Chp 21

Electric Force

Grav.
weak
Strong.

$$\frac{e^{-\alpha r}}{r^2}$$

$$\vec{F} = G\frac{m_1 m_2}{r^2}\hat{r}$$

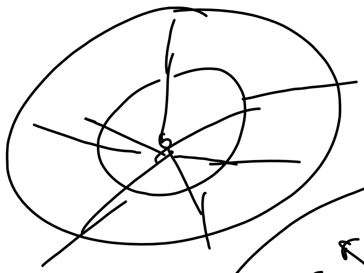
$$\vec{F} = \underbrace{\frac{1}{4\pi\epsilon_0}}_{k}\frac{q_1 q_2}{r^2}\hat{r}$$

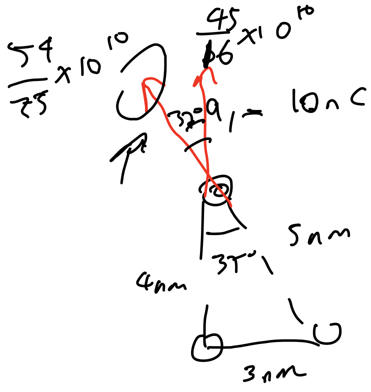
$$\epsilon_0 \mu_0 = \frac{1}{c^2}$$

$$\hat{r} = \frac{\vec{r}}{|\vec{r}|}$$

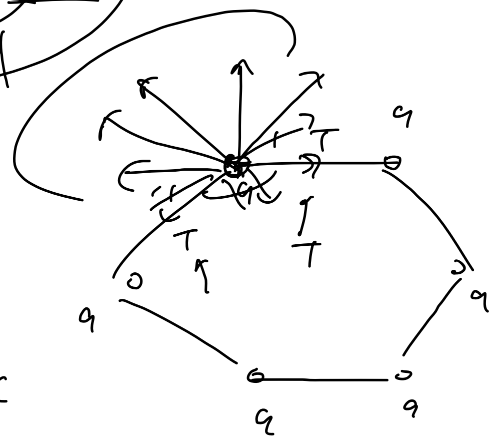
$m > 0$

$q = \pm, 0$





$q_3 = 6nC$

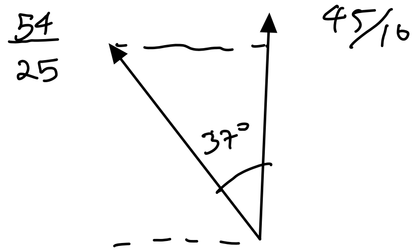


$$|\vec{F}_{q_1 q_2}| = 9\times 10^9 \times \frac{5\times 10 \times \cancel{10^{-18}}}{4^2 \times \cancel{10^{-18}}} = \frac{45\times 10}{16}\times 10^9$$

$$\frac{45}{16}\times 10^{10}$$

$$|\vec{F}_{q_1 q_3}| = 9\times 10^9 \times \frac{10\times 6\times \cancel{10^{-18}}}{25\times \cancel{10^{-18}}}$$

