332

$$\oint\!\!\oint \vec{E}\cdot d\vec{A} = \frac{\iiint \rho \, d^3 r}{\varepsilon_0}$$

$$\vec{\nabla}\cdot\frac{\hat{r}}{r^2}$$

$$\vec{\nabla}_r = \frac{1}{r^2}\frac{\partial}{\partial r}(r V_r)$$

$$\vec{\nabla}\cdot\frac{\hat{r}}{r^2} \qquad \rho = \vec{\nabla}\cdot\vec{E}$$

$$\iiint \vec{\nabla}\cdot\frac{\hat{r}}{r^2}\, d^3 r = \oint\!\!\oint \frac{\hat{r}}{r^2}\cdot d\vec{A}$$

$$d^3 r = r^2 dr \sin\theta \, d\theta \, d\phi$$

$$d\vec{A} = r^2 \sin\theta \, d\theta \, d\phi$$

$$\oint\!\!\oint \frac{\hat{r}}{r^2}\cdot r^2 \sin\theta \, d\theta \, d\phi$$

$$=$$

332

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$$=$$

$$\iiint \vec{\nabla}\cdot\frac{\hat{r}}{r^2}\, d^3r = \oiint \frac{\hat{r}}{r^2}\cdot d\vec{A}$$

$$d^3r = r^2\, dr\, \sin\theta\, d\theta\, d\phi$$

$$d\vec{A} = r^2 \sin\theta\, d\theta\, d\phi\, \hat{r}$$

$$\oiint \frac{\hat{r}}{\cancel{r^2}}\cdot \cancel{r^2}\sin\theta\, d\theta\, d\phi\, \hat{r}$$

$$= 4\pi$$

2 contradicts [illegible]

$$\vec{\nabla}\cdot\frac{\hat{r}}{r^2}$$

$$\delta(x) : \int_{-\infty}^{+\infty} \delta(x)\, dx = 1$$

$$\cancel{\int_0^{\infty} \delta(x) = ?}$$

x=0 x=1 x=2 x=3

$$\rho = [\delta(x) + \delta(x-1) + \delta(x-2) + \delta(x-3)]q$$

$$\vec{E} = \sum \vec{E}_i$$

$$\vec{F}_{21} = k \frac{q_1 q_2}{r_{12}} \hat{r}_{12}$$

$\bullet^{1}\ (x_1, y_1)$ $\qquad$ $\bullet^{2}\ (x_2, y_2)$

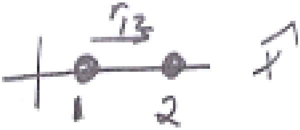
$\xrightarrow{\qquad\qquad}$

$\vec{r}_{12}$ $\qquad$ $(\hat{r}_{ip})$

$$\vec{r}_1 = x_1 \hat{x} + y_1 \hat{y}$$

$$\vec{r}_2 = x_2 \hat{x} + y_2 \hat{y}$$

$$\vec{r}_{12} = \vec{r}_2 - \vec{r}_1 = (x_2 - x_1)\hat{x} + (y_2 - y_1)\hat{y}$$

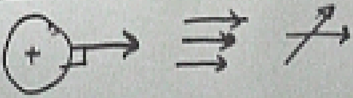


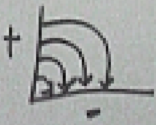
$\vec{r}_{12} = (2-1)\hat{x} = 1\hat{x}$

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

$\ominus \rightarrow$ accelerates

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

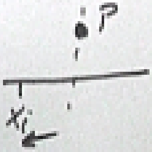




$$\vec{E}_p = \sum_{i=1}^{n} k \frac{q_i}{r_{ip}^2} \hat{r}_{ip}$$

$$\vec{E}_p = \int_{\text{all } q_i} k \frac{dq_i}{r_{ip}^2} \hat{r}_{ip}$$

λ



$$\vec{r}_i = x_i \hat{x} + 0 \hat{y}$$

$$\vec{r}_p = 0 \hat{x} + y_p \hat{y}$$

$$\vec{r}_{ip} = \vec{r}_p - \vec{r}_i = -x_i \hat{x} + y_p \hat{y}$$

$$\vec{r}_i = x_i\hat{x} + 0\hat{y}$$

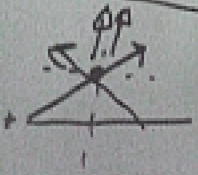
$$\vec{r}_p = 0\hat{x} + y_p\hat{y}$$

$$\vec{r}_{ip} = \vec{r}_p - \vec{r}_i = -x_i\hat{x} + y_p\hat{y}$$

$$\vec{E}_p = \int_{-\frac{L}{2}}^{L/2} k \frac{\lambda dx_i}{\left[[x_i^2+y_p^2]^{1/2}\right]^2} \frac{-x_i\hat{x}+y_p\hat{y}}{\sqrt{x_i^2+y_p^2}}$$

$$E = \int \frac{k \lambda dx_i}{[x_i^2+y_p^2]^{3/2}} (-x_i\hat{x}+y_p\hat{y})$$

$$\vec{E} = \int \frac{k dq_i \cdot \vec{r}_{ip}}{|\vec{r}_{ip}|^{3/2}}$$



$|r_{i,p}|^{3/2}$

$$\vec{E} = \int_{-\frac{L}{2}}^{\frac{L}{2}} \frac{k \lambda \, dx_i \, y_p \hat{y}}{\left[x_i^2 + y_p^2\right]^{3/2}}$$

