Toppersnotes
Unleash the topper in you

THE IIT - JEE SECRET

JEE MAINS AND JEE ADVANCED

PHYSICS

VOL - I

SIERRA
INNOVATIONS
Private Limited

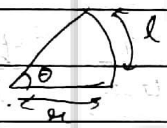
Contents

UNIT & DIMENSION

Fundamental Quantities

(a)	Mass	[M]	kg
(b)	Length	[L]	m
(c)	Time	[T]	S
(d)	Temperature	[Θ, K]	K
(e)	Current	[I],[A]	A
(f)	Mole	[Mole]	Mole
(g)	Luminous	[Cd]	Candela

$$\theta = \frac{l}{r}$$



$$\text{Velocity} = [L]^1[T]^{-1}$$

$$\text{Force} = ma$$
$$= M^1L^1T^{-2}$$

$$\text{Electrical resistance} = \frac{V}{I}$$

$$= H = I^2RT$$

$$\text{Energy} =$$
$$\Rightarrow \frac{1}{2}mv^2 \text{ or } WT$$
$$\Rightarrow M^1L^1T^{-2} \times L^1$$
$$\Rightarrow M^1L^2T^{-2}$$

$$\frac{M^1L^2T^{-2}}{I^2T} = R$$

$$R = M^1L^2I^{-2}T^{-3}$$

Uni. gravitational constant = g

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

$$M^1L^1T^{-2} = \frac{GM^2}{L^2}$$

$$G = M^{-1}L^3T^{-2}$$

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}$$

$$\frac{F \times r^2}{q_1q_2} = \frac{1}{4\pi\varepsilon_0}$$

$$\frac{F \times r^2 \times 4\pi}{q_1q_2} = \frac{1}{\varepsilon_0}$$

$$\varepsilon_0 = \frac{q_1q_2}{F \times r^2 \times 4\pi}$$

$$= \frac{I^2T^2}{M^1L^1T^{-2} \times L^2}$$

$$= I^2T^4M^{-1}L^{-3}$$

$$g = LT^{-2}$$

P , F , ρ

$P = m \times v$

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

$F = m \times a$

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

$F = P^1 V^1$

$V = T^{-1}$

Density $= \rho = ML^{-3}$

$P = F^x \rho^y$

$ML^{-1}T^{-1} = [ML^{-1}T^{-2}]^x [\cancel{ML}^{-3}]^y$

$ML^{-1}T^{-1} = [M]^{x+y} [L]^{x-3y} [T]^{-2x}$

$x + y = 1$

$x = \frac{1}{-y}$

$x - 3y = 1$

$-\frac{1}{y} - 3y = 1$

$+9y = 1$

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

$x = \frac{1}{2}$

$F = \frac{\mu_0}{4\pi} \times \frac{I_1 I_2}{r^2}$

$\mu_0 = MLT^{-2}T^{-2}$

$$P = F^x L^y T^z$$

$$ML^{-1}T^{-2} = [M^1L^1T^{-2}]^x [L]^y [T]^z$$

$$= M^x L^{x+y} T^{-2x+z}$$

$x = 1$ $\quad\quad y = -2$

$x+y = -1$

$-2x+z = -2$

Conversion of Units

Force → SI – N

CGS – dyne

$$F = M^1L^1T^{-2}$$

$$1N = [1kg]^1 [1m]^1 [1s]^{-2}$$

$$= [1000g]^1 [100cm] [1s]^{-2}$$

$$1\,dyne = [1g]^1 [1cm]^1 [1s^{-2}]$$

$$\frac{1N}{1dyne} = \left[\frac{1000g}{1g}\right]^1 \left[\frac{100cm}{1cm}\right]^1 \left[\frac{1s}{1s}\right]^{-2}$$

$$1N = 10^5\ dyne$$

$L = 25m$, $M = 200kg$ $\quad T = 10^{-6}s$

$$E = M^1T^{-2}L^2$$

$$25J = {}^{25}[1kg]^1 [1m]^2 [1s]^{-2}$$

$$1\,s.t. = [200kg]^1 [25m]^2 [10^{-6}]^{-2}$$

$$\frac{25J}{1\,S.T.} = {}^{25}\left[\frac{1kg}{200kg}\right]\left[\frac{1m}{25m}\right]^2\left[\frac{1s}{10^{-6}s}\right]^{-2}$$

$$= \cancel{25}\left[\frac{1}{200}\right]\left[\frac{1}{25\times25}\right]\left[\frac{1}{10^{12}}\right]$$

8

$25J = \cancel{5}2\times10^{-15}$ S.T.

