cosec (90 - θ) = sec θ

   cos (90 – θ) = sin θ

3. sin (90 + θ) = cosθ

   cos (90 + θ) = –sin θ

   tan (90 + θ) = -cot θ

4. a) sin (180° – θ) = sin θ; sin (180 + θ) = – sin θ

b) cos (180° – θ) = –cos θ; cos (180 + θ) = – cos θ

c) tan (180° – θ) = –tan θ; tan (180 + θ) = tan θ

SOME USE FULL IDENTITIES

1. sin (A + B) = sin A and B + cos A sin B
2. cos (A + B) = cos A cos B – sin A sin B
3. sin (A – B) = sin A cos B – cos A sin B
4. cos (A – B) = cosA cosB + sinA sin B
5. sin 2A = 2 sinA cosA
6. cos 2A = $\cos^2$A – $\sin^2$A = 1 – 2 $\sin^2$A = 2 $\cos^2$A – 1.

***Illustration* 2:**

$$\cos(-30^\circ) = \cos 30^\circ = \frac{\sqrt{3}}{2}$$

Illustration 3:

sin 30° = cos (90°–30°) = cos60°
and cos 60° = sin (90 – 60) = sin 30°

Illustration 4:

i) sin 120° = sin (90° + 30°) = cos 30°
ii) cos 120° = cos (90° + 30°) = –sin 30°

***Illustration 5*:** A straight line inserted at the origin terminates at the point (3,2) as it sweeps out an angle θ in standard position. Evaluate all six functions of θ.

Solution : x = 3, y = 2. Therefore, according to the definitions

$$r = \sqrt{x^2 + y^2} = \sqrt{3^2 + 2^2} = \sqrt{13}$$

$$\sin\theta = \frac{y}{r} = \frac{2}{\sqrt{13}}, \ \operatorname{cosec}\theta = \frac{r}{y} = \frac{\sqrt{13}}{2}$$

$$\tan\theta = \frac{y}{x} = \frac{2}{3}, \ \cot\theta = \frac{x}{y} = \frac{3}{2}$$

***Illustration* 6:** A straight line from the origin sweeps out an angle θ, and it terminates at the point (3, – 4). Evaluate the six functions of θ.

Solution : x = 3, y = 2. Therefore,

$$r = \sqrt{3^2 + (-4)^2} = \sqrt{9+16} = \sqrt{25} = 5$$

$$\sin\theta = -\frac{4}{5}, \ \operatorname{cosec}\theta = -\frac{5}{4}$$

$$\tan\theta = -\frac{4}{3} \ \cot\theta = -\frac{3}{4}$$

VECTORS

➢ Introduction

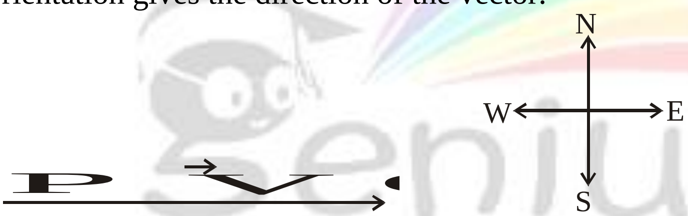
The modern scientific concepts find an easily and clear expression in the language of vectors. 'Vector' is an inevitable tool for the present day scientist and engineer of clear understanding of the science of measurements.

➢ Vectors & Scalars

- **Scalar:** A physical quantity which has only magnitude is called scalar.
- **Example:** Mass, time, speed, work, energy, volume, density etc. are scalars.
- **Vector:** A physical quantity which has magnitude and specific direction and which follows vector law of addition is called vector.
- **Example:** Velocity, Acceleration etc are vectors.

➢ Graphical Representation Of Vectors

A vector is represented by an arrow. The length of the arrow is proportional to the magnitude of the vector and its orientation gives the direction of the vector.



For example, a velocity of 50 ms^{-1} from west to east can be represented by an arrow PQ of length 5 cm drawn along the west east direction with the arrow head pointing towards the east. Analytically the above vector may be represented by $\overrightarrow{PQ}$ or by a single letter $\vec{V}$. The magnitude of a vector is called modulus of the vector. The modulus of the vector $\overrightarrow{PQ}$ is represented by $|\overrightarrow{PQ}|$ and it is always positive. P is called the origin and Q is called the terminus of the vector.

➢ Different Kinds Of Vectors

- **Parallel vectors:** If two or more vectors are parallel to the same line, they are said to be parallel vectors. In figure (a), the vectors $\vec{P}, \vec{Q}, \vec{R} \& \vec{S}$ are parallel vectors. Further, $\vec{P}$ *and* $\vec{R}$ are like vectors or $\vec{Q}$ *and* $\vec{R}$ are unlike vectors.

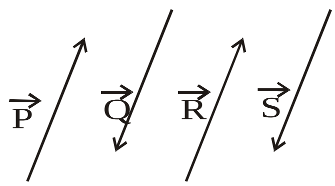


figure (a)

- **Equal vectors:** "If two or more vectors have equal magnitude and acting in the same direction, they are said to be equal vectors". In the figure (b), the two vectors arrows have equal length and same orientation.

  Hence they represent two equal vectors $\vec{A} \& \vec{B}$ even though they start at different initial points and end at different terminus.

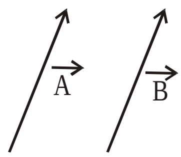


figure (b)

Hence they represent two equal vectors $\vec{A} \& \vec{B}$ even though they have at different initial points terminal points.

- **Negative vector:** If two vectors $\vec{A}$ *and* $\vec{B}$ are such that they have equal magnitude but opposite directions, each vector is negative of the other.
  Thus $\vec{A} = -\vec{B}$ or $\vec{B} = -\vec{A}$.

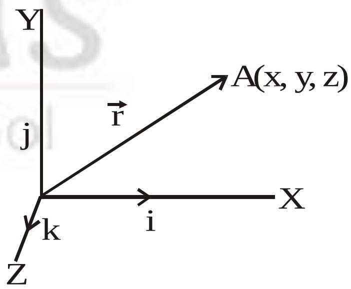
- **Null vector:** "A vector of zero magnitude is called zero vector or null vector". It is represented by $\vec{0}$. The initial point and terminal point of the null vector coincide. Its direction is indeterminate.

- **Unit Vector:** "A vector of unit magnitude is called unit vector". The unit vector in the direction of given vector is obtained by dividing the given vector with its magnitude. It is conventional to denote unit vector with a "cap" instead of "bar" over the symbol. Thus if $\vec{A}$ is a given vector, the unit vector in the direction of A is written as
  $A = \frac{\vec{A}}{|\vec{A}|}$ (where A is read as A cap or A hat)

- **Note:** In the right handed Cartesian coordinate system, $\hat{i}, \hat{j}$ and $\hat{k}$ are choosen as unit vectors along, the X-axis, Y-axis and Z-axis respectively.

➢ **Position Vector**

"The vector used to specify the position of a point with respect to some fixed point (say origin 'O') is called position vector". It is denoted as $\vec{r}$.



Consider a point 'A' with coordinates x, y, z in the Cartesian coordinate system. Thus the position of 'A' can be expressed in the vector form as $\overrightarrow{OA} = \vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$. Here i, j and k are unit vectors along the X, Y and Z axes respectively. The distance of 'A' from the origin eventually becomes the magnitude of $\vec{r}$.

