Note Title 8/31/2012

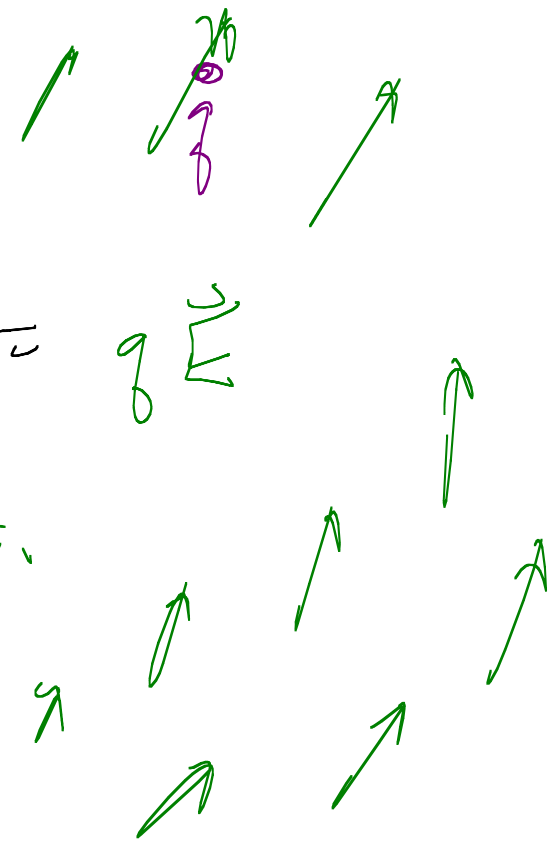
Phys 2120-4 8/31/12

Ch 20 Electric field.

$\vec{E}$ vector N/C $\vec{F} = q\vec{E}$

$\vec{E}$ has a value at each point.