$= 0.2\times10^{-15}$ S.T.

Checking Homogenity of Dimensions

Rule-I Terms having +, - and = should have equal dimensions in both sides.

II Argument of trignometric functions should be dimensionless.

III Exponent should be dimensionless.

IV In $\log_a N$, N should be dimensionless

$$\frac{F \times P^2}{P} + \frac{xL}{T^2} - \frac{y^3}{M^3}$$

For $\frac{MLT^{-2}\times(ML^{-1}T^{-2})^2}{ML^{-3}} = \frac{xL}{T^2}$

$$\frac{MLT^{-2}\times(ML^{-1}T^{-2})^2}{M^1L^{-3}\times L^1T^{-2}} = x$$

$\Rightarrow M^2L^{-2}T^{-4}\times L^3$

$x = M^2L^1T^{-4}$

$$\frac{y^3}{m^3} = M^2L^1T^{-4} \times L^1T^{-2}$$

$$y^3 = M^5L^2T^{-6}$$

$$y = M^{5/3}L^{2/3}T^{-2}$$

★ The equation which is dimensionally correct, it can be correct or cannot be.

Dimension Relationship

$$T = m^x l^y g^z$$

$$M^0L^0T^1 = M^x l^y (L^1T^{-2})^z$$

$$= M^x L^{y+z} T^{-2z}$$

$x=0$ $\qquad$ $z = \frac{-1}{2}$

$y+z = 0$ $\qquad$ $y = \frac{1}{2}$

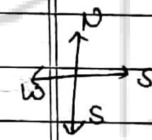
$-2z = 1$

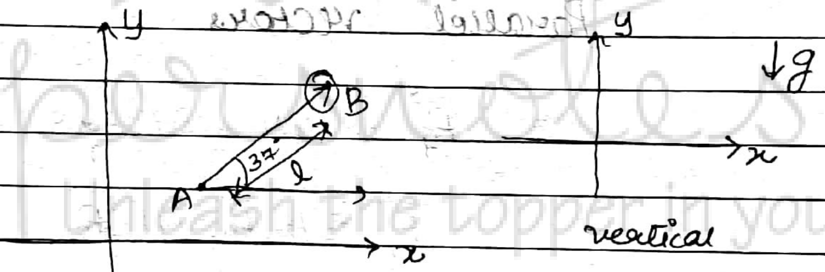
VECTORS

Vectors:- Quantity which need magnitude and direction, for complete discription and follows the law of vector algebra.

Scalars:- Quantity which can be described with magnitude.

If horizontal and vertical is given in question, then it concludes that gravity is present.



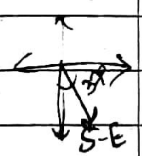


horizontal

★ REPRESENTATION OF 2-D VECTORS

Length - magnitude
Arrow head - direction

$\vec{F} = 5N,\ 37^\circ$ N of E
$|\vec{F}| = 5N$



★ Equality

When magnitude and direction are equal, then 2 vectors are equal.

$$\vec{F_1} = \vec{F_2}$$
$$\vec{F_1} \neq \vec{F_3}$$

$\vec{F_3} = 5N$, N-E

$\vec{F_1} = \vec{F_2} = 5N$, S-E

$$|\vec{V_1}| > |\vec{V_2}|$$

Parallel vectors

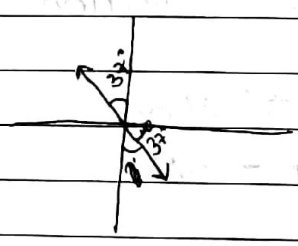
$\vec{F_4} = 2N$, 37° E of S

$$\vec{F_4} \parallel \vec{F_1} \parallel \vec{F_2}$$

Anti-parallel vectors

$\vec{F_4} = 2N$, 37° E of S ★

$\vec{F_5} = 2N$, 37° W of N



Opposite vectors (Negative vectors)

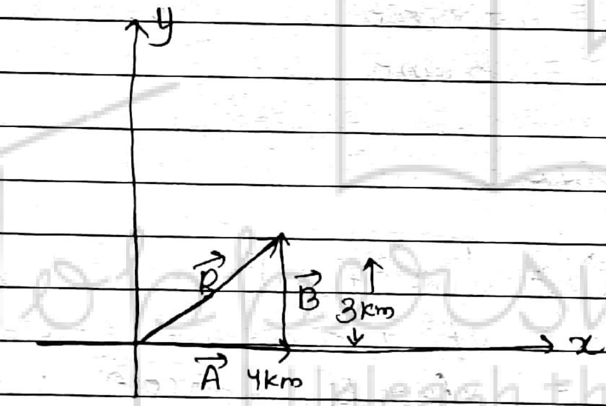
$\vec{F_6} = 5N$, 37° W of N

$\vec{F_1} = -\vec{F_6}$

$\vec{F_1}$ anti $\parallel$ to $\vec{F_6}$.