➢ **Displacement**

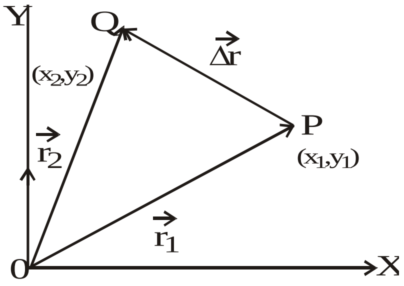
Displacement is a shortest distance between two points. It is a vector quantity.

➢ **Displacement Vector**

The position of the point Q with reference to the origin is represented by the position vector $\vec{r}_2$. Let the coordinates of the point Q are (x_2, y_2).

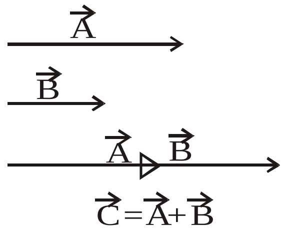
Similarly $\overrightarrow{OP}$ represented by a position vector $\vec{r}_1$, let the coordinates of the point P are (x_1, y_1).

As the displacement vector is the difference of two position vectors $\vec{r}_1 = x_1\hat{i} + y_1\hat{j}$ and $\vec{r}_2 = x_2\hat{i} + y_2\hat{j}$, where $\hat{i}, \hat{j}$ are unit vectors along X, Y axis respectively. Thus, the displacement vector $\Delta\vec{r} = \vec{r}_2 - \vec{r}_1 = (x_2 - x_1)\hat{i} + (y_2 - y_1)\hat{i}$.

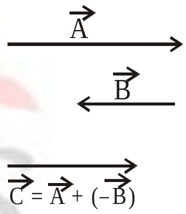


- **Addition Of Vectors**

- **Addition Of Two Vectors In Same Direction**
  If two vectors are in the same direction, their resultant (sum) is obtained by adding their vector lengths as shown in the figure. The direction of resultant is same as the individual vectors. Addition of vectors in same direction.

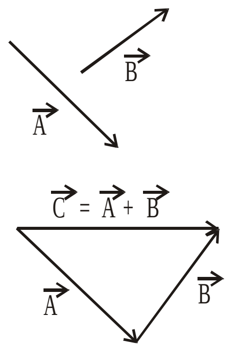


- **Addition Of Two Vectors In Opposite Direction**
  If the vectors are mutually opposite, their resultant is obtained by subtracting the length of smaller vector.



Addition of vectors in opposite from that of larger vector as shown in figure. The direction of resultant is same as that of larger vector. (Triangle law)

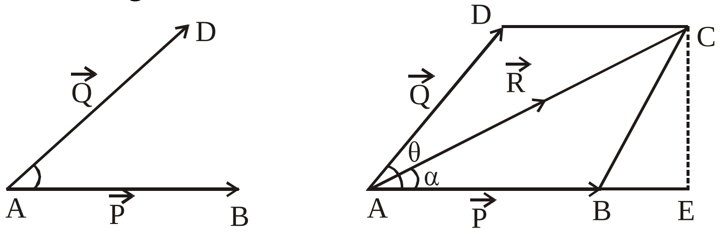
- **Addition Of Two Vectors Inclined Mutually**
  If two vectors are mutually inclined, the following procedure is adopted to find their sum. $\vec{A}$ and $\vec{B}$ are the given vectors. $\vec{B}$ is slides parallel to itself, such that its "tail" coincides with the head of $\vec{A}$ as shown in figure. Then the directed line segment drawn from the tail of $\vec{A}$ to the head of $\vec{B}$ represents the addition of $\vec{A}$ and $\vec{B}$.



- **Triangle Law Of Vectors**
  If two vectors are represented in magnitude and direction by the two sides of a triangle taken in order, the third side of the triangle taken in reverse order represents their resultant in magnitude and direction.

- **Parallelogram Law Of Vectors**
  Two vector quantities (Ex- velocity, acceleration, force, etc) can be added using parallelogram law. This law is useful to find both magnitude and direction of resultant.

- **Statement:** If two vectors are represented in magnitude and direction by the adjacent sides of a parallelogram drawn from a point, the diagonal passing through that point represents their resultant both in magnitude and direction.



- **Explanation:** $\vec{P}$ *and* $\vec{Q}$ are two vectors represented by $\overrightarrow{AB}$ and $\overrightarrow{AD}$. Both vectors act at the common point A and mutually inclined at angle 'θ' as shown in figure. If the parallelogram ABCD is completed taking AB and AD as adjacent sides, then the diagonal $\overrightarrow{AC}$ represents their resultant $(\vec{R})$ both in magnitude and direction.

Magnitude of the Resultant : The line of action of $\vec{P}$ is extended. The perpendicular drawn from 'C' meets the extension of AB at E.

From the figure, it is obvious that $\overrightarrow{BC} = \overrightarrow{AD} = \vec{Q}$ and $\angle \overrightarrow{CBE} = \theta$

$\therefore$ Length of AB = magnitude of $\vec{P} = P$ Length of BC = magnitude of $\vec{Q} = Q$

Length of AC = magnitude of $\vec{R} = R$

From triangle CBE, $BE = BC\cos\theta \Rightarrow BE = Q\cos\theta$ .... (i)

$\frac{EC}{BC} = \sin\theta$ and $EC = Q\sin\theta$ .... (ii)

$(AC)^2 = (AE)^2 + (EC)^2$

$\Rightarrow$ $(AC)^2 = (AB + BE)^2 + (EC)^2$ $\Rightarrow$ $(AC)^2 = (AB)^2 + (BE)^2 + 2AB.BE + (EC)^2$

$\Rightarrow$ $R^2 = P^2 + Q^2\cos^2\theta + 2PQ\cos\theta + Q^2\sin^2\theta \Rightarrow R^2 = P^2 + Q^2 + 2PQ\cos\theta$

$\Rightarrow$ $\boldsymbol{R = \sqrt{P^2 + Q^2 + 2PQ\cos\theta}}$ .... (iii)

- **Direction of the Resultant:** The resultant makes angle 'α' with $\vec{A}$ (say).

From triangle CAE: $\tan\alpha = \frac{EC}{AE} = \frac{EC}{AB + BE} \Rightarrow \tan\alpha = \frac{Q\sin\theta}{P + Q\cos\theta}$

$\Rightarrow$ $\boldsymbol{\alpha = \tan^{-1}\left[\frac{Q\sin\theta}{P + Q\cos\theta}\right]}$ .... (iv)

The expression (iii) and (iv) gives the magnitude and direction of the resultant of $\vec{P}$ and $\vec{Q}$.

➤ **Special Cases :**

- If $\vec{P}$ and $\vec{Q}$ are in the same direction, then $\theta = 0^\circ$, and $\cos\theta = 1$

$\therefore$ From equation (iii) and (iv), R = P + Q and $\alpha = 0$

Hence the magnitude of resultant is sum of the magnitude of individual vectors. The direction of resultant is same as that of individual vectors.

- If $\vec{P}$ and $\vec{Q}$ are opposite, then $\theta = 180^\circ$ and $\cos\theta = -1$

$\therefore\ R = P - Q$ i.e. $R = P - Q$ or $Q - P$ and $\alpha = 0^\circ$ or 180º.

Thus the magnitude of resultant is equal to difference of magnitudes of individual vectors and the direction of resultant is same as that of the vector or larger magnitude.

