Week 5: Electrostatics Primer. {Electromagnetism Primer?}

week 10

1. $\vec{E}$: Gauss's Law

2. V

3. C

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1. $\vec{E}$, Gauss's Law

Electric field : $\vec{E} \equiv$ <u>force</u> per unit charge (+ve)

$$\vec{E} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r^2} \cdot \hat{r}$$

$$\vec{F} = \vec{E} q_2$$

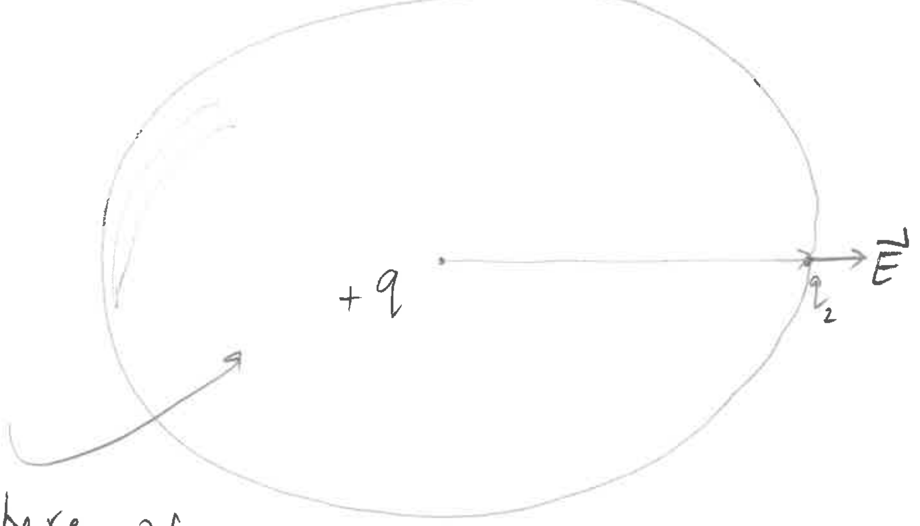
Gauss's Law : how do we get $\vec{E}$ from 'q'

A $\quad \int \vec{E} \cdot d\vec{a} = \frac{q}{\varepsilon_0}$

same.

B. $\quad \vec{\nabla} \cdot \vec{E} = \frac{\rho}{\varepsilon_0}$

charge density



Sphere of radius - 'r'

hard to see differential form work here

use integral form of Gauss's Law

@ q_2: $\int \vec{E} \cdot d\vec{a} = \frac{q_{enclosed}}{\varepsilon_0}$

$$E \cdot 4\pi r^2 = \frac{q}{\varepsilon_0}$$

$$E = \frac{1}{\varepsilon_0} \cdot \frac{q}{4\pi r^2} \quad ; \quad \vec{E} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r^2} \cdot \hat{r}$$

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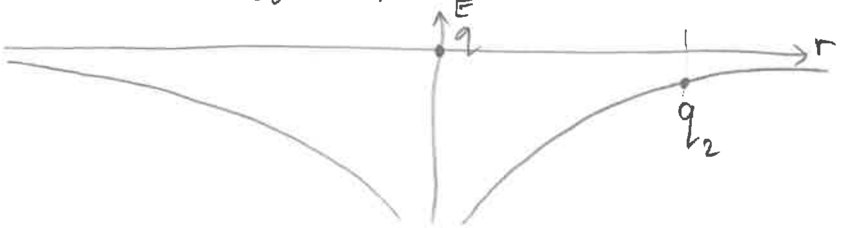
2. V: Electric <u>scalar</u> potential.

Electric potential - V ≡ <u>Energy</u> per unit charge (+ve)

$$V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r} \quad ; \quad E = V \cdot q$$



It takes energy to put 2 +ve charges together. ≡ $E = V \cdot q$

$$V = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r} \quad ; \quad \vec{E} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r^2}$$

A. $\int_{\infty}^{r} \vec{E} \cdot d\vec{r} = V_r$

same

B. $-\vec{\nabla} V = \vec{E}$

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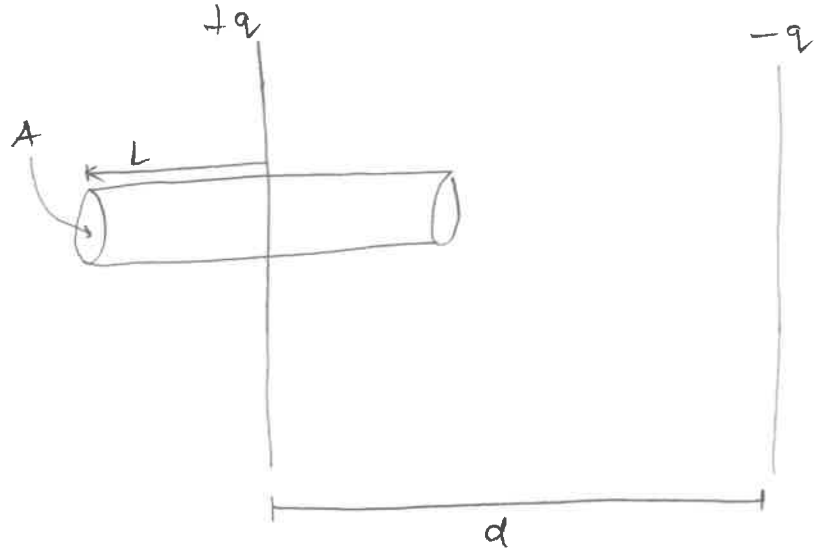
3. Capacitance : C

≡ propotionality between charge stored for applied potential

$$q = C \cdot V$$

$$C = \frac{q}{V}$$

So what is capacitence between 2 plates?