$$= \frac{54}{25}\times 10^{10}$$



$$\sqrt{F_{Tx}^2 + F_{Ty}^2} = F_T$$

$$\frac{\int dm\, r}{\int dm} = r_{cm}$$

$$I = \int r^2\, dm$$

$$\frac{m_1 r_1 + \cdots}{m_1 + \cdots}$$

$$\int r^2\, dm = dI$$

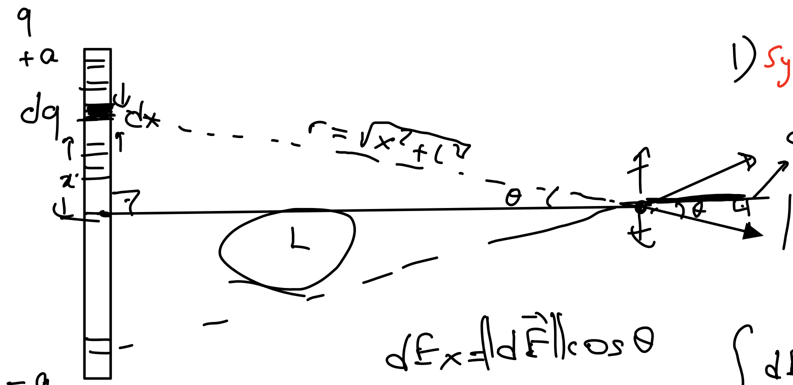
$\vec{E}(\vec{r}, t)$

$T(\vec{r}, t)$

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

$$\vec{F} = k\frac{q_1 q_2}{r^2}\hat{r}$$

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



1) Symmetric wrt $y = 0$ axis

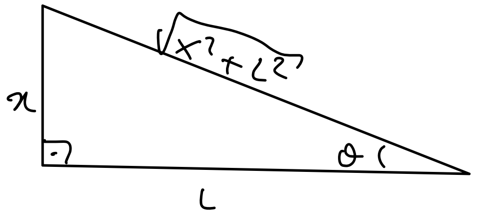
$$dE_x = dE\cos\theta$$

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

$$dE_x = |d\vec{E}|\cos\theta$$

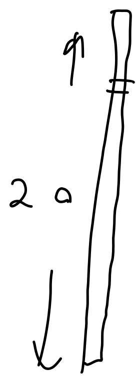
$$\int dE_y = 0$$

$$2\cdot\int_0^a dE_x = \int \frac{k\, dq}{(x^2 + L^2)^{r}} \cos\theta$$



$$\cos\theta = \frac{L}{\sqrt{x^2+L^2}}$$

$$E_T = 2\int_0^a \frac{k\,dq \cdot L}{(x^2+L^2)^{3/2}}$$



q — 2a

? — dx

$$dq = dx\,\frac{q}{2a}$$

λ

1D - charge density

$$\frac{Q}{\cancel{K}} \cdot \cancel{K} = Q$$

1D $dq = \lambda\, dx$

2D $dq = \sigma\, dA$

3D $\underline{dq = \rho\, dV}$ $\Rightarrow$ $\rho = \frac{Q}{V}$

$$\frac{M}{V} = \rho$$

$\lambda(x) = \lambda_0(1+\alpha x)$

$\lambda_0 \sin(\alpha \cancel{x})$

$$E = 2k\int_0^a \frac{\overbrace{\lambda dx}^{dq} \cdot L}{(x^2+L^2)^{3/2}} = 2k\lambda L \int_0^a \frac{dx}{(x^2+L^2)^{3/2}}$$

$$\int x^n dx =$$

$$\int \sin x \, dx$$

$$\int e^x dx$$

$$1 + \tan^2\theta = 1 + \frac{\sin^2}{\cos}$$

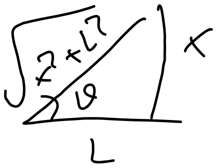
$$\frac{\cos^2 + \sin^2}{\cos^2} = \frac{1}{\cos^2}$$

$$x = L\tan\theta \qquad dx = L\, d(\tan\theta) = \frac{L\, d\theta}{\cos^2\theta}$$

$$d\left(\frac{\sin\theta}{\cos\theta}\right) = (1 + \tan^2\theta)\, d\theta$$

$$\sin\theta \frac{1}{\cos\theta} \Rightarrow \cos\theta \cdot \frac{1}{\cos\theta} + \sin\theta \frac{+\sin\theta}{\cos^2\theta}$$

$$\int \frac{dx}{\underbrace{(x^2+L^2)}^{3/2}} = \int \frac{L\,d\theta/\cos^2\theta}{\left(L^2/\cos^2\theta\right)^{3/2}}$$

$x = L\tan\theta \rightarrow$ 

$$x^2+L^2 = L^2\tan^2\theta + L^2 = L^2(1+\tan^2\theta) = \frac{L^2}{\cos^2\theta}$$

$$\int \frac{\cancel{L}\,\frac{d\theta}{\cancel{\cos^2\theta}}}{L^{\cancel{3}}/\cos^{\cancel{3}}\theta} = \frac{2k\lambda L}{L^2}\int \underbrace{\cos\theta\, d\theta}_{\sin\theta}$$

$$\frac{\cancel{2}kQ\cancel{L}}{\cancel{2}a\,L\cancel{x}}\left.\frac{x}{\sqrt{x^2+L^2}}\right|_0^a \Rightarrow \frac{a}{\sqrt{a^2+L^2}}$$

$$\frac{kQ}{\cancel{a}\cdot L}\,\frac{\cancel{a}}{\sqrt{a^2+L^2}} = \boxed{\frac{kQ}{L\sqrt{\cancel{a^2}+L^2}} = E}$$

$$\frac{kQ}{L^2}$$