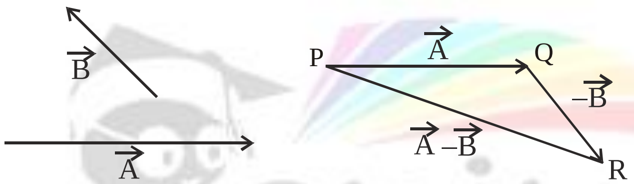
- If $\vec{P}$ and $\vec{Q}$ are perpendicular, then $\theta = 90^\circ$ and $\cos\theta = 0$

  $\therefore\quad R = \sqrt{P^2 + Q^2}$ and $\alpha = \tan^{-1}(Q/P)$
- If $|\vec{P}| = |\vec{Q}|$, then $R = 2P\cos\theta/2$ and $\alpha = \theta/2$

  $\therefore$ If the vectors have equal magnitude, then the resultant will bisect the angle between them.

➢ **Subtraction Of Vectors**

The subtracting of vector $\vec{B}$ from the vector $\vec{A}$, is same as addition of $-\vec{B}$ to $\vec{A}$ as shown in figure i..e., $\vec{A} - \vec{B} = \vec{A} + (-\vec{B})$



The vector $\vec{B}$ is reversed to get negative vector of $\vec{B}$. Then reversed vector $-\vec{B}$ is shifted parallel to itself such that tail of $-\vec{B}$ coincides with head of $\vec{A}$. The directed line segment $\overrightarrow{PR}$ represents the subtracting of $\vec{B}$ from $\vec{A}$.

Vector subtracting does not obey commutative law. i.e., $\vec{A} - \vec{B} \neq \vec{B} - \vec{A}$.

➢ **Resolution Of A Vector Into Two Rectangular Components**

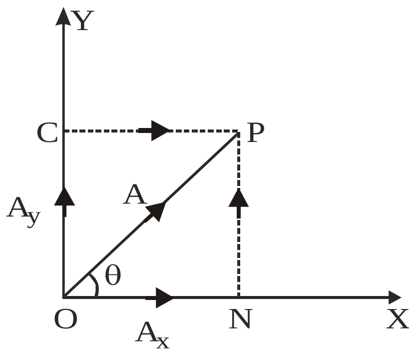
- The process of splitting a vector is called resolution of a vector. The parts obtained after resolution are known as components of the given vector.

- If the components of a given vector are perpendicular to each other, then they are called **rectangular components.** These are the most important components of a vector.

  Let, $\vec{A}_x$ and $\vec{A}_y$ are the rectangular components of $\vec{A}$.

  Applying triangle law of vectors to the vector triangle ONP, we get

  $\vec{A}_x + \vec{A}_y = \vec{A}$ or $\vec{A} = \vec{A}_x\hat{i} + \vec{A}_y\hat{j}$



- This equation confirms that $\vec{A}_x$ and $\vec{A}_y$ are the components of $\vec{A}$.

  In right angled triangle ONP,

  $\cos\theta = \dfrac{A_x}{A}$ or $A_x = A\cos\theta$ (i)

$\sin\theta = \frac{A_y}{A}$ or $A_y = A\sin\theta$ (ii)

- Squaring and adding (1) and (2), we get
  $A_x^2 + A_y^2 = A^2\cos^2\theta + A^2\sin^2\theta$

  or $A_x^2 + A_y^2 = A^2(\cos^2\theta + A^2\sin^2\theta)$ $\therefore$ $A_x^2 + A_y^2 = A^2$ $[\because \cos^2\theta + \sin^2\theta = 1]$

  or $A = \sqrt{A_x^2 + A_y^2}$

Illustration 7 :

Two vectors of magnitude *x* when subtracted given a vector of magnitude of *x*. Find the angle between two vectors which are subtracted.

Sol. $R = 2x\sin\theta/2 = x$

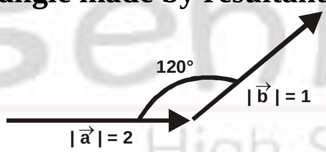
Therefore, $\sin\frac{\theta}{2} = \frac{1}{2}$

Therefore, $\frac{\theta}{2} = 30°$

Therefore, $\theta = 60°$

Illustration 8 :

Find the resultant and the angle made by resultant with b



Sol. $R^2 = \sqrt{2^2 + 1^2 + 2\times 2\times 1\cos 60°} = \sqrt{4 + 1 + 4\times\frac{1}{2}}$

$R = \sqrt{5+2}$

$R = \sqrt{7}$

$\tan\beta = \frac{a\sin\theta}{b + a\cos\theta}$

$\beta = \tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$

Illustration 9 :.

The resultant of two vectors A and B where B > A is of magnitude 10 m and perpendicular to B. If the magnitude A is 20. Find the magnitude of B and angle between A and B.

Sol. On ΔAOC

$\cos\theta = \frac{10}{20} = \frac{1}{2}$

$\therefore$ $\theta = 60°$

$\therefore$ Angle between $\vec{A}$ and $\vec{B}$

$|\vec{B}|\ \sqrt{20^2 - 10^2} = \sqrt{400 - 100} = \sqrt{300}$

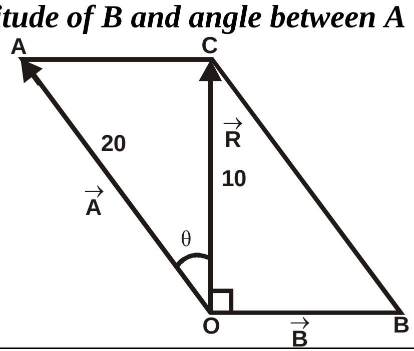


Illustration 10 :.
Force acting on a particle is $\vec{F} = 6\hat{i} - 8\hat{j} + 10\hat{k}N$, acceleration it with $|\vec{a}| = 1ms^{-2}$. The mass of the body is
Solution

$$|\vec{F}| = \sqrt{6^2 + (-8)^2 + (10)^2} = 10\sqrt{2}N$$

$$m = \frac{|\vec{F}|}{|\vec{a}|} = \frac{10\sqrt{2}}{1} = 10\sqrt{2}\ kg$$

Illustration 11 :.A body moves towards North with constant speed 8 m/s. it turns towards west by 60º without change in speed. Find value of change in velocity [in SI units]
Solution :

$$\Delta V = 2V\sin\left(\frac{\theta}{2}\right) = 2\times 8\sin\left(\frac{60}{2}\right) = 8\,m/s$$

Illustration 12 :.
A body moves from origin 4 m towards East then 4 m towards North then $3\sqrt{2}\,m$ towards North-East. If the total displacement is $x\sqrt{2}\,m$. Find x.
Solutions

Displacement $= |4\hat{i} + 4\hat{j} + 3\sqrt{2}\cos 45\hat{i} + 3\sqrt{2}\sin 45\hat{j}|$

$= |7\hat{i} + 7\hat{j}| = 7\sqrt{2}$

DIFFERENTIATION:

DIFFERENTIAL CO-EFFICIENT OR DERIVATIVE OF A FUNCTION:

The differential co-efficient or derivative of variable y with respect to variable x is defined as the instantaneous rate of change of y w.r.t. x.

- It is denoted by $\frac{dy}{dx}$. i.e. y be a function of x i.e. y = f(x) here, x is the independent variable and y is the dependent variable.
- The symbol $\frac{d(\ )}{dx}$ represent the rate of change w.r.t. x, or the derivative w.r.t. x.