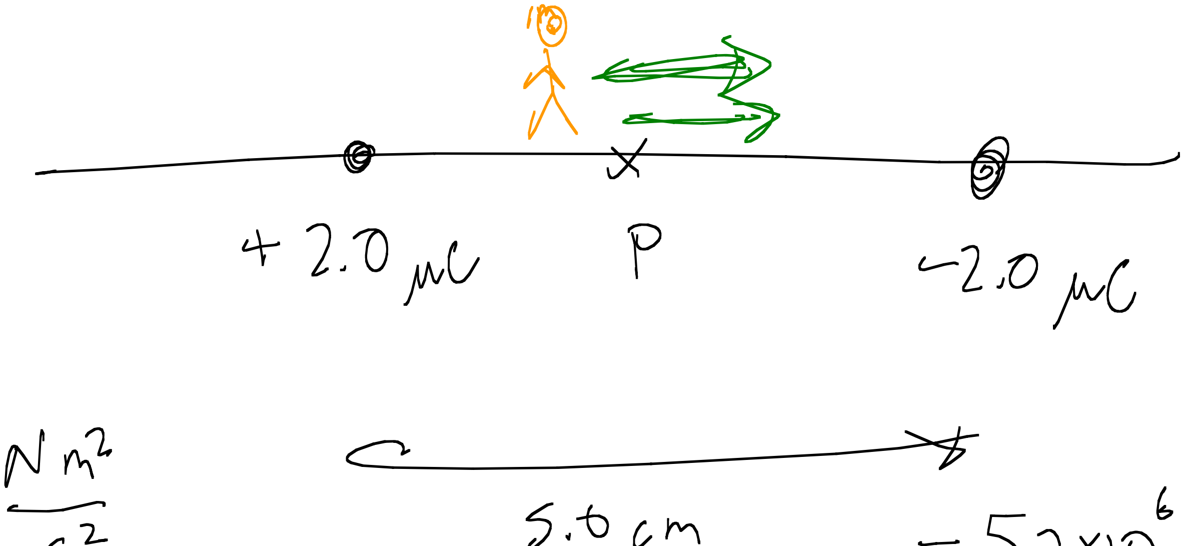
$\vec{E}(\vec{r})$



20.27

c) From pt charge

$$|\vec{E}| = \frac{k|q|}{r^2}$$



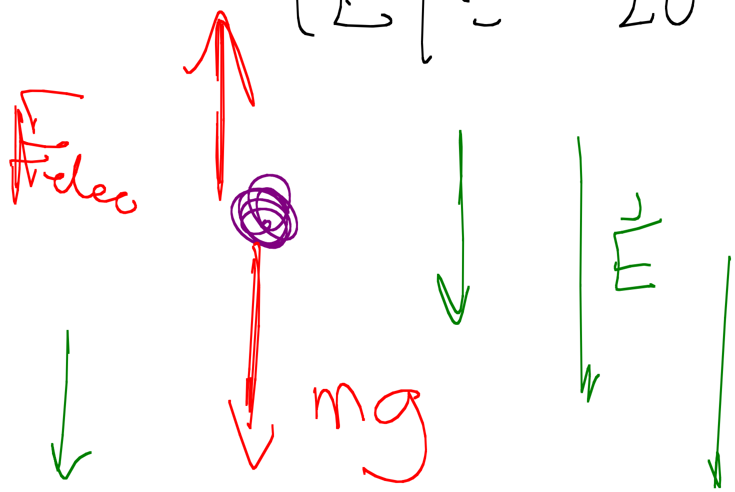
$$k = 9.0\times10^{9}\ \frac{Nm^2}{C^2}$$

$$\vec{E} = \frac{2\left(9.0\times10^{9}\ \frac{Nm^2}{C^2}\right)\left(2.0\times10^{-6}\ C\right)}{\left(2.5\times10^{-2}\ m\right)^2} = 5.2\times10^{6}\ \frac{N}{C}\ \hat{i}$$

20.32 Oil drop, Millikan

What mass of drops?

$|\vec{E}| = 20\ MN/C = 20 \times 10^6\ \frac{N}{C}$



10 elementary charges

? $q = 10\left(-1.6 \times 10^{-19}\ C\right)$

$= -1.6 \times 10^{-18}\ C$

$\vec{F} = q\vec{E}$

$mg = |q|E$

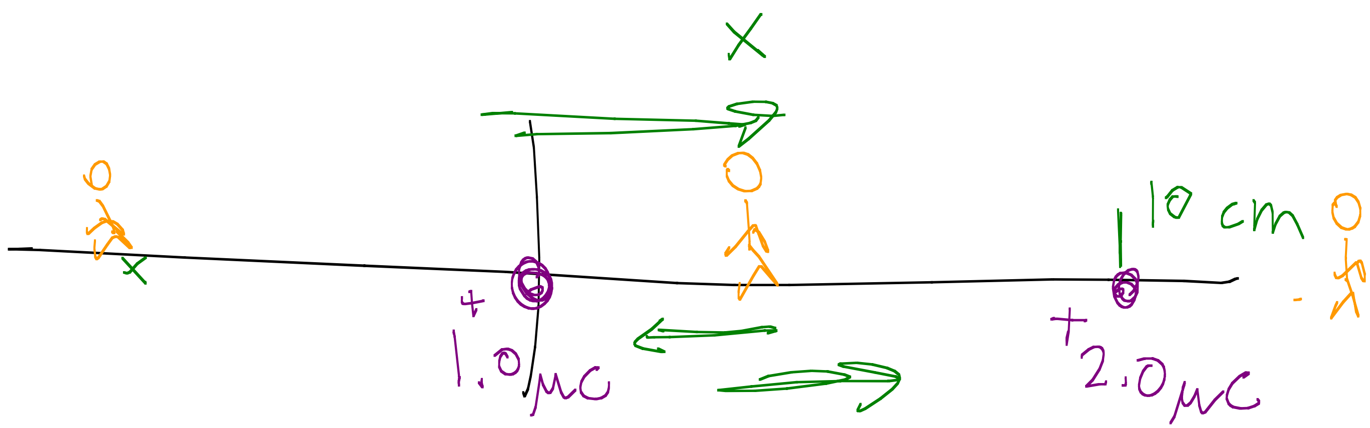
$$mg = |q|E$$

$$m = \frac{qE}{g} = \frac{(1.6\times10^{-18}\ C)(20\times10^{6}\ \frac{N}{C})}{9.8\ \frac{m}{s^2}}$$

$$= 3.26\times10^{-12}\ kg$$

Assume $\rho = 0.9199\ \frac{g}{cm^3}$ $\Longrightarrow$ $R = 9.46\ \mu m$

20.46 A 1.0 μC charge and 2.0 μC charge are 10 cm apart. Find a point where the field is zero



$$E_x = +k\frac{(1.0\times10^{-6}C)}{x^2} - k\frac{(2.0\times10^{-6}C)}{(10\times10^{-2}cm - x)^2} = 0$$

