(1) Phys 1402 2016-08-06 Lec 4

SI Sessions

M 5–6pm CA-228

Tu 1–2pm ECDC-219b

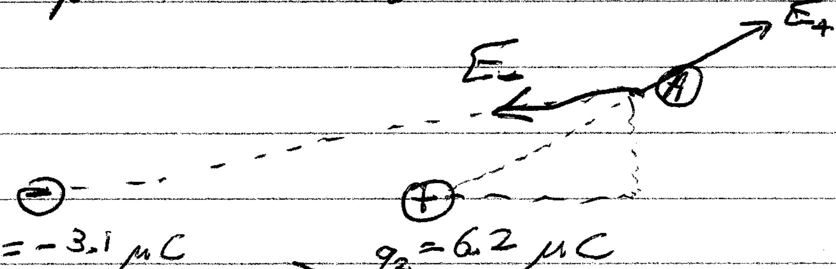
Th 5–6pm BH-126

office hours M 10–11am GC

W 10–11am

Current chapters 15–16.

HW1-11



Where is $\vec{E} = 0$?

What is $\vec{E}$?

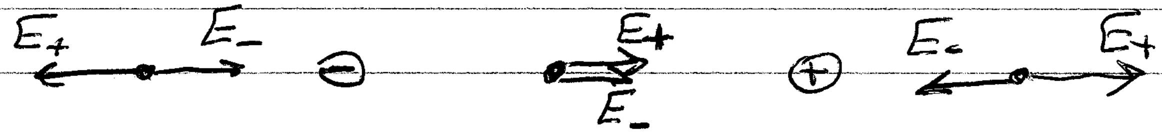
$$\vec{E} = \vec{E}_- + \vec{E}_+$$

How can two vectors add to zero?

* Equal & opposite.

When can they be <u>opposite</u>?

- Not if the point (A) is off-axis.
- What about on-axis?



maybe here not here maybe here

② How can $|E_-| = |E_+|$?

⊖ $-3.1\ \mu C$ ⊕ $6.2\ \mu C$

$$E_- = \frac{kq_-}{r_-^2} \qquad E_+ = \frac{kq_+}{r_+^2}$$

$$\frac{k|q_-|}{r_-^2} = \frac{kq_+}{r_+^2}$$

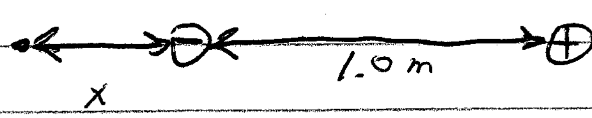
We know q_+ is bigger than $|q_-|$.

$$\frac{q_+}{|q_-|} = 2 \qquad \text{also} \qquad \frac{r_+^2\, k|q_-|}{r_-^2} = \frac{k q_+}{r_+^2}|q_-|$$

$$\frac{q_+}{|q_-|} = \frac{r_+^2}{r_-^2} = \left(\frac{r_+}{r_-}\right)^2 = 2$$

Bigger charge must be further away!

∴ we must be to the left of ⊖.



$r_- = x \qquad r_+ = 1 + x$

$$\left(\frac{1+x}{x}\right)^2 = 2 \qquad \frac{1+x}{x} = 1.414$$

Electric Field: Force per unit charge

$$\vec{E} = \frac{\vec{F}}{q_0} \leftarrow \text{test charge}$$

Electric Potential: Energy per unit charge

$$\Delta V = \frac{\Delta PE}{q_0}$$

Potential Difference (no word energy) ↗ ΔV

Potential Energy Diff. ↖ ΔPE

With gravity $\quad F_g = mg$ (down) $\quad PE_g = mgy$

$$\Delta PE_g = mgy_f - mgy_i = mg\Delta y$$

$$\frac{\Delta PE_g}{\Delta y} = mg$$

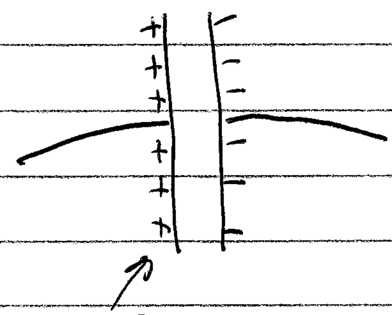
$$\frac{\text{Energy}}{\text{dist}} = \text{Force} \qquad \text{Energy} = F \cdot \text{Dist}$$