PHYSICAL EXAMPLES OF DIFFERENTIATION CO-EFFICIENT AS RATE OF MEASUREMENT:

- Instantaneous acceleration of a body, a = rate of change of velocity 'v' with time t at the given instant.

  i.e. $a = \lim_{\Delta t\to 0} = \frac{\Delta v}{\Delta t} = \frac{dv}{dt}$

- Force is equal to rate of change in momentum

  i.e. $F = \frac{dp}{dt}$

FUNDAMENTAL FORMULAE OF DIFFERENTIATION :

- If 'c' is same constant then $\frac{dc}{dx} = 0$
- If y = cx where c = constant

  then = $\frac{dy}{dx} = \frac{d(cx)}{dx} = c\frac{dx}{dx} = c$
- If $y = x^n$, where n is a real number, then

  $\frac{dy}{dx} = \frac{dx^n}{dx}$

  $\frac{dy}{dx} = nx^{n-1}$
- If y = (u – v)

  where u and v are the functions of x

  i.e. $\frac{dy}{dx} = \frac{d(u+v)}{dx}$

  $\frac{dy}{dx} = \frac{du}{dx} + \frac{dv}{dx}$
- If $y = (u - v)$

  then $\frac{dy}{dx} = \frac{d(u-v)}{dx}$

  $\frac{dy}{dx} = \frac{du}{dx} - \frac{dv}{dx}$

DERIVATIVES OF TRIGONOMETRIC FUNCTIONS

(a) If $y = \sin x$ then

$\frac{dy}{dx} = \frac{d(\sin x)}{dx} = \cos x$

(b) If y = cos x then

$\frac{dy}{dx} = \frac{d(\cos x)}{dx} = -\sin x$

(c) If $y = \tan x$ then

$\frac{dy}{dx} = \frac{d(\tan x)}{dx} = \sec^2 x$

(d) If y = cot x ; then

$\frac{dy}{dx} = \frac{d(\cot x)}{dx} = -\text{cosec}^2 x$

(e) If y = sec x, then

$\frac{dy}{dx} = \frac{d(\sec x)}{dx} = \tan x.\sec x$

(f) If y = cosec x then

$\frac{dy}{dx} = \frac{d(\text{cosec } x)}{dx} = -\cot x.\text{cosec } x$

DERIVATIVE OF LOGARITHMIC

(a) If $y = \log_e x$, Then $\frac{dy}{dx} = \frac{1}{x}\log_e e = \frac{1}{x}$

(b) If $y = \log_e u$; then $\frac{dy}{dx} = \frac{1}{u} \times \frac{d(u)}{dx}$

Illustration 13: If $y = (x+4)$, ***then find the*** $\frac{dy}{dx}$ ***where x = function, and 4 is the constant.***

Solution:

$$y = (x+4)$$

$$\frac{dy}{dx} = \frac{d(x+4)}{dx}$$

$$\frac{dy}{dx} = \frac{dx}{dx} + \frac{d4}{dx}$$

$$\frac{dy}{dx} = 1.$$

Illustration 14:If $y = 3x$ **then find the** $\frac{dy}{dx}$

Solution:

$$\frac{dy}{dx} = \frac{d(3x)}{dx}$$

$$= x\frac{d3}{dx} + \frac{3dx}{dx}$$

$$\frac{dy}{dx} = 3$$

If y = $\frac{u}{v}$

Now, $\frac{dy}{dx} = \frac{d(u/v)}{dx}$

$$\frac{dy}{dx} = \frac{v\frac{du}{dx} - u\frac{dv}{dx}}{v^2}$$

Illustration 15: If y = x/3 then find $\frac{dy}{dx}$

Solution: $\frac{dy}{dx} = \frac{d(x/3)}{dx}$

$$\frac{dy}{dx} = \frac{3\frac{dx}{dt} - x\frac{d(3)}{dx}}{(3)^2}$$

$$\frac{dy}{dx} = \frac{3 \times 1 - 0}{9}$$

$$\frac{dy}{dx} = \frac{1}{3}$$

Illustration 16:

Differentiate the following with respect to x: (i) y = (3x + 2) (ii) y = $(2x^2 + 4)$

Solution :

(i) $\frac{dy}{dx} = \frac{d(3x+2)}{dx}$

$\frac{dy}{dx} = \frac{3dx}{dx} + \frac{d2}{dx}$

$\frac{dy}{dx} = 3$

(ii) $\frac{dy}{dx} = \frac{d(2x^2+4)}{dx}$

$= \frac{d2x^2}{dx} + \frac{d4}{dx}$

$= \frac{2dx^2}{dx} + \frac{d4}{dx}$

= 4x + 0

Illustration 17 : **Differentiate the following with respect to x**

(i) y = (1+sinx) (ii) y = 2 sin x

Solution:

(i) $\frac{dy}{dx} = \frac{d(1+\sin x)}{dx}$

$= \frac{dl}{dx} + \frac{d\sin x}{dx} = 0 + \cos x$

$\frac{dy}{dx} = \cos x$

(ii) $\frac{dy}{dx} = \frac{d2\sin x}{dx} = \frac{2d\sin x}{dx} = 2.\cos x$

Illustration 18 :

If y = 2x + 3 then he value of y for $x = \frac{1}{2}$ is

Solution

$y = 2\left(\frac{1}{2}\right) + 3 = 4$

Illustration 19 :

The area of a square of length L is A. i.e., area A = L^2. If we change L o L + dL, then area will charge A to A + dA then $\frac{dA}{dL} =$__________

Solution

$A + \Delta A = (L + \Delta L)^2 = L^2 + 2(\Delta L) + (\Delta L)^2$

$\Rightarrow \Delta A = 2L(\Delta L) + (\Delta L)^2$.

for small values of $\Delta L (\Delta L)^2$ can be neglected hence $\frac{\Delta A}{\Delta L} = 2L$.

Illustration 20 :

The curve for $y = 2x^2$ is drawn its slope is given by $\tan\theta = \frac{dy}{dx} = 4x$. then the slope at x = 6 is

Solution.

$\frac{dy}{dx}$ at x = 6 is 4 × 6 = 24.

INTEGRATION

- The process of integration is just the reverse of differentiation
- The symbol $\int$ is used to represent the integration
- $f(x)$ is the differential co-efficient of a function f(x) with respect to x.

FUNDAMENTAL FORMULAE OF INTEGRATION

1. $\int x^n dx = \frac{x^{n+1}}{n+1}$, provided $n \neq -1$

2. $\int dx = \int x^{\circ} dx = \frac{x^{0+1}}{0+1} = x$

3. $\int (u+v) dx = \int u dx + \int v dx$

4. $\int cu dx = c \int u dx$

   where c is a constant and u is a function of x

5. $\int cx^n dx = c\left(\frac{x^{n+1}}{n+1}\right)$

6. $\int x^{-1} dx = \int \frac{dx}{x} = \log_e x$

7. (i) $\int \sin x dx = -\cos x$

   (ii) $\int \sin(nx) = \frac{-\cos nx}{n}$

8. (i) $\int \cos x.dx = \sin x$

   (ii) $\int \cos nx.dx = \frac{\sin x}{n}$

9. $\int \sec^2 x dx = \tan x$

10. $\int \text{cosec}^2 x.dx = -\cot x$

11. $\int \sec x.\tan x.dx = \sec x$

12. $\int \text{cosec}\, x.\cot x.dx = -\text{cosec}\, x$.

Illustration 21:

$\int A\sin\omega t\, dt =$ (where A and ω are constants)

Solution:

$\because \int A\sin\omega t\, dt = A\left[\frac{-\cos\omega t}{\omega}\right].$

Illustration 22:

$\int \frac{M}{\ell}x^2\, dx =$ (M, ℓ are constants)

Solution

$\because \int \frac{M}{\ell}x^2\, dx$

$= \frac{M}{\ell}\int x^2\, dx$ ($\because$ M, ℓ are constants)

$= \frac{M}{\ell}\left[\frac{x^3}{3}\right]$

Illustration 23:

$\int \frac{q}{c}dq =$ (Here c is a constant)

Solution :

$\because \int \frac{q}{c}dq = \frac{1}{c}\int q$ ($\because$ c constant)

$= \frac{1}{c}\left[\frac{q^2}{2}\right].$

QUANTITIES AND UNITS

Physical Quantities

Any thing that we measure to describe the laws of physics are known as physical quantities. Physical quantities can be classified on the following bases.

