VECTORS (IN 2D)

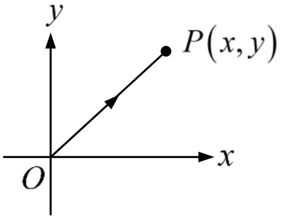
Position Vector – *Vector that starts from origin*

Free Vector – *No fixed position*

Zero/Null Vector, $\mathbf{0}$ – *Magnitude = 0*

Equal Vectors – *same magnitude, same dir.*

Negative Vectors – *same magnitude, opp. dir.*

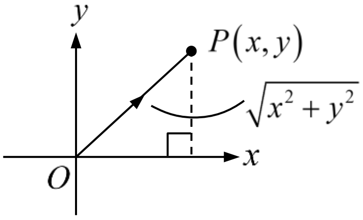


$$\overrightarrow{OP} = \mathbf{p} = \underset{\sim}{p}$$
$$= \begin{pmatrix} x \\ y \end{pmatrix}$$

Magnitude

Scalar quantity of a vector

$$\left|\overrightarrow{OP}\right| = |\mathbf{p}| = \left|\underset{\sim}{p}\right| = \sqrt{x^2 + y^2}$$



Scalar Multiple

If $\mathbf{a} = \begin{pmatrix} x \\ y \end{pmatrix}$,

$$k\mathbf{a} = k\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} kx \\ ky \end{pmatrix}$$

$$|k\mathbf{a}| = k|\mathbf{a}|$$

If $\mathbf{a} = k\mathbf{b}$,

$\mathbf{a}$ parallel to $\mathbf{b}$

If $\mathbf{a} = k\mathbf{b}$,

$k > 0 \Rightarrow \mathbf{a}$ and $\mathbf{b}$ same direction

$k < 0 \Rightarrow \mathbf{a}$ and $\mathbf{b}$ opposite direction

If A, B and C are **collinear** (they are lying on a straight line),

$$\overrightarrow{AB} = k\overrightarrow{AC}$$

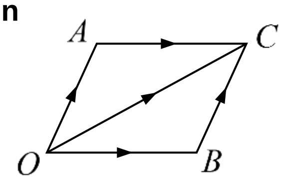
Vectors Algebra

Laws

1. Commutative: $\mathbf{a} + \mathbf{b} = \mathbf{b} + \mathbf{a}$
2. Associative: $\mathbf{a} + (\mathbf{b} + \mathbf{c}) = (\mathbf{a} + \mathbf{b}) + \mathbf{c}$
3. Distributive: $(\lambda + \mu)\mathbf{a} = \lambda\mathbf{a} + \mu\mathbf{a}$

   $\lambda(\mathbf{a} + \mathbf{b}) = \lambda\mathbf{a} + \lambda\mathbf{b}$

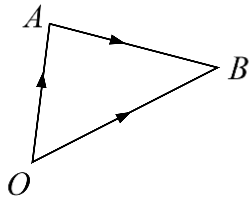
Addition



Triangle Law: $\overrightarrow{OA} + \overrightarrow{AC} = \overrightarrow{OB} + \overrightarrow{BC} = \overrightarrow{OC}$

Parallelogram Law: $\overrightarrow{OA} + \overrightarrow{OB} = \overrightarrow{OC}$

Subtraction



$$\overrightarrow{AB} = \overrightarrow{AO} + \overrightarrow{OB}$$
$$= \left(-\overrightarrow{OA}\right) + \overrightarrow{OB}$$
$$= \overrightarrow{OB} - \overrightarrow{OA}$$