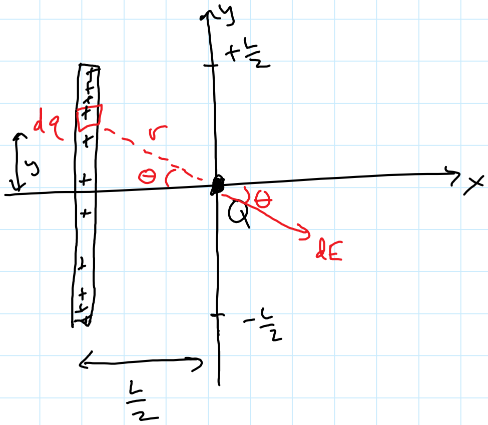
Phy 4B Review 4/21

Friday, April 21, 2017 11:00 AM

Find the force on a charge, Q, at the origin due to the following charge distribution:



$\lambda = A y^2$

↑ positive constant

$$dE = k \frac{dq}{r^2}$$

use components

$$dE_x = dE \cos\theta \qquad dE_y = dE \sin\theta$$

$$= \frac{k\,dq}{r^2}\cos\theta \qquad E_y = 0 \text{ by symmetry}$$

$$E_x = \int \frac{k\,dq}{r^2}\cos\theta$$

$$dq = \lambda\,dy$$

$$r = \sqrt{\left(\frac{L}{2}\right)^2 + y^2}$$

$$\cos\theta = \frac{\frac{L}{2}}{r}$$

$$= \int_{-\frac{L}{2}}^{+\frac{L}{2}} \frac{k\,\lambda\,dy}{\left[\left(\frac{L}{2}\right)^2 + y^2\right]} \frac{\frac{L}{2}}{\sqrt{\left(\frac{L}{2}\right)^2 + (y)^2}}$$

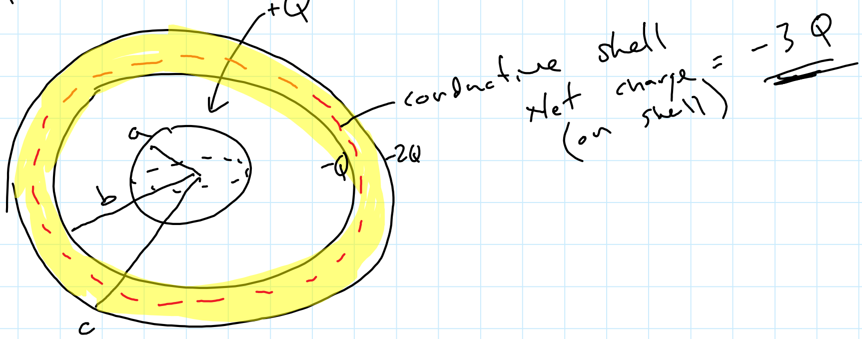
$$\int_{-\frac{L}{2}} \frac{\quad}{\left[\left(\frac{L}{2}\right)^2 + y^2\right]} \quad \sqrt{\left(\frac{L}{2}\right)^2 + (y)^2}$$

$$= \frac{L}{2} \int \frac{kA\, y^2 \, dy}{\left[\left(\frac{L}{2}\right)^2 + y^2\right]^{3/2}}$$

$$= \frac{kL}{2} A \int_{-\frac{L}{2}}^{+\frac{L}{2}} \frac{y^2 \, dy}{\left[\left(\frac{L}{2}\right)^2 + y^2\right]^{3/2}}$$

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

Like 24-59 in book



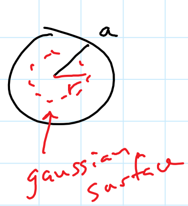
1) Find q_{inner} and q_{outer} for the conductive shell

$$q_{inner} = -Q$$

$$q_{outer} = -2Q$$

2) Find E every where

$r < a$



$$\oint \vec{E} \cdot d\vec{A} = \frac{q_{in}}{\epsilon_0}$$

$$EA = \frac{q_{in}}{\quad}$$

$$E\,4\pi r^2 = \frac{q_{in}}{\epsilon_0}$$

$$E = \frac{1}{4\pi\epsilon_0}\frac{q_{in}}{r^2}$$

Find q_{in}:

