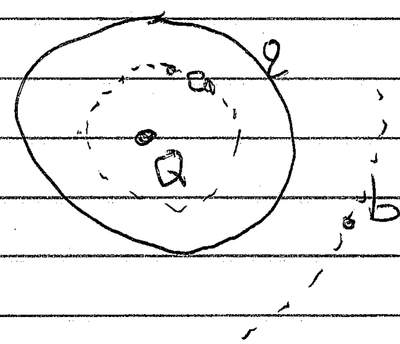
① Phys-1402 2015-09-10 Lec 5

SMTE-0095
- Register TODAY
- Finish TOMORROW

HW1 #6



Due to any charge:
$\Phi_E = 4\pi k q = \frac{q}{\varepsilon_0}$

At point "a", draw a Gaussian surface.
Inside that is only Q = "enclosed charge"
The Flux thru a's Gaussian surface is
$\Phi = 4\pi k Q$
It is related to E:
$\Phi = E \cdot A$
← Area of a's surface

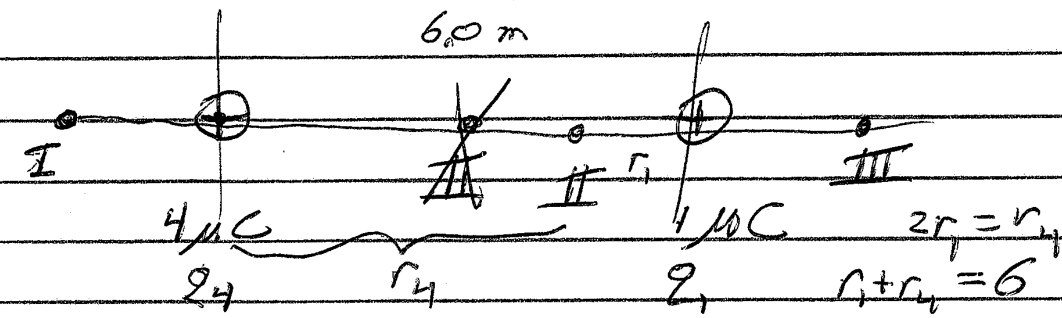
$A_{sphere} = 4\pi R^2$

$E = \frac{\Phi}{A} = \frac{\Phi}{4\pi a^2}$

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

For radius b, $Q_{enc} = Q + q$

(2)



Where is $E = 0$?

- Two contributors to E, added as vectors.
- Must be equal & opposite

At I: E_4 = strong because q_4 close, Left
E_1 = weak b/c q_1 far, Left

At III: E_4 = right, q_4 strong but far
E_1 = right, q_1 weak but close
Could be equal, but not opposite.

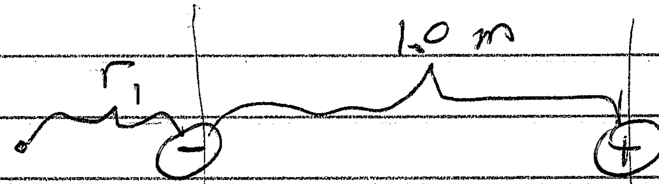
At II: E_4 = Right
E_1 = Left
Can be opposite!

$$E_4 = \frac{k q_4}{r_4^2} \qquad E_1 = \frac{k q_1}{r_1^2}$$

$$\frac{k q_4}{r_4^2} = \frac{k q_1}{r_1^2} \Rightarrow 4r_1^2 = r_4^2$$

$$2r_1 = r_4$$

(3)



$q_1 = \text{small} = -2.2\,\mu C$ $\qquad q_2 = \text{big} = +6.6\,\mu C$

$E_1 =$	→	←	←
$E_2 =$	←	←	→
Opposite?	✓	✗	✓

Must be close to the smaller charge.

✓		✗

$$|E_1| = |E_2|$$

$$\frac{k|q_1|}{r_1^2} = \frac{k|q_2|}{r_2^2}$$

$$\frac{2.2}{r_1^2} = \frac{6.6}{r_2^2}$$

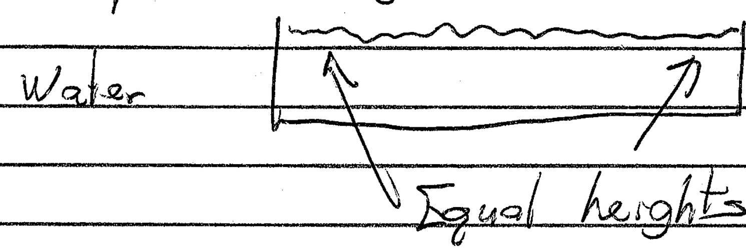
$$r_2^2 = \frac{6.6}{2.2} r_1^2 = 3 r_1^2$$