$$= k \lambda y_p \hat{y} \int \frac{dx_i}{\left[x_i^2 + y_p^2\right]^{3/2}}$$

$$= k \lambda y_p \hat{y} \left[\frac{x_i}{y_p^2 \sqrt{x_i^2 + y_p^2}} \right]_{-L/2}^{L/2}$$

$$= k \lambda y_p \hat{y} \left[\frac{L}{y_p \left(\left(\frac{L}{2}\right)^2 + y_p^2\right]^{1/2}} \right]$$

close: $y_p \to 0 \quad \frac{1}{y_p} \qquad y_p \to \infty$

$|r_{i,p}|^{3/2}$

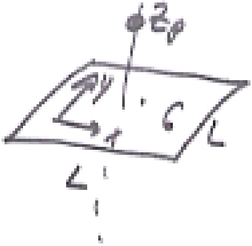
$$\vec{E} = \int_{-\frac{L}{2}}^{\frac{L}{2}} \frac{k \lambda \, dx_i \, y_p \hat{y}}{\left[x_i^2 + y_p^2\right]^{3/2}}$$

$$= k \lambda y_p \hat{y} \int \frac{dx_i}{\left[x_i^2 + y_p^2\right]^{3/2}}$$

$$= k \lambda y_p \hat{y} \left[\frac{x_i}{y_p^2 \sqrt{x_i^2 + y_p^2}} \right]_{-L/2}^{L/2}$$

$$= k \lambda y_p \hat{y} \left[\frac{L}{y_p \left[\left(\frac{L}{2}\right)^2 + y_p^2\right]^{1/2}} \right]$$

close: $y_p \to 0 \quad \frac{1}{y_p} \qquad y_p \to \infty$



$$Q = \iint \sigma \, dx \, dy$$

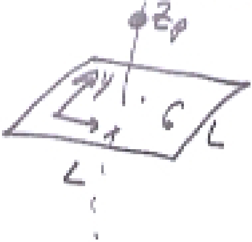
$$\sigma = \frac{Q}{L^2}$$

$x_i, y_i, 0 \quad \vec{r}_i = x_i\hat{x} + y_i\hat{y} + 0\hat{z}$

$$\vec{r}_p = z_p\hat{z}$$

$$\vec{r}_{ip} = \vec{r}_p - \vec{r}_i = -x_i\hat{x} - y_i\hat{y} + z_p\hat{z}$$

$$\vec{E} = k\sigma \int_{x=-\frac{L}{2}}^{+L/2} \int_{y=-L/2}^{+L/2} \frac{dx_i dy_i \cdot (-x_i\hat{x} + y_i\hat{y} + z_p\hat{z})}{\left[x_i^2 + y_i^2 + z_p^2\right]^{3/2}}$$



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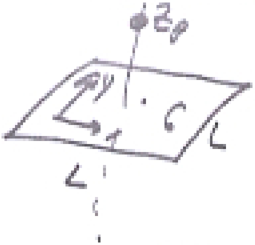

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$$\vec{E} = k\sigma \int_{x=-L/2}^{+L/2} \int_{y=-L/2}^{+L/2} \frac{dx_i \, dy_i \, (-x_i \hat{x} + y_i \hat{y} + z_p \hat{z})}{[x_i^2 + y_i^2 + z_p^2]^{3/2}}$$

$\imath = r_{ip}$

dz_p

$$\sigma = \frac{Q}{4\pi a^2}$$

$$\vec{r}_i = x_i\hat{x} + y_i\hat{y} + 0\hat{z}$$

$$\vec{r}_p = 0\hat{x} + 0\hat{y} + z_p\hat{z}$$

$$\vec{r}_{ip} = -x_i\hat{x} - y_i\hat{y} + z_p\hat{z}$$

$$\vec{E} = k\sigma \int_{r_i=0}^{a} \int_{\theta=0}^{2\pi} \frac{-x_i\hat{x} - y_i\hat{y} + z_p\hat{z}}{\left[\underbrace{x_i^2 + y_i^2}_{r_i^2} + z_p^2\right]^{3/2}} \, r_i \, dr_i \, d\theta_i$$

$$x_i = r_i \cos\theta_i$$

$$y_i = r_i \sin\theta_i$$

$$\vec{E} = k\sigma \, 2\pi \int_{r_i=0}^{a} \frac{z_p\hat{z}}{[r_i^2 + z_p^2]^{3/2}} \, r_i \, dr_i$$

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$r = r_{ip}$

$\sigma = \frac{Q}{4\pi a^2}$

$\vec{r}_i = x_i \hat{x} + y_i \hat{y} + 0\hat{z}$

$\vec{r}_p = 0\hat{x} + 0\hat{y} + z_p\hat{z}$

$\vec{r}_{ip} = -x_i \hat{x} - y_i \hat{y} + z_p \hat{z}$

$$\vec{E} = k_6 \int_{r_i=0}^{a} \int_{\theta=0}^{2\pi} \frac{-x_i\hat{x} - y_i\hat{y} + z_p\hat{z}}{\left[\underbrace{x_i^2 + y_i^2}_{r_i^2} + z_p^2\right]^{3/2}} \, r_i \, dr_i \, d\theta_i$$

$x_i = r_i \cdot \cos\theta_i$

$y_i = r_i \cdot \sin\theta_i$

$$\vec{E} = k\sigma\, 2\pi \int_{r_i=0}^{a} \frac{z_p \hat{z}}{\left[r_i^2 + z_p^2\right]^{3/2}} \, r_i \, dr_i$$

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