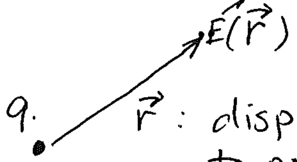
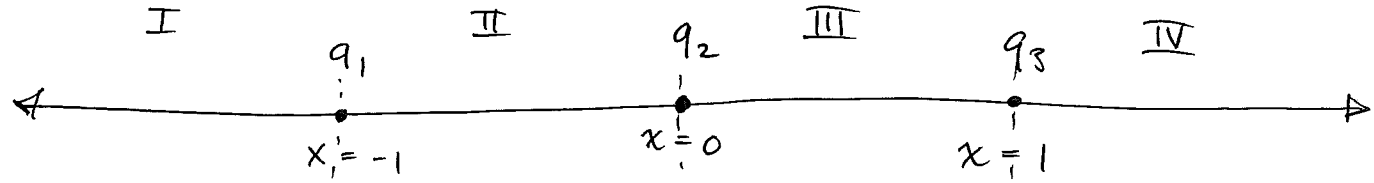
Problem 7:



$\vec{r}$: displacement from charge to position of $\vec{E}$ calculation.

Unit vectors are tricky: $\hat{r}_1, \hat{r}_2, \hat{r}_3$ are unit vector for each charge.



$\hat{r}_1 = \hat{r}_2 = \hat{r}_3 = -\hat{x}$

$\hat{r}_1 = \hat{x}$, $\hat{r}_2 = \hat{r}_3 = -\hat{x}$

$\hat{r}_1 = \hat{r}_2 = \hat{x}$, $\hat{r}_3 = -\hat{x}$

$\hat{r}_1 = \hat{r}_2 = \hat{r}_3 = \hat{x}$

So, each region I – IV has a different Eqn for $\vec{E} = 0$:

Region I: $x < -1$:

$$\frac{\vec{E}(\vec{x})\cdot\hat{x}}{k} = 0 = -\frac{q_1}{(x+1)^2} + -\frac{q_2}{x^2} - \frac{q_3}{(x-1)^2}$$

Region II: $-1 < x < 0$:

$$\frac{\vec{E}(\vec{x})\cdot\hat{x}}{k} = 0 = +\frac{q_1}{(x+1)^2} - \frac{q_2}{x^2} - \frac{q_3}{(x-1)^2}$$

Region III: $0 < x < 1$

$$\frac{\vec{E}(\vec{x})\cdot\hat{x}}{k} = 0 = +\frac{q_1}{(x+1)^2} + \frac{q_2}{x^2} - \frac{q_3}{(x-1)^2}$$

Region IV: $1 < x$

$$\frac{\vec{E}(\vec{x}) \cdot \hat{x}}{k} = 0 = \frac{+q_1}{(x+1)^2} + \frac{q_2}{x^2} + \frac{q_3}{(x-1)^2}$$

Region III was relevant for answering the question.

for instance $q_1 = -6$ $q_2 = 1$ $q_3 = 6$

See plots...

Remember: $\frac{\hat{r}}{r^2} = \frac{\vec{r}}{r^3}$

if you use this form, there is no funny business w/ unit vectors.

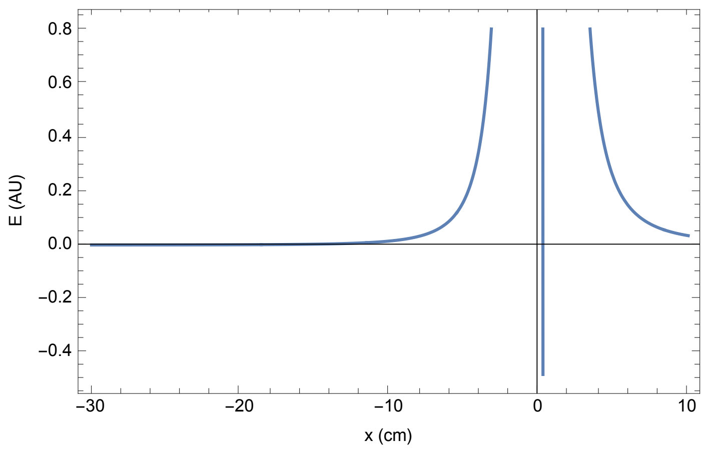
In[41]:=

$$\texttt{Plot}\left[\frac{-6\,(x+1)}{\texttt{Abs}[x+1]^3}+\frac{x}{\texttt{Abs}[x]^3}+\frac{6\,(x-1)}{\texttt{Abs}[x-1]^3},\ \{x,\,-30,\,10\},\ \texttt{Frame}\to\texttt{True},\ \texttt{Exclusions}\to x\,(1+x)\,(x-1)==0,\ \texttt{FrameLabel}\to\{\text{"x (cm)"},\ \text{"E (AU)"}\}\right]$$

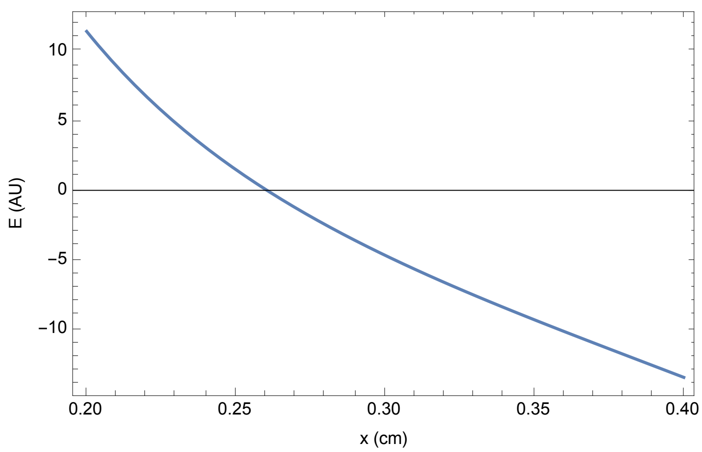
$$\texttt{Plot}\left[\frac{-6\,(x+1)}{\texttt{Abs}[x+1]^3}+\frac{x}{\texttt{Abs}[x]^3}+\frac{6\,(x-1)}{\texttt{Abs}[x-1]^3},\ \{x,\,.2,\,.4\},\ \texttt{Frame}\to\texttt{True},\ \texttt{Exclusions}\to x\,(1+x)\,(x-1)==0,\ \texttt{FrameLabel}\to\{\text{"x (cm)"},\ \text{"E (AU)"}\}\right]$$

$$\texttt{Plot}\left[\frac{-6\,(x+1)}{\texttt{Abs}[x+1]^3}+\frac{x}{\texttt{Abs}[x]^3}+\frac{6\,(x-1)}{\texttt{Abs}[x-1]^3},\ \{x,\,-30,\,-20\},\ \texttt{Frame}\to\texttt{True},\ \texttt{Exclusions}\to x\,(1+x)\,(x-1)==0,\ \texttt{FrameLabel}\to\{\text{"x (cm)"},\ \text{"E (AU)"}\}\right]$$

Out[41]=



Out[42]=



Out[43]=