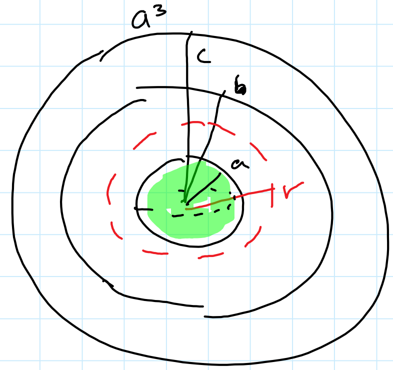
$$q_{in} = \frac{Q_{total}}{V_{total}} V_{in}$$

$$= \frac{\frac{4}{3}\pi r^3}{\frac{4}{3}\pi a^3} Q$$

$$= \frac{r^3}{a^3} Q$$

$$E = k\frac{r^3 Q}{a^3}\frac{1}{r^2}$$

$$= \frac{kQ}{a^3} r \;\hat{r}$$



$a < r < b$

$$\oint E \cdot dA = \frac{q_{in}}{\epsilon_0}$$

$$E\,A = \frac{q_{in}}{\epsilon_0}$$

$$E = \frac{1}{4\pi\epsilon_0}\frac{q_{in}}{r^2}$$

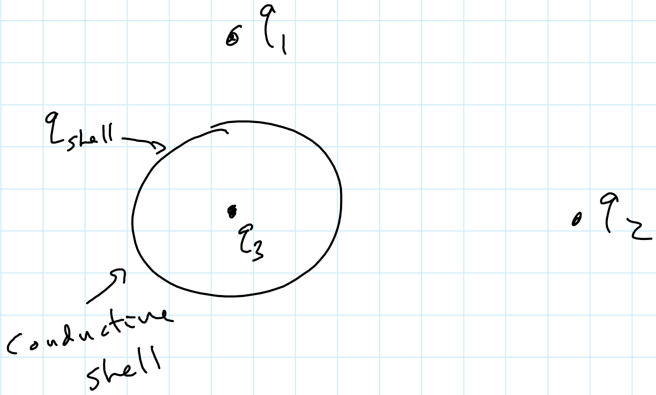
$$= k\frac{Q}{r^2}\;\hat{r}$$

$b < r < c$

$E = 0$ inside conductor

$r > c$

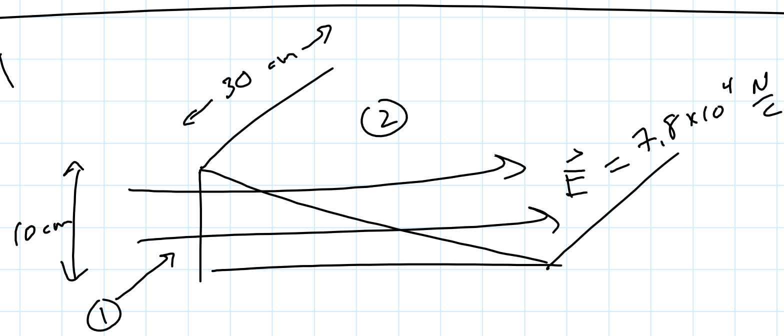
$$E = \frac{k(2Q)}{r^2}\;\hat{r}$$



q_3 is shielded from all other charges because it is in a conductive shell

$F = 0$ on q_3

24-4



a) $\Phi_{①} = EA \cos 180° = -(7.8 \times 10^4)(0.3 \times 0.1) \frac{N\,m^2}{C}$

b) $\Phi_{②} = -\Phi_{①} =$