$$\vec{E} = k \frac{q}{|\vec{r}_p - \vec{r}_1|} \hat{r}_{1p}$$

$$W = \sum \vec{F} \cdot d\vec{r}$$

$$F = q_p \cdot E_p$$

$$W = \int_{\infty}^{|\vec{r}_p - \vec{r}_1|} k \frac{q_1 q_p}{|\vec{r}_p - \vec{r}_1|} \hat{r}_{1p} \cdot d\vec{r}_{1p}$$

$$\vec{r}_p - \vec{r}_1 = r_{1p}$$

$$W = k q_1 q_p \int_{\infty}^{|r_p|} \frac{dr}{r^2} \hat{r} \cdot d\vec{r}$$

$$W = \frac{k q_1 q_p}{|\vec{r}_{1p}|}$$

$$W = \int_{\infty}^{|r_p - r_1|} k \frac{q_1 q_p}{|r_p - r_1|^2} \hat{r}_{1p} \cdot d\vec{r}_{1p}$$

$$r_p - r_1 = r_{1p}$$

4.

$$W = k q_1 q_p \int_{\infty}^{|r_p|} \frac{dr}{r_p^2} \hat{r} \cdot d\vec{r}$$

$$W = \frac{k q_1 q_p}{|\vec{r}_{1p}|}$$

$$\vec{E} = \frac{\vec{F}}{q} \qquad V = \frac{k q_1}{|\vec{r}_{1p}|} = \frac{W}{q}$$

① ⟵ ⟶ ②

$$\vec{E} = -\frac{\Delta V}{\Delta r} \hat{r} \qquad \vec{E} = -\frac{dV}{dr} \hat{r}$$

$$\boxed{\vec{E} = -\vec{\nabla} V}$$

$$f(x,y) = ax^2 + by^3$$

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

$$\vec{\nabla} f = 2axy\hat{x} + 3by^2\hat{y}$$

$$f = ax^2y^3$$

$$\frac{\partial f}{\partial x} = 2axy^3$$

$$\frac{\partial f}{\partial y} = 3ax^2y^2$$

$$\vec{E} = -\vec{\nabla} V$$

$$E = \left[\frac{Volt}{m}\right]$$

$$V\left[\frac{J}{C}\right] \quad [Volt]$$

$$E\left[\frac{J}{Cm}\right]$$

$$V_P = k \frac{q}{|\vec{r}_{1,P}|}$$

$$V_{B2} = \frac{k q_1}{r_{12}}$$

(0,0) (1,0)

$V_2 = V_{\text{due a 1}} + V_{\text{due a 2}}$

$V_{@1} = \frac{k q_1}{r_{1,2}}$ $V_{@2}$

$W_3 = q_3 \left(V_{@3\ \text{from 1}} + V_{@3\ \text{from 2}} \right)$

$V = k \frac{q_1}{r_{1,P}}$

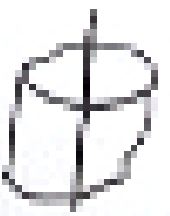
$W_4 = q_4 \left(V_{@4\ \text{from 1}} + V_{@4\ \text{from 2}} + V_{@4\ \text{from 3}} \right)$

$W = \frac{1}{2} \int V \, dq$

$\int_A^B \vec{E} \cdot d\vec{l} = -\Delta V$

$\vec{E} = -\frac{\Delta V}{\Delta x} \hat{i}$

$\Delta V = -\vec{E} \cdot \vec{\Delta l}$



$$\vec{E} = \frac{q}{4\pi\varepsilon_0 s^2}\hat{s}$$

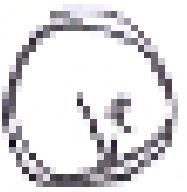
$$V = -\int_{\infty}^{r} \vec{E}\cdot d\vec{r}$$

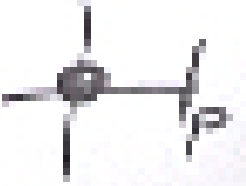
V U

ΔV ΔU

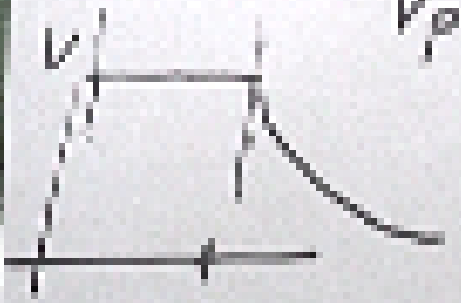
$W = q_0 V_0$

2)





$$V_p = \frac{kQ}{r_p} \quad |\vec{r}_p| = r_p$$



$$V_p = \frac{kQ}{q}$$

SWAP

$$C = \frac{Q}{V} \quad | \quad \frac{C}{V} = 1F$$

q