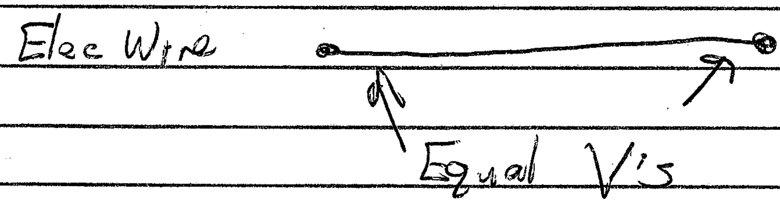
$$r_2 = \sqrt{3}\, r_1 \qquad r_1 + (1.0\,m) = r_2$$

Voltage in Circuits

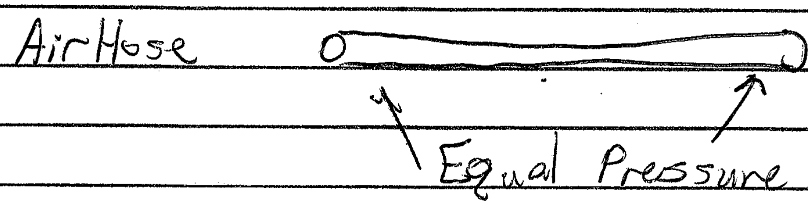
- Voltage is not "stuff"
- Voltage doesn't move or flow.
- Only voltage differences matter.
- Wires "conduct electricity" which allows them to carry voltage.

- Analogy 1: Height on a landscape.

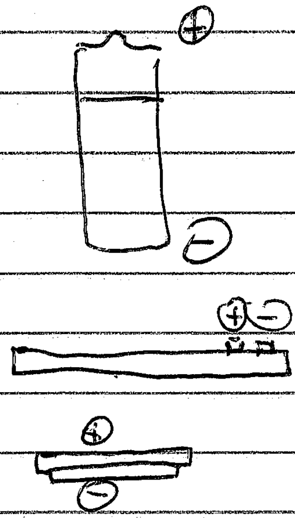


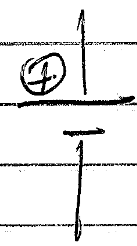


- Analogy 2: Pressure in a pipe/tank



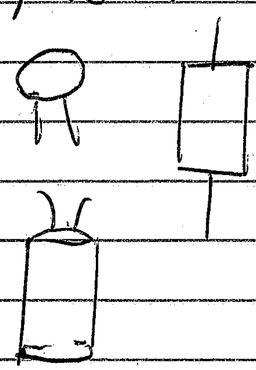
Battery - Generates constant voltage

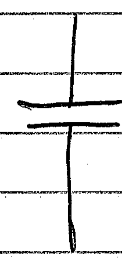




Schematic symbol for battery

Capacitor - tank for holding charge





Capacitor

$Q = CV$ C= capacitance

$C = \frac{\varepsilon_0 A}{d}$

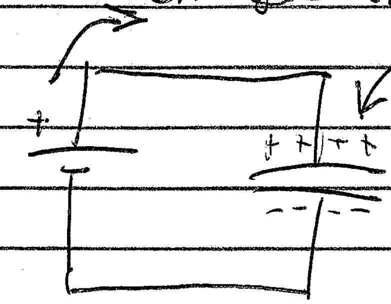
Note: $Q = 5\,\mu C$ means $q_1 = +5\,\mu C$

$q_2 = -5\,\mu C$

Examples: charges under pressure

charges make "back pressure"

$V = 9.0\,V$



$C = 4.5\,\mu F$

$Q = ? = CV$

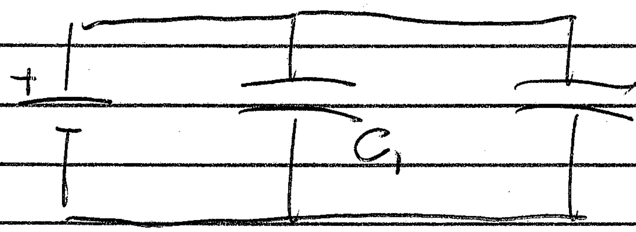
$$Q = CV = (4.5\times10^{-6}\,F)(9.0\,V)$$

$$= 40.5\times10^{-6}\,C$$

$$= 40.5\,\mu C$$

Parallel

$9.0\,V = \mathcal{E}$



C_1 C_2

Both C's are exposed to 9.0 V.

Q_1 and Q_2 are different.