Do algebra k's cancel,

$(1.0\mu C)(0.1$

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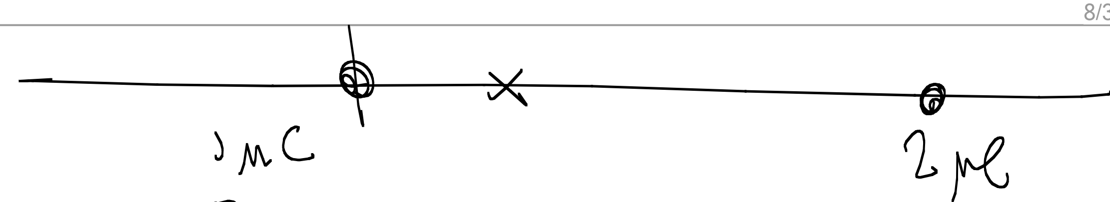


$$(1.0\,\cancel{\mu C})(0.10\,m - x)^2 = (2.0\,\cancel{\mu C})\,x^2$$

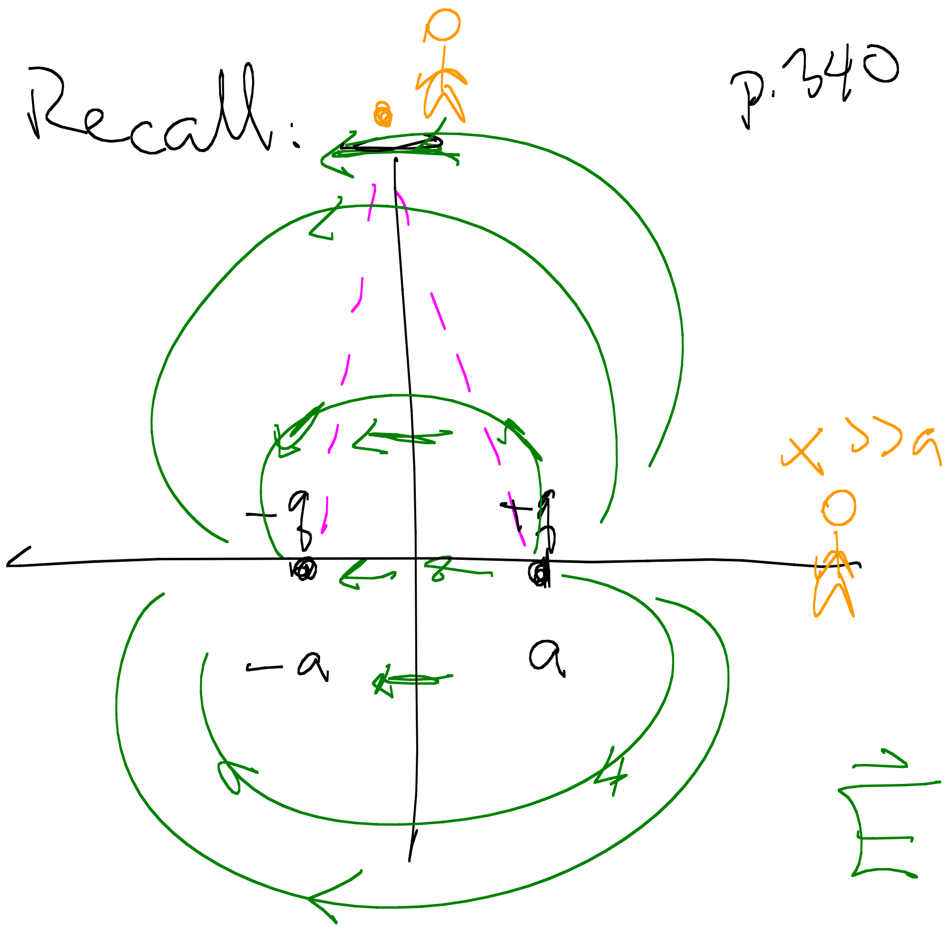
Take sqrt root

$$(0.10\,m - x) = \sqrt{2}\,x$$

$$\Rightarrow 0.10\,m = (\sqrt{2}+1)\,x$$

$$x = 4.1\,cm$$

Recall:



