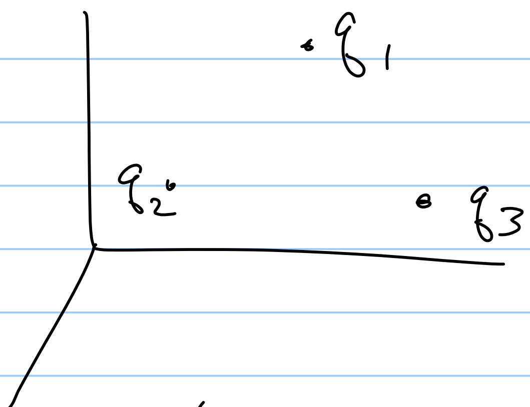
Note Title 1/19/2009

Tablet distribution Monday 12:00 → 1 or
4:30 – 5:30
Modern lab

Training session: Tues 12:00 → 1
5:30 → 6:30
MEYER HALL 220

Work in assembling charges in terms of E



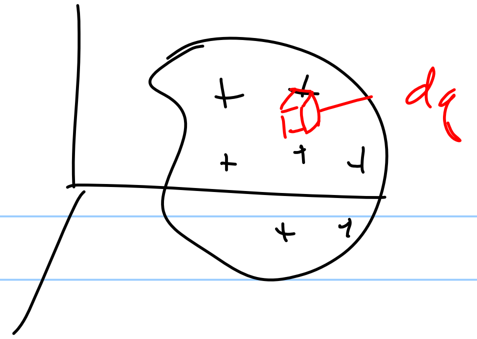
$$W = k\left(\frac{q_2 q_1}{r_{12}} + \frac{q_3 q_1}{r_{13}} + \frac{q_3 q_2}{r_{23}}\right)$$

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

V at q_1 due to other charges — V at q_2 due to other charges — V at q_3 due to other charges

$$W = \frac{1}{2}\sum_i q_i V_i \longrightarrow \frac{1}{2}\int dq\, V$$

(V) at dq due to all other charges



Change from ρ & V to E

$$W = \frac{1}{2}\int V\,dq = \frac{1}{2}\int V(\vec{r})\,\rho(\vec{r})\,d\tau$$

$d\tau$: $r^2 \sin\theta\, d\theta\, d\varphi$

$$\vec{\nabla}\cdot\vec{E} = \rho/\epsilon_0 \qquad \vec{E} = -\vec{\nabla}V \Rightarrow \nabla^2 V = -\rho/\epsilon_0$$

$$W = \frac{1}{2}\int V(r)\left[-\epsilon_0 \nabla^2 V(r)\right] d\tau$$

$V(r)$: at field point; ∇^2: w.r.t r

need $V\nabla^2 V$

$$\vec{\nabla}\cdot f\vec{A} = f\,\vec{\nabla}\cdot\vec{A} + \vec{A}\cdot\vec{\nabla}f$$ identity 5 in front of book

$f = V \qquad \vec{A} = \vec{\nabla}V$

$$\vec{\nabla}\cdot(V\vec{\nabla}V) = V\,\vec{\nabla}\cdot(\vec{\nabla}V) + \vec{\nabla}V\cdot\vec{\nabla}V$$

$$V\nabla^2 V = \vec{\nabla}\cdot V\vec{\nabla}V - (\vec{\nabla}V)^2$$

$$W = \frac{1}{2}\int V(r)\left[-\epsilon_0 \nabla^2 V(r)\right] d\tau = -\frac{\epsilon_0}{2}\left[\int \vec{\nabla}\cdot(V\vec{\nabla}V)\,d\tau - \int(\vec{\nabla}V)^2 d\tau\right]$$

$\vec{B} = V\vec{\nabla}V$

divergence theorem: $\int \vec{\nabla}\cdot\vec{B}\,d\tau = \oint \vec{B}\cdot d\vec{a}$

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

$$W = \frac{\epsilon_0}{2}\left[-\oint \underbrace{\left(V \vec{\nabla} V\right)}_{-\vec{E}}^{\vec{B}} \cdot d\vec{a} + \int E^2 \, d\tau \right] = \frac{\epsilon_0}{2}\left[\oint V \vec{E} \cdot d\vec{a} + \int E^2 \, d\tau \right]$$