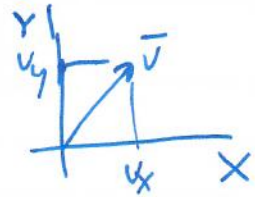


VECTORS

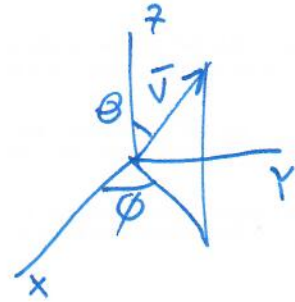
BASICS

$$\vec{v} = \vec{v}_x + \vec{v}_y = v_x \vec{i} + v_y \vec{j}$$

$$2D \quad \begin{cases} v_x = v \cos \theta \\ v_y = v \sin \theta \end{cases}$$

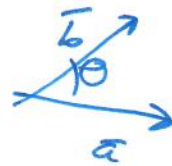


$$3D \quad \begin{cases} v_x = v \sin \theta \cos \phi \\ v_y = v \sin \theta \sin \phi \\ v_z = v \cos \theta \end{cases}$$



Dot product

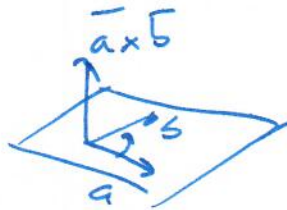
$$\begin{aligned} \vec{a} \cdot \vec{b} &= a_x b_x + a_y b_y + a_z b_z \\ &= |\vec{a}| |\vec{b}| \cos \theta \end{aligned}$$



Meaning
↓
projection

Cross product

$$\vec{a} \times \vec{b}$$



$$\vec{a} \times \vec{b} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ a_x & a_y & a_z \\ b_x & b_y & b_z \end{vmatrix}$$

$$|\vec{a} \times \vec{b}| = |\vec{a}| |\vec{b}| \sin \theta$$

Ande

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$$\omega = \frac{v}{R^2}$$

$$R^2$$

Surfaces as vectors

$$\vec{S}$$

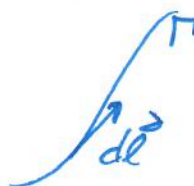


$$\vec{S} = \int d\vec{S} = \int dS \vec{u}_s$$

$$\vec{S} = \int d\vec{S} = \int dS \vec{u}_s$$

Line Integral

$$I = \int_{\Gamma} \vec{v} \cdot d\vec{\ell}$$



$\Gamma \equiv \text{path}$

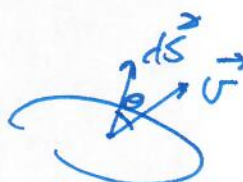
Example: work

Circulation Γ is a closed path

$$C = \oint \vec{v} \cdot d\vec{\ell}$$

Flux

$$\Phi = \int \vec{v} \cdot d\vec{S}$$



$$\left. \begin{array}{l} \text{Max: } \theta = 0 \\ \text{Min: } \theta = \frac{\pi}{2} \end{array} \right\} \frac{\Phi}{|\vec{v}|}$$

Nabla operator

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Divergence

$$\begin{aligned}\vec{\nabla} \cdot \vec{v} &= \left(\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z} \right) (v_x, v_y, v_z) \\ &= \frac{\partial v_x}{\partial x} + \frac{\partial v_y}{\partial y} + \frac{\partial v_z}{\partial z}\end{aligned}$$

Gradient

$$\vec{\nabla} \cdot \phi = \left(\frac{\partial \phi}{\partial x}, \frac{\partial \phi}{\partial y}, \frac{\partial \phi}{\partial z} \right)$$

Curl

$$\vec{\nabla} \times \vec{v} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ v_x & v_y & v_z \end{vmatrix}$$

Divergence theorem / Gauss theorem

$$\oint \vec{v} \cdot d\vec{S} = \iiint_V (\vec{\nabla} \cdot \vec{v}) dV$$

Ampere theorem

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