$$W = \int (2y)\,dx - y^2\,dy \qquad y = \tfrac{1}{2}x,\ dy = \tfrac{1}{2}dx$$

Path

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

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

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

$$W_1 \neq W_2$$

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

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

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

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

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

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

Green's theorem in the plane:

$$\iint_A \left(\frac{dQ}{dx} - \frac{dP}{dy}\right)dx\,dy = \int_{dA} (P\,dx + Q\,dy)$$

$$\underset{\text{flux}}{\Phi_E} = \oiint \vec{E}\cdot d\vec{A} = \frac{1}{\epsilon_0}\iiint \rho \, d\tau \leftarrow \text{tao}$$

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

$$\iint\cancel{\int}\cancel{\vec{\nabla}}\cdot\vec{E}\,d\tau = \oiint \vec{E}\cdot d\vec{A}$$

$A' = A_\perp \leftarrow$ perpendicular

$$V\cdot A'$$

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

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

$$\Phi_2 - \Phi_1 = (E_x^2$$