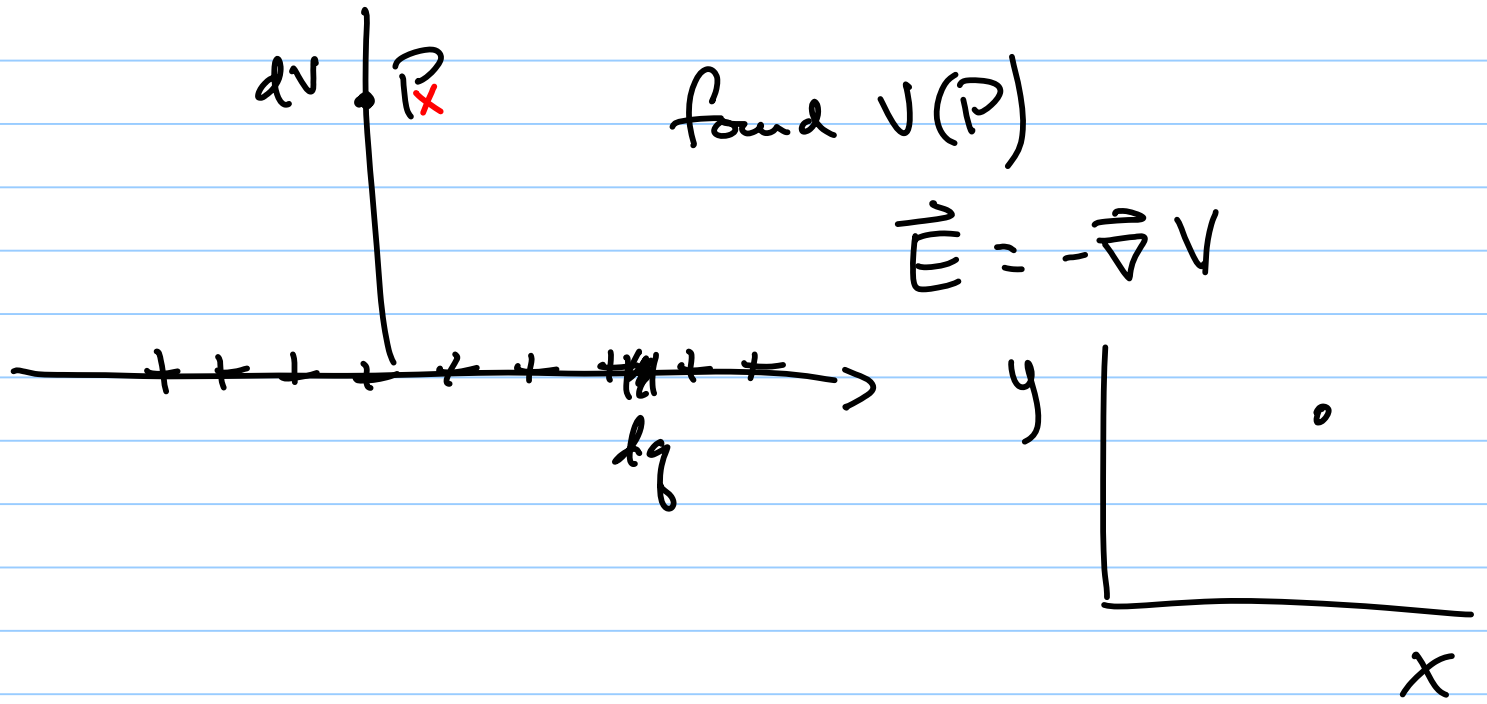
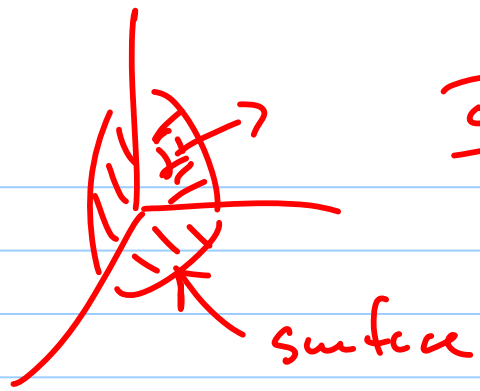
Lecture 8

Note Title 1/27/2006



found $V(P)$

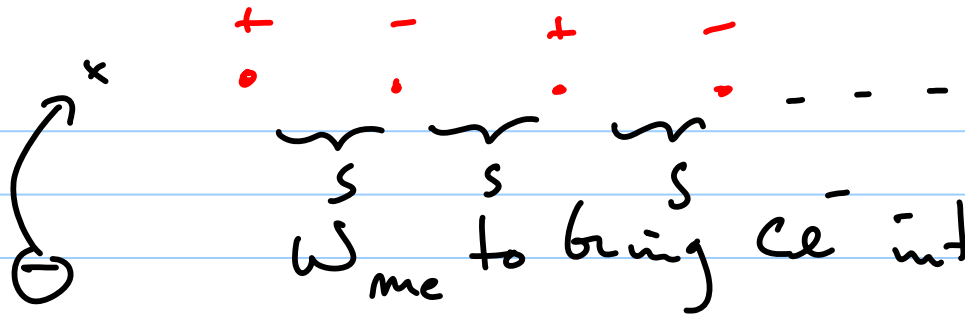
$$\vec{E} = -\vec{\nabla} V$$



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

$$\int \vec{v} \cdot \vec{v}\, d\tau = \oint \vec{v} \cdot d\vec{a}$$

$$\iint \vec{v} \cdot R^2 \sin\theta \, d\theta \, d\phi$$



W_{me} to bring e^- into this NaCl lattice (1-D)

