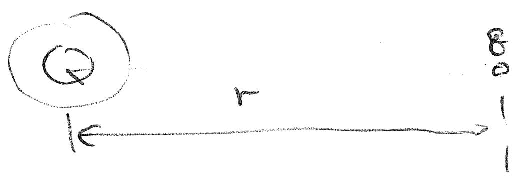
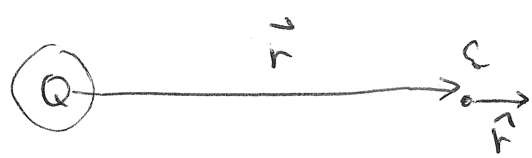
WEEK 2 (FALL 2010)

[LAST WEEK 23.1 23.4
23.2 23.6
23.3 23.7]

[THIS WEEK 24]

LAST TIME





$$\vec{F}_{Qq} = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{|\vec{r}|^2}\hat{r}$$

~~ACTIVE FIGURE~~

$$\vec{E}_Q = \frac{\vec{F}_{Qq}}{q} = \frac{1}{4\pi\varepsilon_0}\frac{Q}{|\vec{r}|^2}\hat{r}$$ ELECTRIC FIELD

ACTIVE FIGURE 23.11

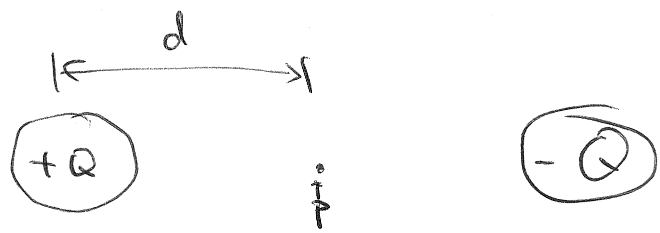
POINTS "RADIALLY OUTWARD"

ACTIVE FIGURE 23.22 ALSO

O.K. ONE CHARGE ONLY IS EASY. BUT WHAT HAPPENS IF THERE ARE MORE CHARGES

EXAMPLE

#1



WHAT IS $\vec{E}$ AT POINT P

TEST CHARGE

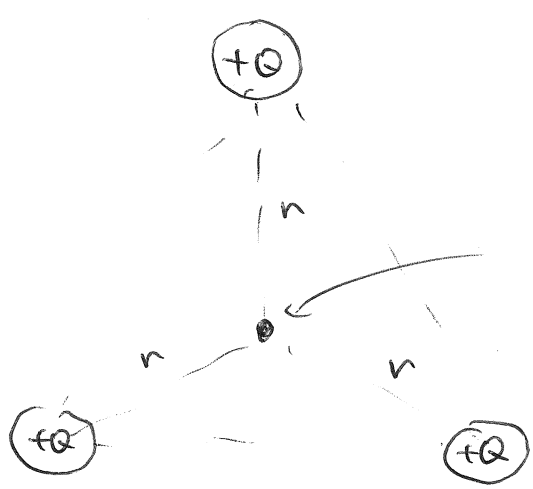
q_0

$$\vec{E}_{total} = \frac{1}{4\pi\epsilon_0}\frac{Qq}{d^2}\hat{x} + \frac{1}{4\pi\epsilon_0}\frac{-Qq}{d^2}\hat{x}$$

$$\vec{E}_{total} = 0 \Rightarrow \vec{E} = 0$$

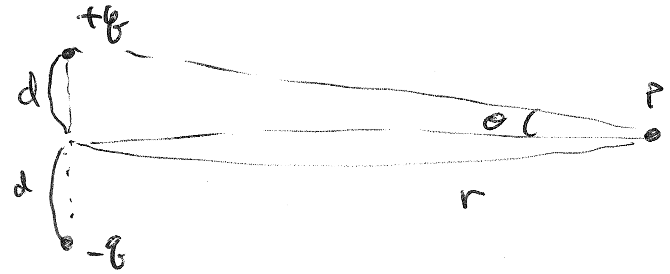
This is a mistake. These fields add rather than cancel because the sign of electric field is the same

#2

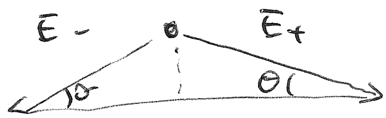


0 FIELD HERE TOO

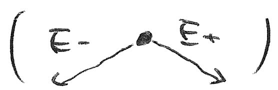
#3



WHAT IS THE ELECTRIC FIELD AT POINT P?

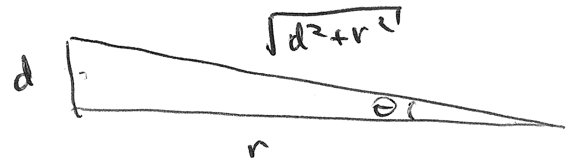


$$|\vec{E_+}| = \frac{1}{4\pi\varepsilon_0}\frac{q}{\left(\sqrt{r^2+d^2}\right)^2} = |\vec{E_-}|$$



SO X COMPONENTS CANCEL EACH OTHER

ONLY Y COMPONENTS ADD



∴ Y COMPONENT

$$E_{+y} = |\vec{E_+}|\frac{d}{\sqrt{d^2+r^2}}$$

$$|\vec{E_+} + \vec{E_y}| = 2E_{+y} = 2\cdot\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2+d^2}\frac{d}{\sqrt{r^2+d^2}}$$

$$= \frac{1}{2\pi\varepsilon_0}\frac{qd}{(r^2+d^2)^{3/2}}$$

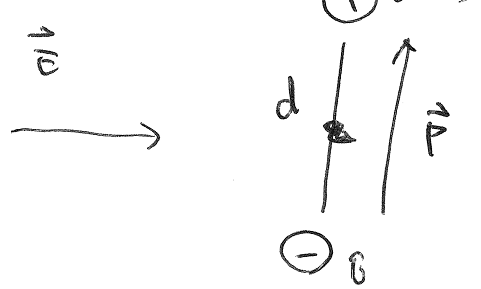
WHAT HAPPENS IF $|\vec{r}| \to \infty$?

$$\lim_{r \to \infty} |E_{TOTAL}| = \frac{1}{2\pi\varepsilon_0} \frac{qd}{r^3}$$

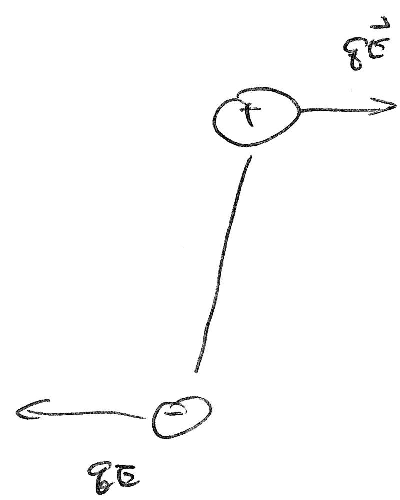
$$E \sim \frac{1}{r^3}$$

ELECTRIC FIELD (MAGNITUDE) GO AS $\frac{1}{r^3}$ AT LARGE DISTANCES

ELECTRIC DIPOLE



$|\vec{p}| = qd$



APPLIES TORQUE $\vec{\tau} = \vec{p} \times \vec{E}$

EXAMPLE WATER