$\vec{E} \longrightarrow V \longrightarrow C$

a. $\vec{E} . 2A = \frac{\rho . A}{\varepsilon_0} \rightarrow E_{+q} = \frac{\rho}{2\varepsilon_0}$; $E_{-q} = \frac{-\rho}{2\varepsilon_0}$; $E = \frac{\rho}{\varepsilon_0}$

b. $V = \int E \cdot dr = \int_0^d \frac{\rho}{\varepsilon_0} . dr = \frac{\rho d}{\varepsilon_0}$

c. C : we need to know charge $\equiv q = \rho A$

$C = \frac{q}{V} = \frac{\rho A}{\left(\frac{\rho d}{\varepsilon_0}\right)} = \varepsilon_0 \frac{A}{d}$

HW5

1.

Notice : $Q_1 + Q_2 = Q_1' + Q_2'$

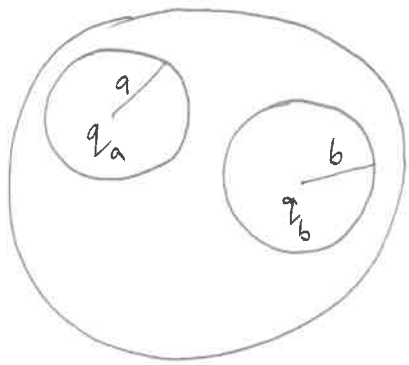
$V_1' = V_2'$

2 Variables: Q' , Q_2'

2 Eq : $\rightarrow$ Solve for $Q_1'(Q_1, Q_2)$

$Q_2'(Q_1, Q_2)$

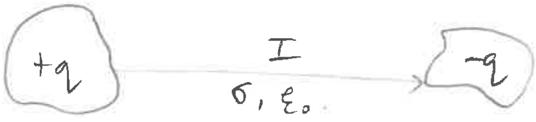
2.



a. $\rho_{a,b} \rightarrow q_a, q_b, a, b$: use Gauss's Law

c. $\vec{E} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r^2} \cdot \hat{r}$

3.



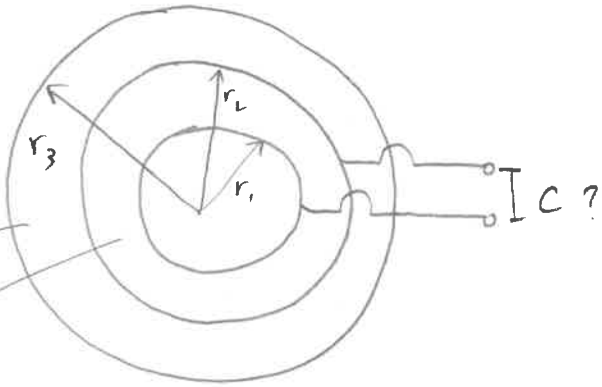
a. Use $\vec{J} = \sigma \vec{E} = \frac{1}{R} \cdot \vec{E}$

& $q = CV$ { + you always have Gauss's $\int E \cdot da = \frac{f}{\varepsilon_0}$ }

c: $I = \frac{\sigma q}{\varepsilon_0} = \frac{dq}{dt} \cdots$

$R = \frac{\varepsilon_0}{\sigma C} = \frac{V}{I} \Rightarrow I = \frac{V \sigma C}{\varepsilon_0} = \frac{q \sigma}{\varepsilon_0}$

4.

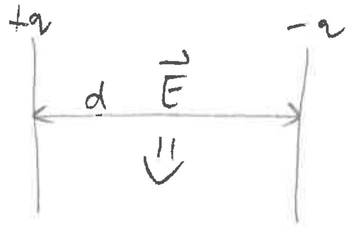


$E_{1,2} = \frac{\sigma_1 r_1}{\varepsilon_0 \cdot r} \longrightarrow V_{1,2} = -\int E \cdot dr$

$E_{2,3} = \frac{\sigma_1 r_1 + \sigma_2 r_2}{\varepsilon_0 r} \longrightarrow V_{2,3} = ?$

$\Delta V = ? \longrightarrow C$

5.



$V_{max} = E \cdot d$; $C = \frac{\varepsilon_0 A}{d}$

you know: $q = CV$

Notice $V = E \cdot x$

& $U = \frac{1}{2} C V^2$.