$$\frac{\Delta V}{\text{dist}} = \vec{E} \qquad \Delta V = \vec{E} \cdot \text{dist}$$

This works as long as $\vec{F}, \vec{E}$ are const.

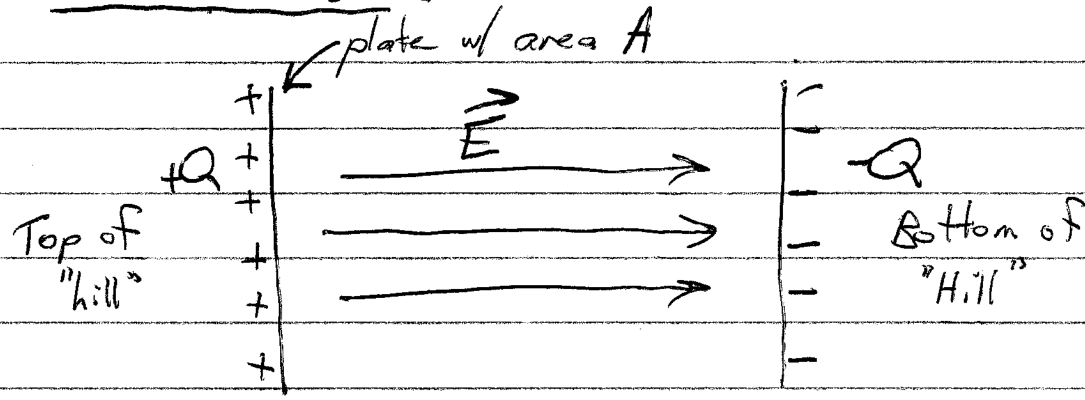
Parallel Plate Capacitor

- Capacitor is a "charge bucket"
  - Normally, getting past nC of charge requires thousands of volts.
  - The capacitor gathers both charges (⊕ and ⊖), and they buffer the "like charges repel" effect.



repelled from each other <u>but also</u> attracted to opposites.

  - Lets us gather <u>more charges</u> with <u>less voltage</u>.



Charge: Q means $q_+ = +Q$ and $q_- = -Q$

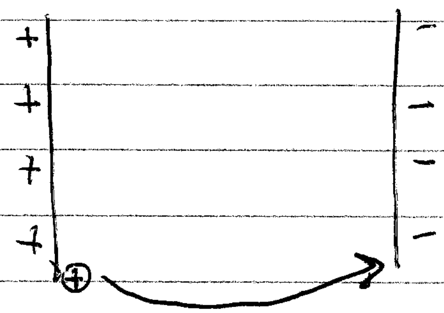
E-Field: $E = \sigma 4\pi k = (Q/A) 4\pi k$

Potential: $\Delta V = E \cdot dist$

Energy in a Capacitor

$$\Delta V = E \cdot d = \left(\frac{4\pi k Q}{A}\right) d$$

Energy released by allowing one little charge to fly across:



$$\Delta PE = q_0 \, \Delta V = q_0 \left(\frac{4\pi k Q}{A}\right) d$$

Energy released by allowing the <u>last</u> little charge to fly across:

$$\Delta PE = q_0 \, \Delta V \approx 0$$

Net effect is

$$\Delta PE = Q\left(\tfrac{1}{2} V_i\right)$$

Energy of capacitor is $\text{Energy} = \frac{1}{2} Q V$