 Phys 1402 2016-09-01 Lec 3

Scientific Notation in computers: "E notation"

On paper: 1.6×10^{-19}

In computer: 1.6e-19

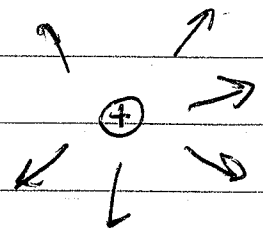
Uses for "e" in physics
- E notation
- Exponential Function (Euler's number) e^x
- Fundamental Charge (electron charge)
- Electric Field (capitalized)

Static Electric Model
- Source Charges cause elec field.
- Test Charges "feel" elec field.

- E-Field points (vector) away from ⊕ toward ⊖

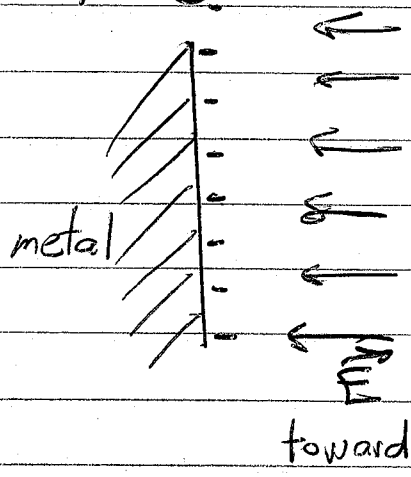
- E-Field pushes ⊕ test charges, pulls ⊖ test charges against $\vec{E}$

$\vec{E}$ of point: q



$$E = \frac{kq}{r^2}$$

Surface Charge - Lots of q's spread out on a surface.



$$k = 9\times10^9 \frac{Nm^2}{kg^2} = \frac{1}{4\pi\varepsilon_0}$$

$$E = 4\pi k\sigma = \frac{\sigma}{\varepsilon_0}$$

σ = surface charge density

$$\sigma = \frac{Q}{A} = \text{charge per unit area}$$

Ex: $E = 150\ N/C$ typical on dry day

$$\sigma = \frac{E}{4\pi k} = \frac{150}{(4\pi \cdot 9\times10^9)} = 1.3\times10^{-9}\ C/m^2$$

$$= 1.3\ nC/m^2 \sim 10^{10} \text{ missing electrons per square meter}$$

Maximum $E \sim 10^6\ N/C$

In Physics I, we started with $\vec{F}$.
Then we learned about energy, E, such as KE, PE

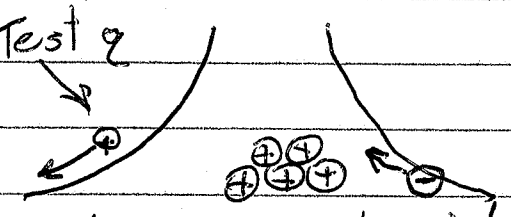
Another model of static electricity
- Source charges cause elec potential, V.
- V makes ⊕ charges go "downhill",
  ⊖ charges go "uphill".

- V is like a hill. High, + V is like big +y.

Pile of Dirt

Each lump of dirt makes the pile taller.
The last lump tends to fall downhill.

Bunch of Charges



⊕ Charges create +V.

⊕ Test charge tends away from others.
⊖ Test tends toward ⊕ charges.

E-Field points "downhill" w/ respect to V.
E is the slope of the hill.
Elec potential (V) is measured in volts (V).

$$E = \text{slope of } V = \frac{\text{rise}}{\text{run}} = \frac{\Delta V}{\Delta x} = \frac{[V]}{[m]}$$

④

- From $E = \frac{F}{q_0}$ E is in N/C

- From $E = \frac{\Delta V}{\Delta X}$ E is in V/m

} same thing

$$\frac{1\ V}{m} = \frac{1\ N}{C}$$

energy

$$1\ V = 1\ \frac{(N \cdot m)}{C} = 1\ J/C$$

Elec Potential is also the energy per charge.

Ex: Point Charge $V = \frac{kq_1}{r}$

$q = 50\ nC$

Distance

$r = 0.1\ m$ $\quad V = \frac{(9\times10^{9})(50\times10^{-9})}{(0.1)} = 4500\ V$

$r = 0.101\ m$ $\quad V = \frac{(\ "\ )(\ "\ )}{(0.101)} = 4455\ V$

$$\frac{\Delta V}{\Delta X} = \frac{-44.6\ V}{0.001\ m} = -44600\ V/m$$

$$E = kq/r^2 = (\ "\ )(\ "\ )/(0.1)^2 = 45000\ N/C$$