$|\vec{F_1}| = |\vec{F_6}|$

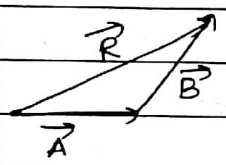
★ Addition of 2 vectors



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

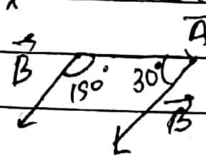
↓

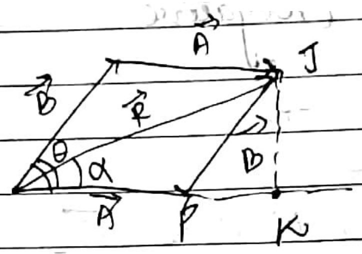
The resultant vector



Parallelogram law of vectors

Smaller angle to the vector angle when 2 vectors are placed ~~head~~ tail to tail, then that angle is called angle between vector ~~angle~~.





$$PK = B\cos\theta$$
$$JK = B\sin\theta$$

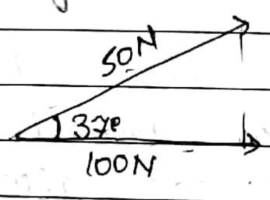
$$KO = A + B\cos\theta$$
$$KJ = B\sin\theta$$

In ΔOJK

$$|\vec{R}| = \sqrt{(KO)^2 + (KJ)^2}$$ scaler
$$= \sqrt{A^2 + B^2\cos^2\theta + 2AB\cos\theta + B^2\sin^2\theta}$$
$$= \sqrt{A^2 + B^2 + 2AB\cos\theta} \quad \text{(numerically)}$$

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

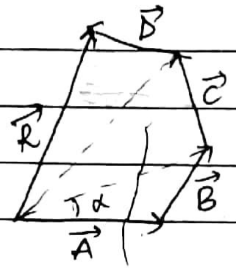
$\vec{F_1} = 100N$ towards E
$\vec{F_2} = 50N$ 37° towards N of E



$$= \sqrt{10000 + 2500 + 10000\cos 37^\circ}$$
$$= \sqrt{10000 + 2500 + \overset{2000}{\cancel{10000}} \times \frac{4}{5}}$$
$$\Rightarrow \sqrt{10000 + 2500 + 8000}$$
$$= \sqrt{20500}$$

