Bring paper, about 1 hour ???

bring 1 sheet of paper

similar to hw . 4 or 5 questions

you're supposed to do terribly on midterms

Wave eq^{n}, no medium needed

Things depend on time. Propagator is Green's f^{n}

$$\phi(\vec{r},t) = \int d^3\vec{r}\,' \int dt' \frac{\rho(\vec{r}\,',t')}{|\vec{r}-\vec{r}\,'|} \delta\left(t'-t+\frac{|\vec{r}-\vec{r}\,'|}{c}\right)$$

$$\rho(\vec{r},t) = q\,\delta(\vec{r}-\vec{r}_0(t))$$

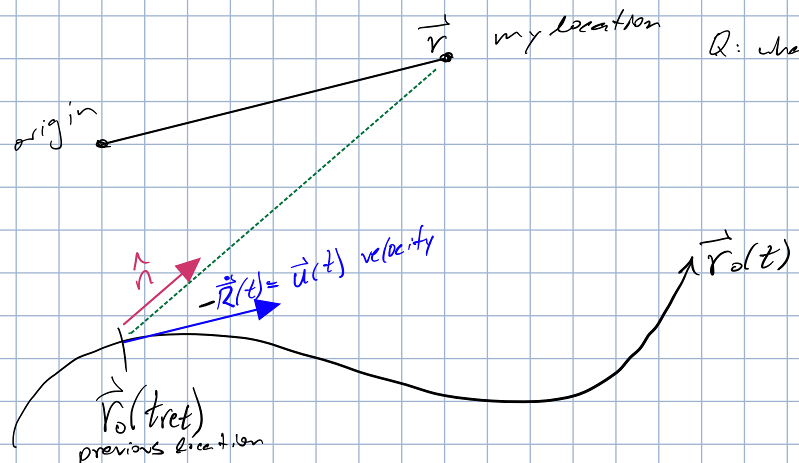
$\vec{r}_0$ - localizes particle. current pos^{n} of particle

$\to \vec{r}\,' = \vec{r}_0(t')$

$$\phi(\vec{r},t) = q\int d^3\vec{r}\,' \int \frac{dt'\,\delta(\vec{r}\,'-\vec{r}_0(t'))}{|\vec{r}-\vec{r}\,'|} \delta\left(t'-t+\frac{\vec{r}-\vec{r}\,'}{c}\right)$$

$$= q\int \frac{dt'}{|\vec{r}-\vec{r}_0(t')|} \delta\left(t'-t+\frac{|\vec{r}-\vec{r}_0(t')|}{c}\right)$$

$\vec{r}$ - my location observer



Q: what's my potential?

$\vec{r}_0(t_{ret}) = \vec{R}(t)$

$\hat{n} = \frac{\vec{R}(t)}{|\vec{R}(t)|}$

Tidy up: $\vec{R}(t') = \vec{r} - \vec{r}_0(t')$ $\quad R(t') = |\vec{R}(t')|$

$$\longrightarrow \phi(\vec{r},t) = q\int \frac{dt'}{R(t')} \cdot \delta\left(t'-t+\frac{R(t')}{c}\right)$$

$\hookrightarrow t' = \underbrace{t - \frac{R(t')}{c}} = \underbrace{t_{ret}}$

$R(t_{ret}) = c\cdot(t - t_{ret})$

change variables $t'' = t' - t + R(t')/c$

$$dt'' = dt' + \tfrac{1}{c}\dot{R}(t')dt$$

But $R^2(t') = \vec{R}(t')\cdot\vec{R}(t')$

$\frac{d}{dt}$ $\longrightarrow 2R(t')\cdot\dot{R}(t') = 2\vec{R}(t')\cdot\dot{\vec{R}}(t')$

$$= -2\vec{R}(t')\cdot\vec{u}(t)$$

$\vec{u} = -\dot{\vec{R}}(t)$

$$\dot{R}(t') = -\frac{\vec{R}(t')}{R(t')}\cdot\vec{u}(t')$$

$$\dot{R}(t') = -\hat{n}\,\vec{u}(t')$$

$$dt'' = \left[1 - \tfrac{1}{c}\hat{n}\cdot\vec{u}(t')\right]dt' \equiv K(t')dt'$$

