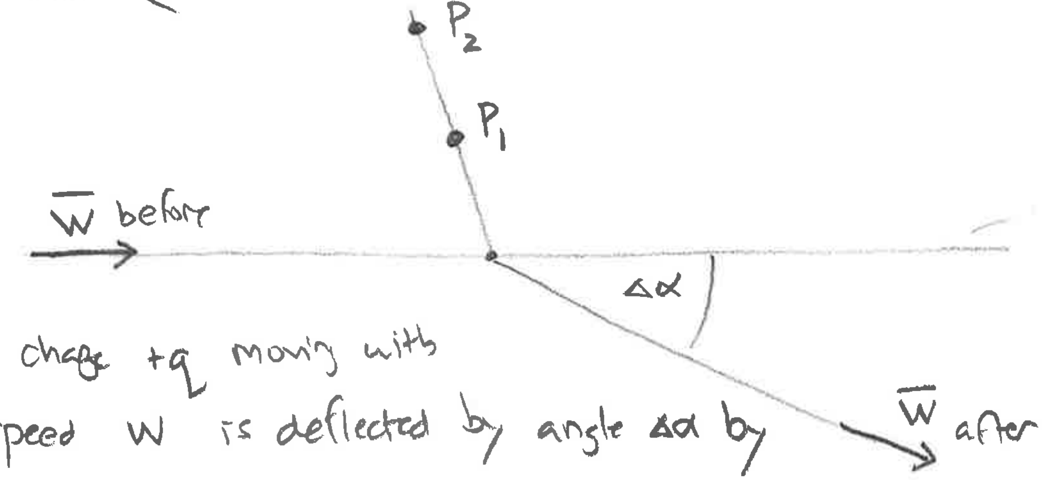
BB 4.2 (Radiation from a deflected moving charge.)



A charge $+q$ moving with speed W is deflected by angle $\Delta\alpha$ by a force acting for a short time Δt.

a) What is the direction of the radiated electric field at point P_1? Answer: it will be anti-parallel to the perpendicular component of the acceleration.

b) The intensity of the radiation will be most intense in a direction perpendicular to the acceleration. This will be approximately in the direction of the velocity of the charge, $\bar{W}$. (If $\Delta\alpha$ is small, then $\bar{W}_{before} \approx \bar{W}_{after}$.)

c) It will be least intense in a direction perpendicular to the velocity $\bar{W}$, or along the acceleration vector $\bar{a}$.

d) Since the radiated intensity $I \propto \frac{1}{r^2}$,

and since the magnetic field strength $B \propto \frac{1}{r}$,

when the distance is doubled, the magnetic field strength is halved.

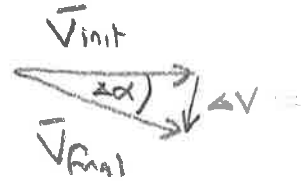
e) How much energy is emitted as radiation by this? If Δt is small, then the energy radiated is given by

$$\text{Energy} = \text{Power} \times \Delta t$$

$$E = \frac{q^2 a^2}{6\pi \epsilon_0 c^3} \Delta t$$

What is the acceleration, a? $\quad a = \frac{\Delta V}{\Delta t}$

What is ΔV?



If $V_{init} = V_{final}$ (in magnitude) then $\Delta V = V \Delta\alpha$ (for small $\Delta\alpha$).

So $\quad a = \frac{V \Delta\alpha}{\Delta t} \quad$ and $\quad E = \frac{q^2 V^2 \Delta\alpha^2}{6\pi \epsilon_0 c^3 \Delta t^2} \Delta t$

And the radiated energy is

$$\boxed{E = \frac{q^2 V^2 \Delta\alpha^2}{6\pi \epsilon_0 c^3 \Delta t}}$$