

$$W = \int_{\text{path}} (2y) dx - y^2 dy \quad y = \frac{1}{2}x, \quad dy = \frac{1}{2}dx$$

$$W_1 = \int_0^2 \left(x \right) \left(\frac{1}{2}x \right) dx - \frac{1}{4}x^2 \left(\frac{1}{2}dx \right)$$

$$= \int_0^2 \left(\frac{1}{2}x^2 - \frac{1}{8}x^2 \right) dx = 1$$

$$W_2 = \int_0^2 \left(x \right) \left(\frac{1}{4}x^2 \right) dx - \left(\frac{1}{4}x^2 \right) \left(\frac{1}{2}x dx \right) = \frac{2}{3} \quad y = \frac{1}{4}x^2 \quad dy = \frac{1}{2}x dx$$

$$W_1 \neq W_2$$

$$W(x, y, z) \Rightarrow dW = \frac{dW}{dx} dx + \frac{dW}{dy} dy + \frac{dW}{dz} dz$$

$$dW = \vec{F} \cdot d\vec{r} = F_x dx + F_y dy + F_z dz$$

$$\vec{\nabla} W = \frac{dW}{dx} \hat{i} + \frac{dW}{dy} \hat{j} + \frac{dW}{dz} \hat{k} = F_x \hat{i} + F_y \hat{j} + F_z \hat{k}$$

$$\vec{F}_c = \vec{\nabla} W = -\vec{\nabla} U$$

$$\vec{\nabla} \times \vec{F}_c = \vec{0} = \text{curl-less}$$

$$\nabla \times F = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{d}{dx} & \frac{d}{dy} & \frac{d}{dz} \\ F_x & F_y & F_z \end{vmatrix} = \left(\frac{dF_z}{dy} - \frac{dF_y}{dz} \right) \hat{i} - \left(\frac{dF_z}{dx} - \frac{dF_x}{dz} \right) \hat{j} + \left(\frac{dF_y}{dx} - \frac{dF_x}{dy} \right) \hat{k}$$

Green's theorem in the plane:

$$\oint_A \left(\frac{dQ}{dx} - \frac{dP}{dy} \right) dx dy = \oint_{\partial A} (P dx + Q dy)$$

$$\Phi_E = \oint \vec{E} \cdot d\vec{A} = \frac{1}{\epsilon_0} \iiint \rho d\tau \leftarrow \text{Gauss}$$

$$\vec{\nabla} \cdot \vec{E} = \frac{1}{\epsilon_0} \rho$$

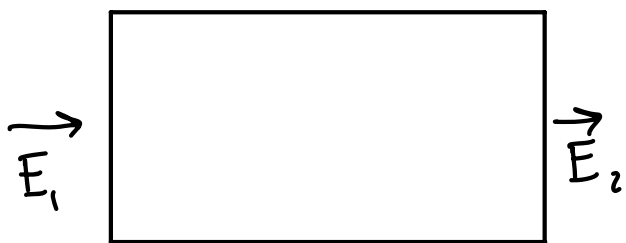
$$\iiint \cancel{\vec{\nabla} \cdot \vec{E}} d\tau = \oint \vec{E} \cdot d\vec{A}$$

$$V \cdot \vec{A}'$$

$A' = A_{\perp} \propto \text{perpendicular}$

$$\vec{V} \cdot \vec{A} = V \cdot A \cos \theta$$

$$\Phi_1 = E_1 A_1 \quad \Phi_2 = E_2 A_2$$



$$\Phi_2 - \Phi_1 = \int \vec{E}_x^2$$