p. 340 Find field value

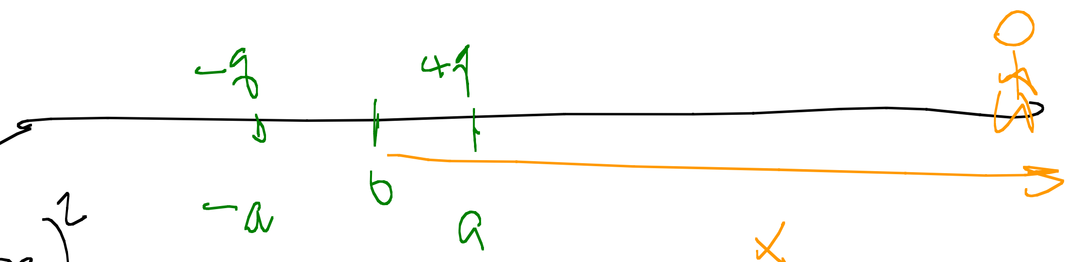
$$\vec{E} = \frac{-2kqa}{(a^2+y^2)^{3/2}}\,\hat{i}$$

Spot $y \gg a$

$$\vec{E} \approx \frac{-2kqa}{y^3}\,\hat{i}$$

20.80 Find field when little man is on x-axis

$x \gg a$



$$E_x = k\frac{q}{(x-a)^2} - k\frac{q}{(x+a)^2}$$

$$= \frac{kq}{x^2}\left[\frac{1}{(1-\frac{a}{x})^2} - \frac{1}{(1+\frac{a}{x})^2}\right] = \frac{kq}{x^2}\left[\left(1+\frac{a}{x}\right)^{-2} - \left(1+\frac{a}{x}\right)^{-2}\right]$$