I. BASED ON THEIR DIRECTIONAL PROPERTIES:

Scalars: The physical quantities which have only magnitude but no direction are called scalar quantities. e.g mass, density, volume, time etc.

Vectors: The physical quantities which have both magnitude and direction and obey laws of vector alzebra are called vector quantities. e.g. displacement, force, velocity etc.

II. BASED ON THEIR DEPENDENCY

Fundamental or base quantities: The quantities which do not depend upon other quantities for their complete definition are known as fundamental or base quantities. e.g. length, mass, time, temperature, electric current, luminous intensity and amount of substance.

Derived quantities: The quantities which can be expressed in terms of the fundamental quantities are known as derived quantities. e.g. speed (distance/time), volume, acceleration, force, pressure etc.

Unit of Physical Quantities

The measure of any quantity is always a multiple of some well defined standard measurement. **This standard measurement is called as unit.** Example 10 kg potato is 10 times of 1 kg which is well defined standard measurement. Thus 1 kg will be consider as a unit of mass. Again 1 kg is 1000 times of 1 gm which is again a well defined standard measurement. Thus 1 gm is also consider as a unit.

Classification of Units

BASIC UNITS SYSTEMS

Quantity	Name of System			
	CGS	FPS	MKS	SI
Length	centimeter	foot	meter	meter(m)
Mass	gram	pounds	kilogram	kilogram(kg)
Time	second	second	second	second(s)
Temperature	Kelvin		Kelvin	Kelvin(K)
Electric Current			ampere	ampere(A)
Luminous Intensity				candela(cd)
Amount of Substance				mole(mol)

In the above all the quantities are independent and called as fundamental quantities and their units are called as fundamental units.

In SI system there are two supplementary units.

(i) Radian (rad): Unit of plane angle
(ii) Steradian (st): Unit of Solid angle

S.I. Prefixes			
S. No.	**Prefix**	**Symbol**	**Power of 10**
1.	exa	E	18
2.	peta	P	15
3.	tera	T	12
4.	giga	G	9
5.	mega	M	6

6.	kilo	K	3
7.	hector	h	2
8.	deca	da	1
9.	deci	d	-1
10.	centi	c	-2
11.	milli	m	-3
12.	micro	μ	-6
13.	nano	n	-9
14.	pico	p	-12
15.	femto	f	-15
16.	atto	a	-18

Practical units of Length	
S. No.	
1.	Light year = 9.46×10^{15}m
2.	Parsec = 3.084×10^{16}m
3.	Angstrom(Å) = 10^{-10}m
4.	Micrometer = 10^{-6}m
5.	Astronomical Unit (AU) = 1.496×10^{11}m
6.	Otto meter = 10^{-21}m.

Illustration 24:* *How many meter are there in 300 nm? How many micrometer are there in 700 nm?

Solution:

300 nm = 300×10^{-9} m = 3×10^{-7}m

700 nm = 700×10^{-9}m

= 700×10^{-3} μm

= 7×10^{-1}μm.

Derived Units: The units of derived quantities or the units that can be expressed in terms of the base units are called derived units. e.g. unit of speed

Some derived units are named in honour of great scientists.

e.g. unit of force - newton (N), unit of frequency - hertz (Hz) etc.

Converstion Factors

Some important conversions:

(i) Unit of density in SI system is $1\frac{kg}{m^3}$ convert into C.G.S. System i.e., g/cm^3.

$$1\frac{kg}{m^3} = \frac{10^3 g}{10^2 \times 10^2 \times 10^2 cm^3} = 10^{-3} \text{ g/cm}^3$$

Thus 1000 kg/m^3 = $10^3 \times 10^{-3}$ g/cm^3

⇒1 g/cm^3 = 10^3 kg/m^3 = 1 g/cm^3.

(ii) Practical unit of speed or velocity is, km/hr. Convert 1 km/hr into m/s.

$$1\frac{\text{km}}{\text{hr}} = \frac{1000\text{m}}{60 \times 60\text{S}} = \frac{5}{18}\text{m / s}$$

Thus 72 km/hr = $\left(72 \times \frac{5}{18}\right)$ m/s = 20 m/s

⇒ 1 m/s = 18/5 km/hr.

(iii) In SI system unit of foce is 1N = $1\text{kg} \times \frac{\text{m}}{\text{s}^2}$

In C.G.S. system unit of force is idyne = 1g × cm/s^2

convert 1N into 1 dyne.

$$1\text{N} = 1\text{ kg} \times 1\frac{\text{m}}{\text{s}^2} = 10^3\text{ g} \times 10^2\text{ cm/s}^2$$

$= 10^5$ g cm/s^2 = 10^5 dyne.

⇒ 1dyne = 10^{-5}N.

DIMENSIONS

Dimensions of a physical quantity are the powers (or exponents) to which the base quantities are raised to represent that quantity.

Dimensional Formula: The dimensional formula of any physical quantity is that expression which represents how and which of the base quantities are included in that quantity. It is written by enclosing the symbols for base quantities with appropriate powers in square brackets i.e. [ ]. e.g. Dimensional formula of mass is [$M^1L^0T^0$] and that of speed (=distance/time) is [$M^0L^1T^{-1}$].

Dimensional Equation: The equation obtained by equating a physical quantity with its dimensional formula is called a dimensional equation, e.g. [v] = $[M^0L^1T^{-1}]$.

For example [F] = $[MLT^{-2}]$ is a dimensional equation, $[MLT^{-2}]$ is the dimensional formula of the force and the dimensions of force are 1 in mass, 1 in length and –2 time.

SOME IMPORTANT QUANTITIES AND THEIR DIMENSIONS

Quantities	Dimensional equation
Distance, Displacement, Length/ depth/ thickness wave length	$M^0L^1T^0$
Mass	$M^1L^0T^0$
Speed, velocity, velocity of sound, velocity of light	$M^0L^1T^{-1}$
Acceleration (a), acceleration due to gravity (g)	$M^0L^1T^{-2}$
Angular velocity, velocity gradient, decay constant of	$M^0L^0T^{-1}$
Gravitational constant	$M^{-1}L^3T^{-2}$
Force, weight, Tension, Centripetal Force	$M^1L^1T^{-2}$
Work, Energy, Torque, Moment of couple, Heat	$M^1L^2T^{-2}$
Linear Momentum, Impulse	$M^1L^1T^{-1}$
Pressure, Coefficient of Elasticity	$M^1L^{-1}T^{-2}$
Temperature	$M^0L^0T\theta^1$
Latent heat	$M^0L^2T^{-2}\theta^0$
Specific heat	$M^0L^2T^{-2}\theta^{-1}$
Charge	A^1T^1
Current	A^1
Potential difference, potential energy, electromotive force	$M^1L^2T^{-3}A^{-1}$
Electrical flux	$M^1L^3T^{-3}A^{-1}$

DIMENSION LESS QUANTITIES

1. Efficiency
2. Amplification factor
3. Power Coefficient
4. Relative Electric Permitivity
5. Refractive Index
6. Strain
7. Angle / Solid angle

Uses of Dimensional Equations

Following are the uses of dimensional equations.