$$\phi(\vec{r},t) = q\int\frac{dt''\,\delta(t'')}{K(t')\,R(t'')}$$

Find $t''=0 \rightarrow t = t_{ret}$

$$\phi(\vec{r},t) = \left[\frac{q}{KR}\right]$$

$$\vec{A}(\vec{r},t) = \left[\frac{q\vec{v}}{KR}\right]$$

$[\;] \rightarrow$ evaluate @ t_{ret}

Lienard-Wiechart potentials

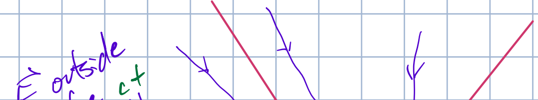
$\vec{\beta} = \frac{\vec{u}}{c}$

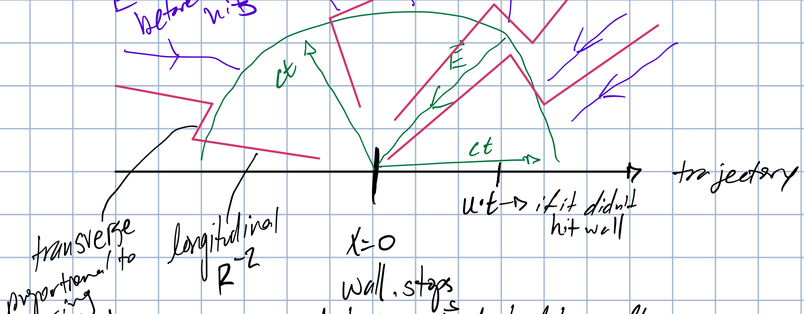
corrections to electrostatic
if particle is moving
similar to OG Coulomb: $\frac{q}{R}$

I want to dead

$$\vec{E}(\vec{r},t) = \underbrace{q\left[\frac{(\vec{n}-\vec{\beta})(1-\beta^2)}{K^3R^2}\right]}_{E_{rel}} + \underbrace{\frac{q}{c}\left[\frac{\vec{n}}{K^3R}\times\left\{(\vec{n}-\vec{\beta})\times\dot{\vec{\beta}}\right\}\right]}_{E_{rad}}$$

$$\vec{B} = \vec{n}\times\vec{E}(\vec{r},t)$$





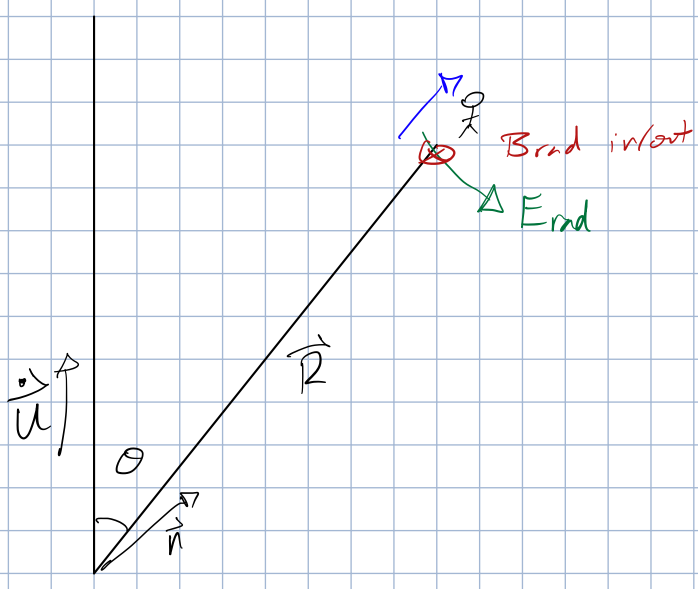
what does $\vec{E}$ look like after it hits wall?

Radiation from Non Relativistic charges

$|\beta| \ll 1 \longrightarrow \kappa \approx 1$

$$\vec{E}_{rad} = \frac{q}{Rc^2} \; \vec{n} \times (\vec{n} \times \dot{\vec{u}})$$

$$\vec{B}_{rad} = \vec{n} \times \vec{E}_{rad}$$



$$|\vec{E}_{rad}| = |\vec{B}_{rad}| = \frac{q\dot{u}}{Rc^2} \sin^2\theta$$

Poynting vector: $(\vec{E} \times \vec{B})$ ★ along $\vec{n}$

energy flow $\quad S = \frac{c}{4\pi} \left(\frac{q\dot{u}}{Rc^2}\right)^2 \sin^2\theta \qquad \frac{\text{energy}}{\text{area} \cdot \text{time}}$

$$\frac{dW}{dt\,dA} = \frac{dW}{dt\,d\Omega \cdot R^2} \quad b/c \quad dA = R^2 d\Omega$$

$$\frac{dW}{dt\,d\Omega} = \frac{q^2 \dot{u}^2}{4\pi c^3} \sin^2\theta$$

Want all power

$$P = \frac{dW}{dt} = \frac{q^2 \dot{u}^2}{4\pi c^3} \int d\Omega \sin^2\theta$$

$$= \frac{q^2 \cdot \dot{u}^2}{2c^3} \cdot \int_{-1}^{1} (1-\mu^2)\, d\mu$$

$$P_{Total} = \frac{2 q^2 \dot{u}^2}{3c^3}$$