CH2 VECTORS & EQUILIBRIUM.

Physical Quantity

- SCALAR [Non-Directional] (Volume, Mass, Work)
- VECTOR [Directional] (Velocity, Force, Torque)

SCALAR ALGEBRA VS VECTOR ALGEBRA

- Simple
  $+, -, \times, \div$
- Special Rules.
  $\oplus$ $\ominus$ $\otimes$
- Division is hopless :(

Modulus of A vector.

→ Only Magnitude representation.
- Abs numerical value of your vector.
  (No info about direction)

Eg: $\vec{a} = 5N$ (North)
$\vec{b} = -5N$ (South)
$\vec{a} \neq \vec{b}$
but $|\vec{a}| = |\vec{b}| = 5N$

Behaviour of Vectors

A vector WILL NOT CHANGE:

ⓐ Parallel Displacement in Space.

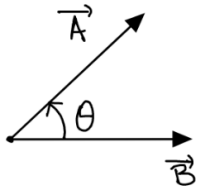
ⓑ Rotated via θ s.t. $\theta = 2\pi n$; $n = \{\mathbb{Z}\}$

2π rad $= 360°$

A vector WILL CHANGE:

ⓐ Any change in magnitude
ⓑ Any change in direction
ⓒ Both ⓐ & ⓑ.

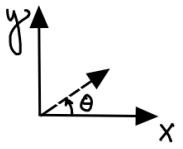
Angle B/w Vectors.



→ Tails or heads must be on mutual point.

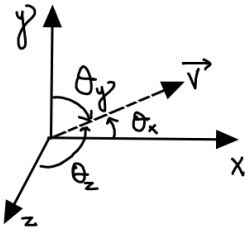
Rectangular Coordinate System.

2D



→ X axis
→ Y axis
→ Mutually intersecting Perpendicularly.
→ One Angle

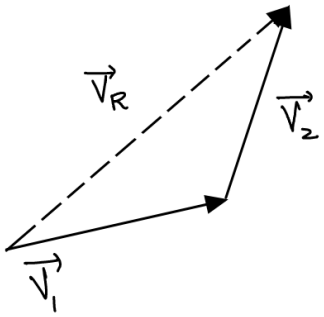
3D.



→ X - axis
→ Y - axis
→ Z - axis
→ Mutually intersecting Perpendicularly.
→ Three Angles.

Head To Tail Rule.

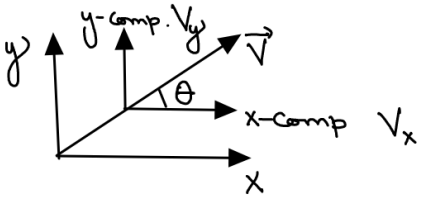
Graphical Rep. of Vector Algebra.



$$\vec{V}_R = \vec{V}_1 + \vec{V}_2$$

Resolution of a Vector.

→ Components
→ Mutually perpendicular.



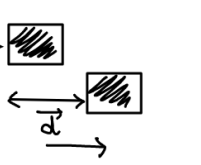
$V_x = V\cos\theta$
$V_y = V\sin\theta$.

$$V_x^2 + V_y^2$$
$$V^2\cos^2\theta + V^2\sin^2\theta$$
$$V^2(\cos^2\theta + \sin^2\theta)$$
$$V^2(1) = V^2 = |\vec{V}|^2. \Rightarrow \boxed{|\vec{V}| = \sqrt{V_x^2 + V_y^2}}$$

$$\frac{V_x}{V_y} \Rightarrow \boxed{\theta = \tan^{-1}\left(\frac{V_y}{V_x}\right)}.$$

SCALAR PRODUCT.

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



$\vec{F}\cdot\vec{d} = W.$

Eg: WORK. $W = F\cdot d.$

Some Properties:

(a) Commutative law

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

(b) Association law.

$$m\vec{A}\cdot n\vec{B} = mn\,\vec{A}\cdot\vec{B}$$

(c) for unit vectors.

$$\hat{i}\cdot\hat{i} = 1 \qquad \hat{i}\cdot\hat{j} = 0$$
$$\hat{j}\cdot\hat{j} = 1$$
$$\hat{k}\cdot\hat{k} = 1 \qquad \hat{k}\cdot\hat{j} = 0.$$

(d) $\angle$ b/w $\vec{A}, \vec{B}$

$$\theta = \cos^{-1}\left[\frac{\sum_{i=j} A_i B_j}{AB}\right]$$

VECTOR PRODUCT

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

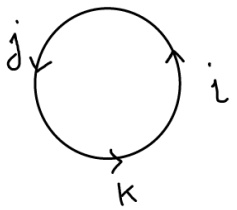
A Few properties:

(a) $\vec{A}\times\vec{B} \neq \vec{B}\times\vec{A}$

(b) $\hat{i}\times\hat{i} = 0 = \hat{j}\times\hat{j} = \hat{k}\times\hat{k}$

(c) $\vec{A}\times\vec{B} = AB\,\hat{n}$ if $\theta = 90°$

(d)



$$\underbrace{\vec{A}\times\vec{B}}_{\parallel} = \vec{V}. = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix} = \begin{matrix} i & j & k \end{matrix}$$