1. Conversion of one system of units into another.
2. Checking the accuracy of various formula or equation.
3. Derivation of formula

Principle of Homogeneity

The dimension of physical quantity on the left hand side of dimensional equation should equal to the net dimensions of all physical quantities on the right hand side of it. The dimensions of both sides in an equation are same.

Ula by Dimensional Analysis Method

Sometimes dimensions can be used to deduce a relation between the physical quantities. If one knows the quantities on which a particular physical quantity depends and if one guesses that this dependence is of product type, method of dimension may be helpful in the derivation of the relation. Taking an example, suppose we have to derive the expression for the time period of a sample pendulum. The simple pendulum has a bob, attached to a string, which oscillates under the action of the force of gravity. Thus, the time period may depend on the length of the string, the mass of the bob and the acceleration due to gravity. We assume that the dependence of time period on these quantities is of product type, that is,

$$t = k\ell^a m^b g^c \qquad \ldots \text{(i)}$$

where k is a dimensionless constant and a, b and c are exponents which we want to evaluate. Taking the dimensions of both sides,

$$T = L^a M^b (LT^{-2})^c = L^{\alpha+c} M^b T^{-2c}.$$

Since the dimensions on both sides must be identical, we have

$a + c = 0$

$b = 0$

and $-2c = 1$

giving $a = \frac{1}{2}$, b = 0 and c = $-\frac{1}{2}$.

Putting these values in equation (i)

$$t = k\sqrt{\frac{\ell}{g}} \qquad \ldots \text{(ii)}$$

Thus, by dimensional analysis, we can deduce that the time period of a simple pendulum is independent of its mass, is proportional to the square root of the length of the pendulum and is inversely proportional to the square root of the acceleration due to gravity at the place of observation.

The limitation of dimensional method is that, the constant of proportionality (k) cannot be found directly.

Illustration 25: ***In the equation x = 3yz^2, x and z represents electrical capacitance and magnetic induction. Calculate dimensional equation of y.***

Solution:

By the principal of homogeneity of dimension

Dimension equation of x = Dimension equation of ($3yz^2$)

$M^{-1}L^{-2}T^4A^2$ = Dimension equation of (y) × $[M^1 L^0 T^{-2} A^{-1}]^2$

Dimension of (y) = $M^{-3}L^{-2}T^8A^4$

To Check the Accuracy of a Formula

It is based on homogeneity principle of dimension, according to it formula is correct dimensionally when LHS = RHS. Dimensionally

Illustration 26: ***Test the correctness of the formula*** $T = k\sqrt{\frac{\ell}{g}}$***, where T = time period,, l = length of pendulum and g = acc due to gravity.***

Solution:

Dimension of LHS is $M^0L^0T^1$

Dimension of RHS is $\sqrt{\frac{L}{LT^{-2}}} = M^0L^0T^1$

L.H.S. = R.H.S. : Dimensionally. Therefore, the given formula is correct.

ASSIGNMENT–1

1. Find the value of the followings
   (i) sin (– 45□) (ii) tan (– 45□)
   (A) $\frac{1}{\sqrt{2}},-1$ (B) $-\frac{1}{\sqrt{2}},1$
   (C) 1, 1 (D) $-\frac{1}{\sqrt{2}},-1$

2. Find the value of the followings
   (i) sin 120□ (ii) cos 120□ (iii) tan 90□
   □□□□□ $\frac{\sqrt{3}}{2},\frac{1}{2},\infty$ (B) $\frac{\sqrt{3}}{2},-\frac{1}{2},\infty$
   (C) $\frac{1}{2},\frac{1}{\sqrt{2}},1$ (D) $\frac{1}{\sqrt{2}},-\frac{1}{2},\infty$

3. If cos □ = $\frac{4}{5}$, find the value of sin □ and tan □
   (A) $\sin\theta\frac{5}{4},\tan\theta\frac{3}{4}$ (B) $\sin\theta\frac{4}{5},\tan\theta\frac{5}{4}$
   (C) $\sin\theta\frac{4}{3},\tan\theta\frac{1}{2}$ (D) $\sin\theta\frac{3}{5},\tan\theta\frac{3}{4}$

4. If cosA = 0.6, the value of 5sin A – 3 tanA is
   (A) 1.2 (B) 1.6
   (C) 0 (D) 2.3.

5. If x = a cos□ and y = a sin□ then which of these relations exist between x and y?
   (A) $x^2 + y^2 = a^2$ (B) $x^2 - y^2 = a^2$
   (C) $xy = \frac{a}{2}$ (D) $\frac{x}{y} = a$.

6. cos 315º =
   (A) $\frac{1}{\sqrt{2}}$ (B) $\frac{1}{\sqrt{3}}$
   (C) $\frac{1}{2}$ (D) $\frac{1}{2\sqrt{2}}$.

7. If $\cos\theta = \frac{-5}{12}$, in which quadrant does □ lie?
   (A) first (B) second
   (C) all (D) fourth.

8. If □ lies in the second quadrant and $\tan\theta = \frac{5}{12}$, find the value of $\frac{2\cos\theta}{1-\sin\theta}$
   (A) 4/3 (B) 3
   (C) –4/3 (D) –3.

9. cos75º =
   (A) $\frac{\sqrt{3}+1}{2\sqrt{2}}$ (B) $\frac{\sqrt{3}-1}{2\sqrt{2}}$
   (C) $\frac{1-\sqrt{3}}{2\sqrt{2}}$ (D) $\frac{\sqrt{3}}{2\sqrt{2}}$.

10. $\sin(-30°) = -\sin 30°$
   (A) $-\frac{1}{2}$ (B) $\frac{1}{2}$
   (C) $-\frac{\sqrt{3}}{2}$ (D) $\frac{\sqrt{3}}{2}$

11. If 0º < □ < 90º and $\cos\theta = \frac{4}{5}$, then which of these have a value of $-\frac{3}{4}$
   (A) cos(90º + □) (B) cosec(180º +□)
   (C) tan(360º–□) (D) sin(270º–□).

12. The value of sin 75º
   (A) $\frac{\sqrt{6}+\sqrt{2}}{2}$ (B) $\frac{\sqrt{6}-\sqrt{2}}{4}$
   (C) $\frac{\sqrt{6}+\sqrt{2}}{4}$ (D) $\frac{1+\sqrt{2}}{4}$

13. Given $\sin\alpha = \frac{3}{5}, \cos\beta = \frac{5}{13}\alpha$ and □ are in 1st quadrant then cos(□ + □) =
   (A) $\frac{63}{65}$ (B) $\frac{-63}{16}$
   (C) $\frac{-16}{65}$ (D) $\frac{+3}{16}$.