$$\left(1+\frac{a}{x}\right)^{-2} \qquad \frac{a}{x} \text{ small}$$

$$\approx 1-2\frac{a}{x}$$

Use this

$$(1+x)^n = 1+nx+\cdots$$

$$\approx 1+nx$$

x small

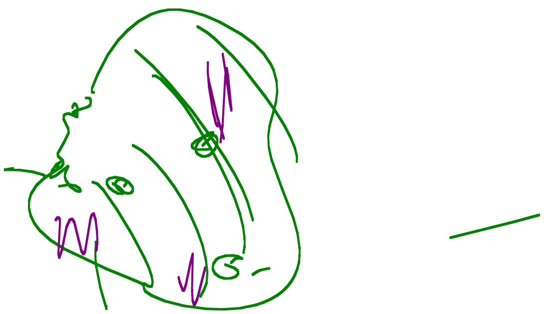
$x \ll 1$

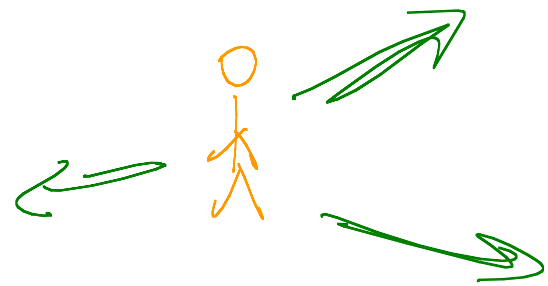
$$2qa = p$$

$$E_x = \frac{kq}{x^2}\left[1+\frac{2a}{x}-\left(1-\frac{2a}{x}\right)\right]$$

$$= \frac{kq}{x^2}\,4\frac{a}{x} = \frac{2k(2qa)}{x^3} = \frac{2kp}{x^3}$$

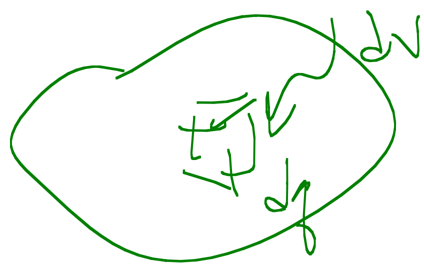
Continuous Charge Distributions



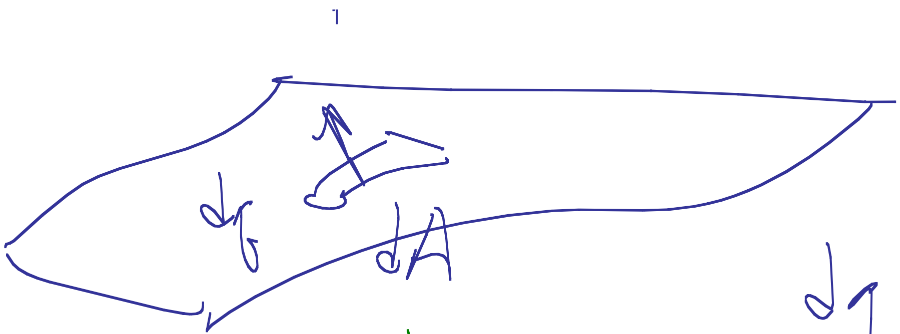


Charge density, charge per volume

$\rho(\vec{r})$

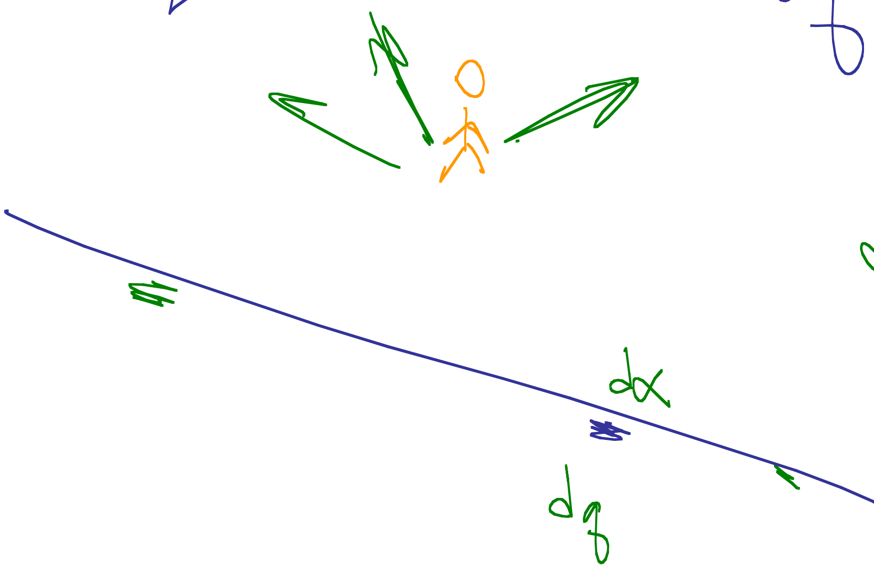


$dq = \rho(\vec{r})\, dV$



Sheet of charge

$$dq = \sigma(\vec{r})\, dA$$



$$dq = \lambda\, dx$$

Example 20.7

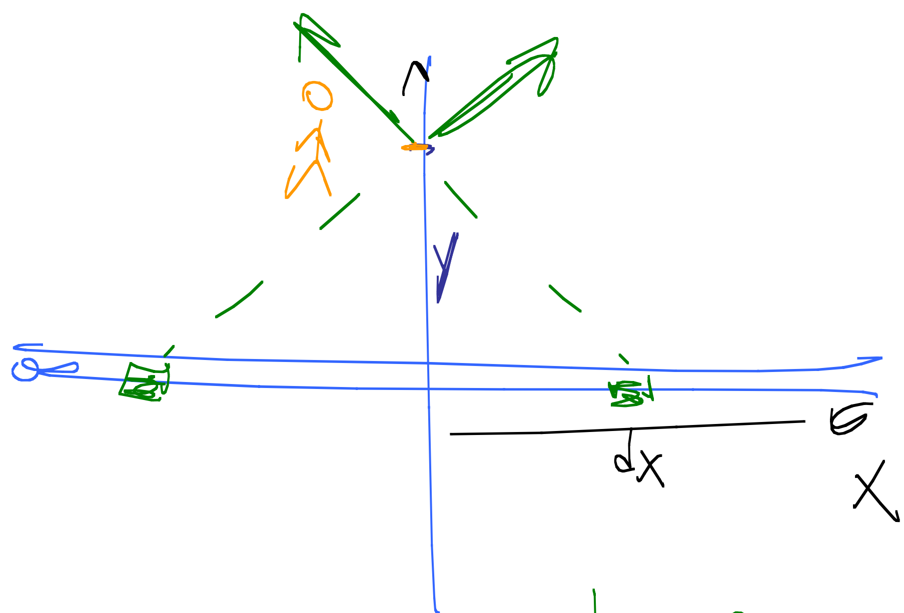
Long elec. power line

