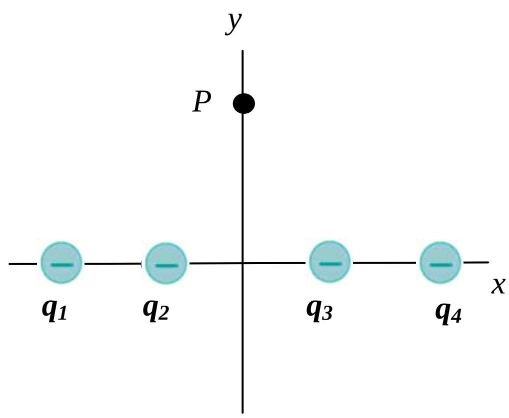
Problem Solving Practice – Electric Field

Q1.

a) Finding the net electric field (both magnitude and direction) of the four point charges $q_1= q_2= q_3= q_4=-q$ at position P. $q_1=(-2L, 0)$, $q_2=(-L, 0)$, $q_3=(+L, 0)$, $q_4=(+2L, 0)$, $P=(0, y)$.



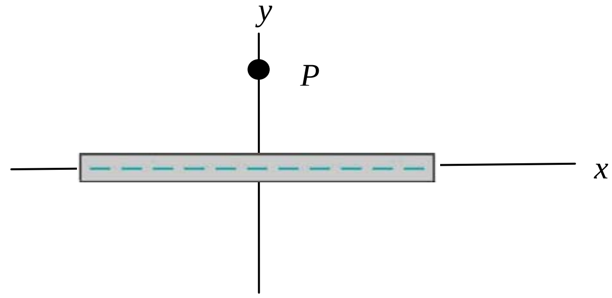
b) What is the electric field at P when the $y<<L$? Does the answer make sense to you conceptually and mathematically?

c) What is the electric field at P when the $y>>L$? Does the answer make sense to you conceptually and mathematically? Please elaborate.

Please write your group solution clearly on the white board with proper figures and check with your discussion instructor before you move on to the next page.

Q2. A charged thin rod of length 2L with total charge -Q spread uniformly as shown below.

a) Find the net electric field at position P(0, y).



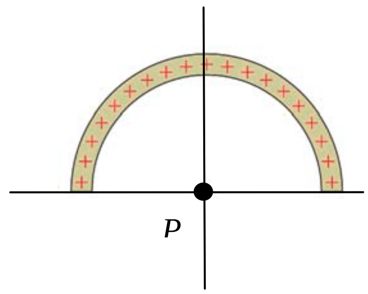
b) Do you use integration? If so, why? If not, why not?

c) What is the electric field at P when the y>>L? Does the answer make sense to you conceptually and mathematically? Please elaborate.

Useful integrals: $\int \frac{dx}{a+x} = \ln(a+x)$, $\int \frac{xdx}{a+x} = x - a\ln(a+x)$, $\int \frac{dx}{\sqrt{x^2 \pm a^2}} = \ln\left(x + \sqrt{x^2 \pm a^2}\right)$,

$\int \frac{xdx}{\sqrt{x^2 \pm a^2}} = \sqrt{x^2 \pm a^2}$, $\int \frac{dx}{x^2 + a^2} = \frac{1}{a}\tan^{-1}\left(\frac{x}{a}\right)$, $\int \frac{dx}{\left(x^2 \pm a^2\right)^{3/2}} = \frac{\pm x}{a^2\sqrt{x^2 \pm a^2}}$, $\int \frac{xdx}{\left(x^2 \pm a^2\right)^{3/2}} = -\frac{1}{\sqrt{x^2 \pm a^2}}$

Q3. A semi-circle charged thin rod of radius R with total charge +Q spread uniformly as shown below. Find the net electric field at position P.



b) Do you use integration? If so, why? If not, why not?

Useful integrals: $\int \frac{dx}{a+x} = \ln(a+x)$, $\int \frac{xdx}{a+x} = x - a\ln(a+x)$, $\int \frac{dx}{\sqrt{x^2 \pm a^2}} = \ln\left(x + \sqrt{x^2 \pm a^2}\right)$,

$\int \frac{xdx}{\sqrt{x^2 \pm a^2}} = \sqrt{x^2 \pm a^2}$, $\int \frac{dx}{x^2 + a^2} = \frac{1}{a}\tan^{-1}\left(\frac{x}{a}\right)$, $\int \frac{dx}{\left(x^2 \pm a^2\right)^{3/2}} = \frac{\pm x}{a^2\sqrt{x^2 \pm a^2}}$, $\int \frac{xdx}{\left(x^2 \pm a^2\right)^{3/2}} = -\frac{1}{\sqrt{x^2 \pm a^2}}$