14. Evaluate the following expression $3\cos^2 30° + \sec^2 30° + 2\cos 0° + 3\sin 90° - \tan^2 60°$
   (A) $\frac{9}{12}$ (B) $\frac{7}{12}$
   (C) 0 (D) 1

15. Evaluating the following :
   $\frac{5\sin^2 30° + \cos^2 45 - 4\tan^2 30°}{2\sin 30°\cos 30° + \tan 45°}$ we get
   (A) $\frac{5}{6}\left(2-\sqrt{3}\right)$ (B) $\frac{6}{5}\left(2-\sqrt{3}\right)$
   (C) $\frac{6}{5}\left(2+\sqrt{3}\right)$ (D) $\frac{5}{6}\left(2+\sqrt{3}\right)$

16. Given $\sin A = \frac{5}{13}$, then cot A has the value

(A) $\frac{12}{5}$ (B) $\frac{6}{13}$

(C) $\frac{13}{12}$ (D) $\frac{12}{13}$

17. If the distance between (x,2) and (3,4) is 8, then the value of x is

(A) $3+\sqrt{60}$ (B) $3-\sqrt{60}$

(C) $3\pm\sqrt{60}$ (D) None of these

18. sin (–30) is equal to

(a) $-\frac{1}{2}$ (b) $\frac{1}{2}$

(c) $\frac{\sqrt{3}}{2}$ (d) $-\frac{\sqrt{3}}{2}$

19. cos 120° is equal to

(A) – sin 90° (B) – sin 30°

(C) sin 60° (D) – sin 60°

20. Evaluating : $4(\sin^4 30° + \cos^4 30° + \cos^4 60°) - 3(\cos^2 45° - \sin^2 90°)$ we get

(A) 0 (B) 1

(C) 2 (D) 3

ASSIGNMENT–2

1. A body moves 4 m towards east and then 3 m north. The displacement and distance covered by the body are

(A) 7 m, 6m (B) 6 m, 5 m

(C) 5 m, 7 m (D) 4 m, 3 m

2. Find the minimum number of unparallel vector producing zero resultant.

(A) 3 (B) 2

(C) 1 (D) none of these

3. Find the number of non-coplanar vector producing zero resultant

(A) 1 (B) 4

(C) 3 (D) none of these

4. Which of the following group of magnitude will not produce zero resultant when taken in form of vector.

(A) 20, 3, 7, 4 (B) 20, 20, 20, 20

(C) 20, 3, 7, 10 (D) 20, 3, 7, 12

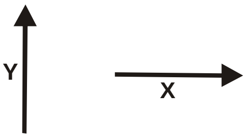
5. Out of the following the resultant of which cannot be 4 Newton?

(A) 2 N and 2 N (B) 2N and 4 N

(C) 2N and 6 N (D) 2 N and 8 N

6. Two vectors of magnitude 6 and 14 give a resultant R, then
   (A) $-8 < R < 20$ (B) $8 < R < 20$
   (C) $-8 \le R \le 20$ (D) $8 \le R \le 20$

7. Two vectors $\vec{X}$ and $\vec{Y}$ are shown. Match the following



Column I | **Column II**

(i)  (a) $\vec{X} + \vec{Y}$

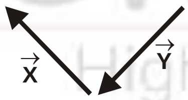
(ii)  (b) $-(\vec{X} + \vec{Y})$

(iii)  (c) $\vec{X} - \vec{Y}$

(iv)  (d) $\vec{Y} - \vec{X}$

(A) (i) - (d) ; (ii) - (c) ; (iii) - (b), (iv) - (a) (B) (i) - (a) ; (ii) - (d) ; (iii) - (c), (iv) - (a)
(C) (i) - (a) ; (ii) - (c) ; (iii) - (b), (iv) - (d) (D) (i) - (d) ; (ii) - (b) ; (iii) - (c), (iv) - (a)

8. The vectors $\vec{X}$ and $\vec{Y}$ are as shown. Match the following



Column I | **Column II**

(i)  (a) $\vec{X} + \vec{Y}$

(ii)  (b) $-(\vec{X} + \vec{Y})$

(iii)  (c) $\vec{X} - \vec{Y}$

(iv)  (d) $\vec{Y} - \vec{X}$

(A) (i) - (d) ; (ii) - (a) ; (iii) - (c), (iv) - (b) (B) (i) - (a) ; (ii) - (c) ; (iii) - (b), (iv) - (d)
(C) (i) - (c) ; (ii) - (b) ; (iii) - (d), (iv) - (a) (D) (i) - (d) ; (ii) - (c) ; (iii) - (b), (iv) - (a)

9. Which of the following is scalar
   (A) displacement (B) force
   (C) velocity (D) distance

10. Which of the following is a vector
   (A) distance (B) speed
   (C) force (D) none of these

11. The magnitude of $3\hat{i} + 2\hat{j} + \hat{k}$ is

(A) $\sqrt{5}$ (B) $\sqrt{6}$

(C) $\sqrt{14}$ (D) $\sqrt{24}$

12. If $\hat{n}$ is a unit vector in the direction of the vector $\vec{P}$, then $\hat{n}$ =

(A) $\frac{\vec{P}}{|\vec{P}|}$ (B) $\vec{P}|\vec{P}|$

(C) $\frac{|\vec{P}|}{\vec{P}}$ (D) $\vec{P}$

13. The maximum value of resultant of two vectors $\vec{P}$ and $\vec{Q}$ is

(A) P + Q (B) P – Q

(C) $\sqrt{P^2+Q^2}$ (D) $\sqrt{P^2-Q^2}$

14. If the angle between two forces increases, the magnitude of their resultant

(A) decreases (B) increases

(C) remains unchanged (D) decreases and increases

15. Two perpendicular forces of 8N and 6N can produce the effect of a single force equal to

(A) 5 N (B) 6 N

(C) 8 N (D) 10 N

16. The resultant of two forces, each P, acting at an angle θ is

(A) $2P \sin\frac{\theta}{2}$ (B) $2P \cos\frac{\theta}{2}$

(C) $2P \cos\theta$ (D) $P\sqrt{2}$

17. A vector is represented by $\hat{i}+3\hat{j}+5\hat{k}$. It's length in X-Y plane is

(A) 1 (B) 3

(C) 5 (D) $\sqrt{10}$

18. The resultant of two like parallel forces $\vec{A}$ and $\vec{B}$ is

(A) $\sqrt{A^2+B^2}$ (B) $\sqrt{A^2-B^2}$

(C) A + B (D) A – B

19. The vector sum of two vectors $\vec{A}$ and $\vec{B}$ is maximum when the angle q between their positive direction is

(A) 0° (B) $\frac{\pi}{4}$

(C) $\frac{\pi}{2}$ (D) $\frac{\pi}{6}$

20. The magnitude of $5\hat{i}-2\hat{j}$

(A) $\sqrt{29}$ (B) $\sqrt{(-29)}$

(C) $\sqrt{7}$ (D) 7

ASSIGNMENT–3

1. $\frac{d}{dx}(\pi) =$

(A) π (B) 0
(C) 1 (D) 1/5

2. $\frac{d}{dx}(x^3) =$

(A) $3x^3$ (B) $3x^2$
(C) $3x^4$ (D) $x^4/4$.

3. $\frac{d}{dx}\sqrt{x} =$

(A) $\frac{1}{\sqrt{x}}$ (B) $\frac{-1}{2\sqrt{x}}$
(C) $\frac{1}{2\sqrt{x}}$ (D) $\sqrt{x}$.

4. $\frac{d}{dx}\left(\frac{1}{\sqrt{x}}\right) =$

(A) $\frac{1}{2\sqrt{x^3}}$ (B) $\frac{1}{\sqrt{x^3}}$
(C) $\frac{-1}{2\sqrt{x^3}}$ (D) $\sqrt{x}$.

5. $\frac{d}{dx}(x^2 + 2x + 3) =$

(A) $2x + 3$ (B) $2(x + 1)$
(C) $3x + 4$ (D) $x^3/3 + x^2 + 3x$.

6. If $x = 2 + 21\,t - 4.9\,t^2$, find $v = \frac{dx}{dt}$ and $a = \frac{dv}{dt}$ at $t = 0.2$.

(A) v = 9.0 a = 9.8 (B) v = 19.0 a = –9.8
(B) v =10.0 a = 9.8 (C) v = 19.0 a = 9.8.

