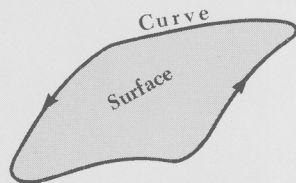


GAUSS



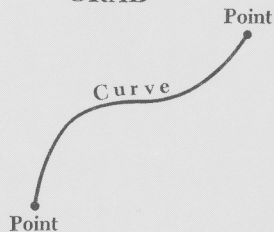
Surface encloses volume

STOKES



Curve encloses surface

GRAD



Points enclose curve

$$\int_{\text{surface}} \mathbf{F} \cdot d\mathbf{a} = \int_{\text{volume}} \text{div } \mathbf{F} dv$$

$$\int_{\text{curve}} \mathbf{A} \cdot d\mathbf{s} = \int_{\text{surface}} \text{curl } \mathbf{A} \cdot d\mathbf{a}$$

$$\varphi_2 - \varphi_1 = \int_{\text{curve}} \text{grad } \varphi \cdot d\mathbf{s}$$

IN CARTESIAN COORDINATES

$$\begin{aligned} \text{div } \mathbf{F} &= \frac{\partial F_x}{\partial x} + \frac{\partial F_y}{\partial y} + \frac{\partial F_z}{\partial z} \\ &= \nabla \cdot \mathbf{F} \end{aligned}$$

$$\begin{aligned} \text{curl } \mathbf{A} &= \hat{x} \left(\frac{\partial A_z}{\partial y} - \frac{\partial A_y}{\partial z} \right) \\ &\quad + \hat{y} \left(\frac{\partial A_x}{\partial z} - \frac{\partial A_z}{\partial x} \right) \\ &\quad + \hat{z} \left(\frac{\partial A_y}{\partial x} - \frac{\partial A_x}{\partial y} \right) \\ &= \nabla \times \mathbf{A} \end{aligned}$$

$$\begin{aligned} \text{grad } \varphi &= \hat{x} \frac{\partial \varphi}{\partial x} + \hat{y} \frac{\partial \varphi}{\partial y} + \hat{z} \frac{\partial \varphi}{\partial z} \\ &= \nabla \varphi \end{aligned}$$

$$\nabla = \hat{x} \frac{\partial}{\partial x} + \hat{y} \frac{\partial}{\partial y} + \hat{z} \frac{\partial}{\partial z}$$