Uniform ch. density

λ

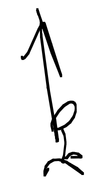
y-components

$$dE_y = \frac{k\lambda y}{(x^2+y^2)^{3/2}}\,dx \longrightarrow \int_{-\infty}^{\infty}$$

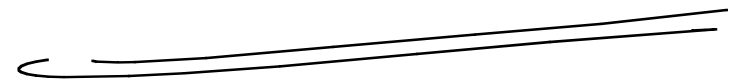


$dq = \lambda\, dx$

Got $E_y = \frac{2k\lambda}{y}$

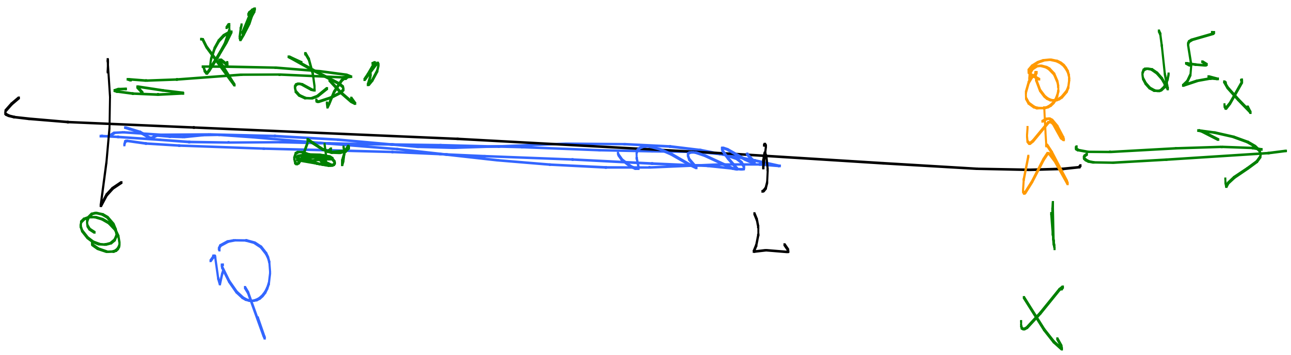


2.55 A thin rod lies on



x-axis between $x=0$ and $x=L$ has total charge Q

Show that for $x > L$ is ....



Distance from man $= x - x'$

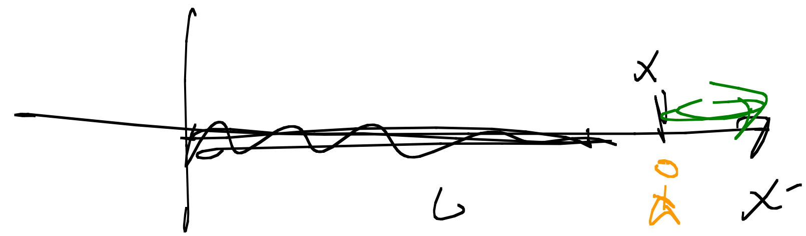
A little piece

$$\lambda = Q/L$$

$$dE_x = k \frac{\lambda\, dx'}{(x - x')^2}$$

$$\lambda\, dx' = dq'$$

$$E_x = \int_0^L k \frac{\lambda \, dx'}{(x - x')^2}$$



$$\lambda = Q/L$$

$$= k\lambda \left(\frac{+1}{(x - x')} \right) \Bigg|_0^L$$

$$= k\lambda \left(\frac{1}{x - L} - \frac{1}{x} \right) = \frac{kQ}{x(x-L)}$$

etc.