7. $\frac{d}{dx}(3 + 2x^3)\sqrt{x} =$

(A) $\frac{3-14x^3}{2\sqrt{x}}$ (B) $\frac{3+14x^3}{2\sqrt{x}}$
(C) $\frac{3-2x^3}{2\sqrt{x}}$ (D) $6x^{\frac{5}{2}}$

8. If $x = a(\theta + \sin\theta)$ and $y = a(1 - \cos\theta)$ then $\frac{dy}{dx} =$

(A) $\tan\frac{\theta}{2}$ (B) $\cot\frac{\theta}{2}$
(C) $\sec\frac{\theta}{2}$ (D) $\frac{\sin\theta}{2}$.

9. $\frac{d}{dx}\left[\frac{3x+4}{4x+5}\right] =$

(A) $\frac{-1}{(4x+5)^2}$
(B) $\frac{1}{(4x+5)^2}$
(C) $\frac{-1}{(4x-5)^2}$
(D)

10. Given PV = K (constant) we can say that

(A) $\frac{dP}{P} = \frac{dV}{V}$
(B) $\frac{dP}{P} = \frac{-dV}{V}$
(C) $\frac{dP}{P} = \frac{2dV}{V}$
(D) $\frac{dP}{P} = \frac{-1dV}{2V}$.

11. Integral of the area of an spherical object over radius gives you?

(A) volume of the object
(B) total area of the object
(C) edge of he object
(D) centre of sphere.

12. $\int x^3\, dx$ where x is a length will have ______ dimensions in time.

(A) 0
(B) 2
(C) 4
(D) 6.

13. If $-\frac{dv}{dr} = E$, then we can say that

(A) $E = \int V\, dr$
(B) $V = \int E\, dr$
(C) $E = -\int V\, dr$
(D) $V = -\int E\, dr$.

14. A certain quantity on differentiation with respect to time gives zero and on integration gives 5t. The quantity is

(A) 5s
(B) (t + 5)s
(C) $(t^2 + 5)$s
(D) $(t^3 + t^2 + 5t)$s.

15. The gradient at any point (x, y) of a curve is $3x^2 - 12$ and the curve passes through the point (2, –7), he equation of the curve is

(A) $x^3 - 4x + 3$
(B) $x^3 + 12x - 9$
(C) $x^3 - 12x + 9$
(D) $x^3 - 12x - 9$.

16. $\int 6\sin x\, dx =$

(A) 6 cosx
(B) -6 cosx
(C) 6 sinx
(D) –6 sinx

17. The curve $y = x^2$. The area between x = 0 and x = 6 is

(A) 27 units
(B) 72 units
(C) 36 units
(D) 40 units.

ASSIGNMENT – 4

1. Find the number of ergs in one Joule.
(A) 10^8 (B) 10^7
(C) 10^5 (D) 10^6

2. Value of acceleration due to gravity is 9.8 m/sec^2. Find its value in km/hr^2.
(A) 127008 (B) 137008
(C) 12000 (D) 14000

3. Length cannot be measured by
(A) Fermi (B) Debye
(C) Micron (D) Light year

4. The unit of reactance is
(A) Ohm (B) Volt
(C) Mho (D) Newton.

5. Number of base SI unit is
(A) 4 (B) 7
(C) 3 (D) 5

6. Parsec is the unit of
(A) time (B) distance
(C) frequency (D) angular acceleration

7. The unit of Planck's constant is
(A) Joule (B) Joule/ s
(C) Joule/m (D) Joule-s

8. Faraday is the unit of
(A) Charge (B) emf
(C) Mass (D) Energy

9. Candela is the unit of
(A) Electricity intensity (B) Luminous intensity
(C) Sound intensity (D) None of these

10. Which of the following pairs is wrong
(A) Pressure- barometer (B) Relative density-Pyrometer
(C) Temperature – Thermometer (D) Earthquake – Seismograph

11. Pascal-area has the dimensions of
(A) energy (B) velocity
(C) pressure (D) force

12. The displacement of a particle is given by : $s = at + bt^2$ where t is time and a and b are two constants. The dimensional formula of the constant b is

(A) $[M^0L^0T^2]$ (B) $[M^0L^1T^0]$
(C) $[M^0LT^{-2}]$ (D) $[M^0L^0T^1]$

13. If force (F), length (L) and time (T) are the fundamental units, then the dimensional formula of the mass will be:

(A) $[FL^{-1}T^2]$ (B) $[FL^2T^2]$
(C) $[FL^{-1}T^{-2}]$ (D) $[FL^{-1}T^{-1}]$.

14. A force F is given by $F = at + bt^2$, where t is time. What are the dimensions of a and b?

(A) $[MLT^{-3}]$ and $[MLT^{-4}]$ (B) $[MLT^{-1}]$ and $[MLT^0]$
(C) $[MLT^{-4}]$ and $[MLT]$ (D) $[MLT^{-3}]$ and $[ML^2T^4]$

15. If E = energy, G = gravitational constant, I = impulse and M = mass, the dimensions of $\frac{GIM^2}{E^2}$ are same as that of

(A) mass (B) length
(C) time (D) force

16. In $\left(P + \frac{a}{V^2}\right)(V - b) = RT$, dimension of 'b' is

(A) $[ML^0T^0]$ (B) $[M^0L^3T^0]$
(C) $[M^3L^0T^0]$ (D) $[M^0L^0T^3]$.

17. Which relation is wrong ?

(A) 1 Calorie = 4.18 Joules (B) $1Å = 10^{-10}$ m
(C) $1MeV = 1.6\times10^{-13}$ Joules (D) 1 Newton = 10^{-5} Dynes

18. The equation $\left(P + \frac{a}{V^2}\right)(V - b)$ = constant. The units of a is, (where p is pressure, v is volume)

(A) Dyne×cm^5 (B) Dyne×cm^4
(C) Dyne×cm^3 (D) Dyne×cm^2.

19. A physical quantity is measured and its value is found to be nu where n = numerical value and u = unit. Then which of the following relations is true.

(A) $n \propto u^2$ (B) $n \propto u$
(C) $n \propto \sqrt{u}$ (D) $n \propto \frac{1}{u}$

20. Chronometer is used to measure [AFMC 2003]

(A) time (B) mass
(C) density (D) distance

KEYS

Assignment – 1		Assignment – 2		Assignment – 3		Assignment – 4	
1.	(D)	1.	(C)	1.	(B)	1.	(B)
2.	(B)	2.	(A)	2.	(B)	2.	(A)
3.	(D)	3.	(B)	3.	(C)	3.	(B)
4.	(C)	4.	(A)	4.	(C)	4.	(A)
5.	(A)	5.	(D)	5.	(B)	5.	(B)
6.	(A)	6.	(D)	6.	(B)	6.	(B)
7.	(B)	7.	(A)	7.	(B)	7.	(D)
8.	(D)	8.	(D)	8.	(A)	8.	(A)
9.	(B)	9.	(A)	9.	(A)	9.	(A)
10.	(A)	10.	(D)	10.	(B)	10.	(B)
11.	(C)	11.	(C)	11.	(A)	11.	(B)
12.	(A)	12.	(A)	12.	(C)	12.	(C)
13.	(C)	13.	(A)	13.	(B)	13.	(A)
14.	(B)	14.	(A)	14.	(A)	14.	(A)
15.	(A)	15.	(D)	15.	(D)	15.	(C)
16.	(A)	16.	(B)	16.	(A)	16.	(B)
17.	(C)	17.	(D)	17.	(C)	17.	(D)
18.	(A)	18.	(C)			18.	(B)
19.	(B)	19.	(A)			19.	(D)
20.	(C)	20.	(A)			20.	(A)