$$W_{me} = -W_{cons} = -(-\Delta PE) = \Delta PE = q\Delta V = q(V_f - V_i)$$

($V_i = 0$)

$$V = \sum_i \frac{1}{4\pi\epsilon_0}\frac{q_i}{r_i} = \frac{1}{4\pi\epsilon_0}\left[\frac{e}{s} - \frac{e}{2s} + \frac{e}{3s} - \cdots\right]$$

$$= \frac{1}{4\pi\epsilon_0}\frac{e}{s}\left[1 - \frac{1}{2} + \frac{1}{3} \cdots\right]$$

$$W_{me} = -eV = \frac{-1}{4\pi\epsilon_0}\frac{e^2}{s}\left[1 - \frac{1}{2} + \frac{1}{3} \cdots\right]$$

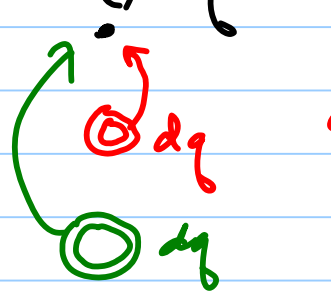
$$\ln(1+x) = 1 - \frac{x}{2} + \frac{x^2}{3} - \cdots \qquad -1 < x \le 1$$

let $x = 1$ $\qquad \ln(2) = .693$

$$W_{me} = \Delta PE = -\frac{.693}{4\pi\epsilon_0 S}$$

Crystal is stable
W_{me} is negative

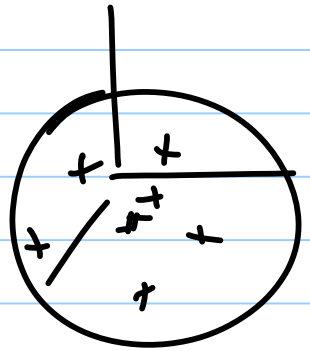
Sphere uniformly charged



$W_{me} = 0$

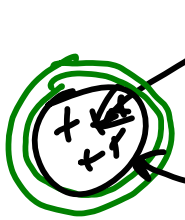
$dW_{me} = dq\,V$ ← voltage at pt where I bring charge into

$$W_{me} = \int V\,dq$$



$dq = \rho\, 4\pi r^2 dr$

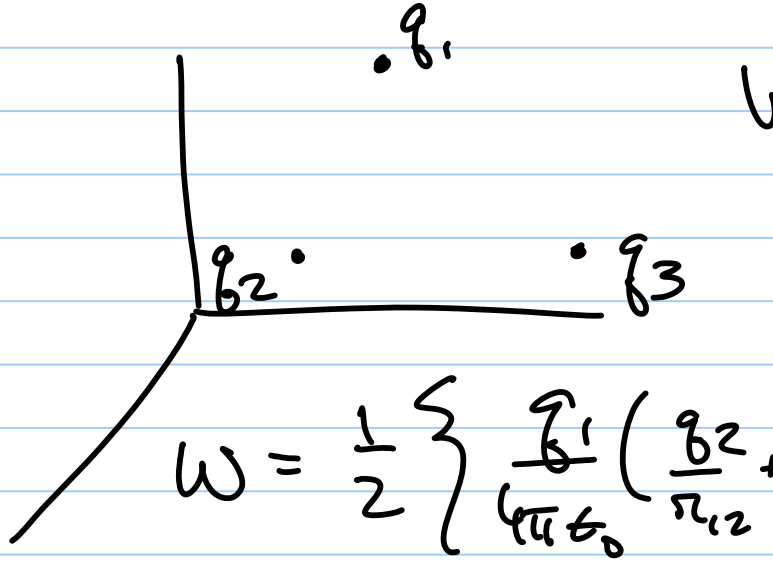
V



$$V = \frac{1}{4\pi\epsilon_0}\frac{Q}{r} = \frac{1}{4\pi\epsilon_0}\frac{\rho\frac{4}{3}\pi r^3}{r}$$

$$W_{me} = \int_0^R dr \; \text{——} = \frac{1}{4\pi\epsilon_0}\frac{3}{5}\frac{q^2}{R}$$

q total charge in sphere



$$W = k\left(\frac{q_1 q}{r_{12}} + \frac{q_1 q_3}{r_{13}} + \frac{q_2 q_3}{r_{23}}\right)$$

$$W = \frac{1}{2}\left\{\frac{q_1}{4\pi\epsilon_0}\left(\frac{q_2}{r_{12}} + \frac{q_3}{r_{13}}\right) + \frac{q_2}{4\pi\epsilon_0}\left(\frac{q_1}{r_{12}} + \frac{q_3}{r_{23}}\right) + \frac{q_3}{4\pi\epsilon_0}\left(\frac{q_1}{r_{13}} + \frac{q_2}{r_{23}}\right)\right\}$$

$$W = \frac{1}{2} q_1 \underbrace{V_{\text{at 1 due to other 2 charges}}}_{} + \frac{1}{2} q_2 \underbrace{V_{\text{at 2 due to other 2 charge}}}_{} + \frac{1}{2} q_3 \underbrace{V_{\text{at 3 due to other}}}_{}$$

$$= \frac{1}{2} \sum_i q_i V(P_i)$$

$V(P_i)$: due to all other charges

If we have uniform charge distribution

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