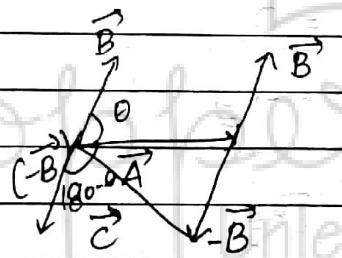
Polygon law of vector addition

$$\vec{R} = \vec{A} + \vec{B} + \vec{C} + \vec{D}$$



Subtraction of 2 vectors

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



$$(180-\theta) = (\pi-\theta)$$

$$|\vec{R}| = \sqrt{A^2+B^2+2AB\cos(\pi-\theta)}$$

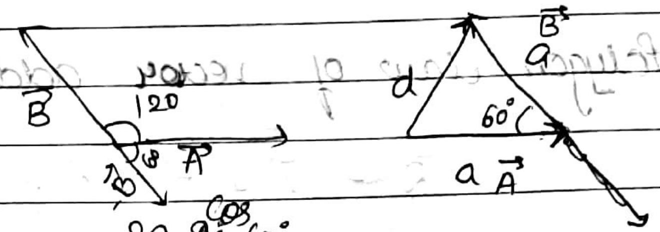
$$\cos(\pi-\theta) = -\cos\theta$$

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

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

$$\Rightarrow A\sqrt{2(1+\cos\theta)}$$

$$\Rightarrow A\cos(\theta/2)$$



$\Rightarrow 2a \cos 60^\circ$

$\Rightarrow \cancel{\frac{2a\sqrt{3}}{2}} = \cancel{a\sqrt{3}}$

$= a$

$\vec{C} = \vec{A} - \vec{B}$

$|\vec{C}| = 2a$

$|\vec{C}| = |\vec{A} - \vec{B}| =$

$\neq |\vec{A}| - |\vec{B}| = 0$

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

★ **Unit Vector**

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

$\vec{u} \parallel \vec{v}$ if $n > 0$

$\vec{u}$ anti $\parallel$ $\vec{v}$ $n < 0$

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

$$\hat{V} = \left(\frac{1}{|\vec{V}|}\right)\vec{V}$$

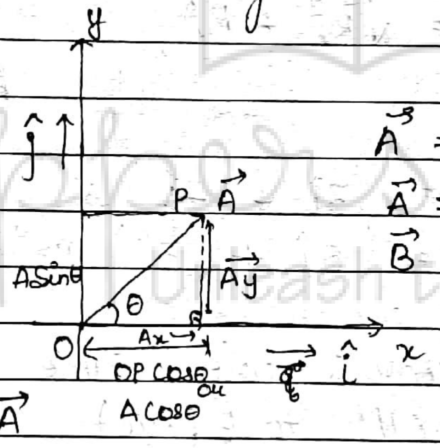
$\hat{V} \parallel \vec{V}$

$|\hat{V}| = 1$ (no unit)

Unit vector

$\vec{V} = |\vec{V}|(\hat{V}) \rightarrow$ direction

splitting of magnitude and vector to get direction.



$\vec{A} = \vec{A_x} + \vec{A_y}$

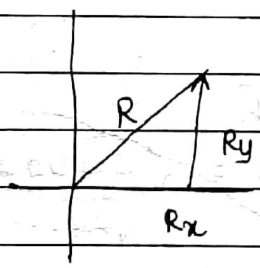
$\vec{A} = (A\cos\theta)\hat{i} + (A\sin\theta)\hat{j}$

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

$\vec{OP} = \vec{A}$

$\hat{j}$ - unit vector along (+ve) y-axis

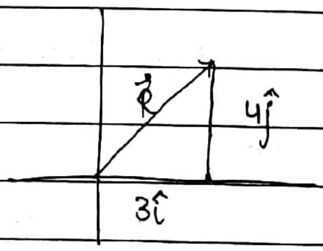
$\hat{i}$ - unit vector along (+ve) x-axis



$\vec{R} = \vec{R_x} + \vec{R_y}$

$\vec{R} = \vec{R_x} - \vec{R_y}$

$3\hat{i} + 4\hat{j}$

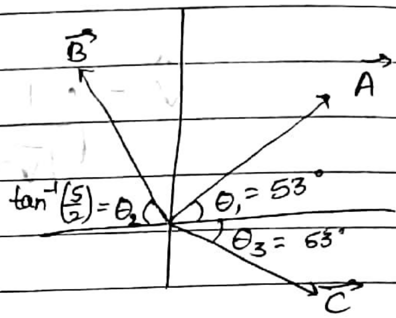


$\vec{A} = 3\hat{i} + 4\hat{j}$

$\vec{B} = -2\hat{i} + 5\hat{j}$

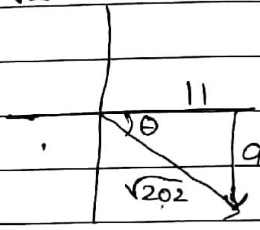
$\vec{C} = 6\hat{i} - 8\hat{j}$

$\vec{R} = \vec{A} - \vec{B} + \vec{C}$



$\vec{A} = 11\hat{i} - 9\hat{j} = \sqrt{202}$

$= 11\hat{i} + 9(-\hat{j})$



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

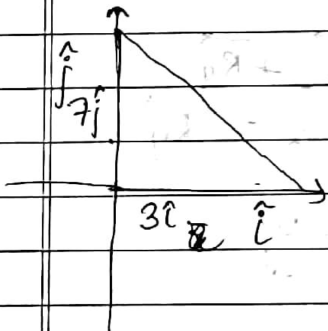
$\hat{B} = \frac{\vec{B}}{|\vec{B}|}$

Q

$\vec{A} = (3\hat{i} + 7\hat{j})\ N$

$\vec{B} = (5\hat{i} + 3\hat{i})\ ms^{-1}$

Write a vector C with same magnitude as A and anti $\parallel^{le}$ to B (-ve)



$|\vec{C}| = |\vec{A}|$

$|\vec{C}| = -\vec{B}$

$|\vec{C}| = \sqrt{9+49}$

$= \sqrt{58}$

$= \sqrt{49+9}$

$= \sqrt{58}$

$= \sqrt{34}$

$\sqrt{58}$

$|\vec{C}| = |\vec{C}|(\hat{C})$

$\hat{C} = -\hat{B}$

$= -\left(\frac{5\hat{i} + 3\hat{j}}{\sqrt{34}}\right) \cancel{ms^{-1}}\ ms^{-1}$