PHY117 HS2024

Today: Electric potential
Capacitance
Dielectrics
Electrodynamics { Electric current
Resistance

Note: sometimes we refer to a potential difference ΔV as V

Be careful with E_0 + $\mathcal{E}_0$:
(two different things)

Week 9, Lecture 2
Nov. 13th, 2024
Prof. Ben Kilminster

what is $V(t)$ if $\bar{\mathcal{E}} = 10\frac{N}{C}\,\hat{x}$?

(assume that $V=0$ at $t=0$)

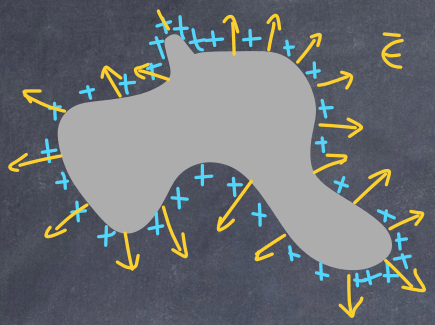
we saw that $\Delta U = q \Delta V$

ΔU: energy [J]

q: charge [C]

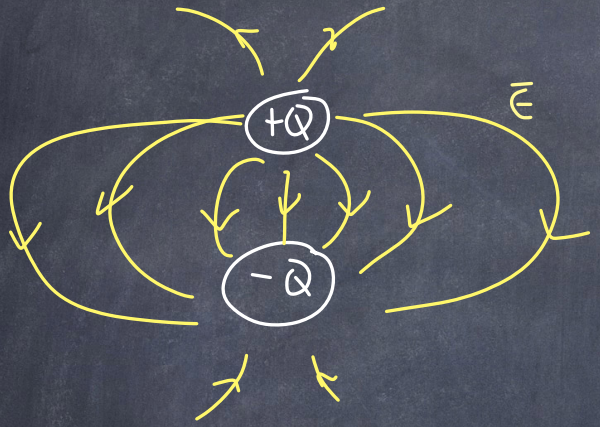
ΔV: potential [V]

What is $\vec{E}$ close to a conductor?

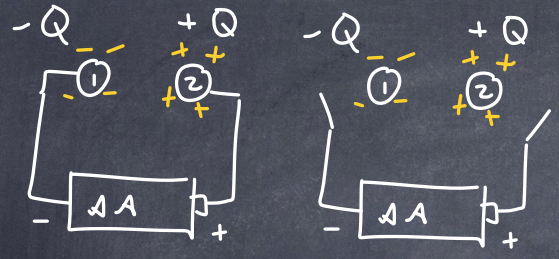


Capacitors :

Any two oppositely charged conductors form a capacitor

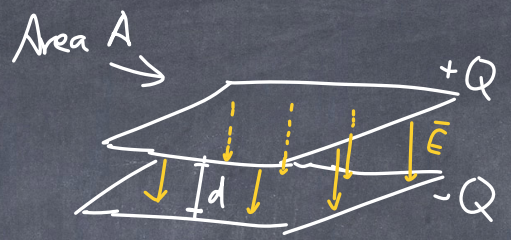


Let's charge a capacitor:

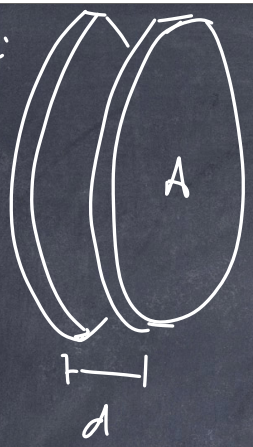


we charge with
$\Delta V = 1.5\,V$

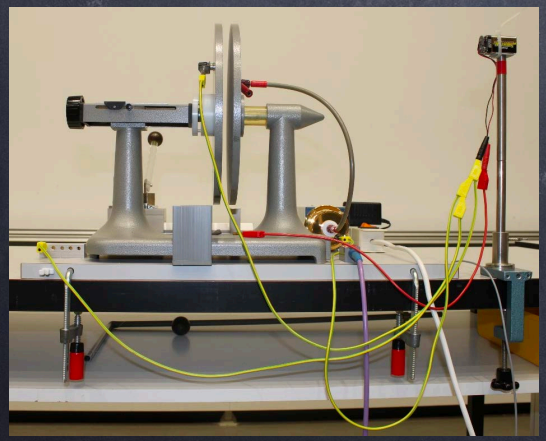
what is the capacitance of a parallel-plate capacitor, with area A, separation d, and a charge +Q, -Q?



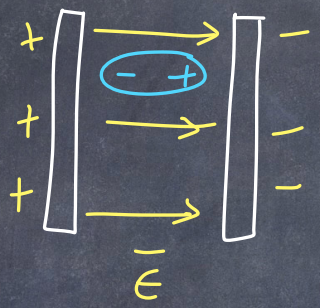
Consider:

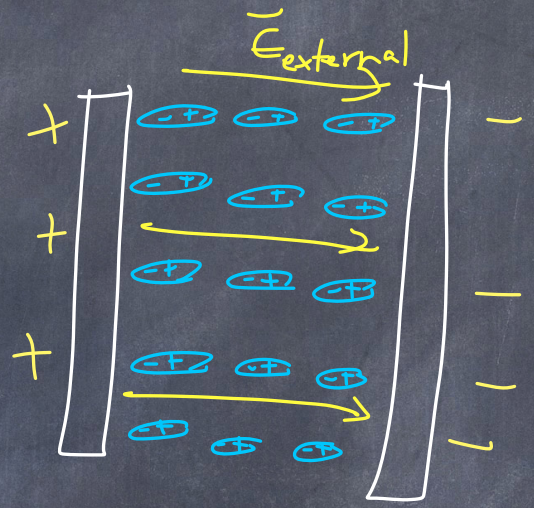


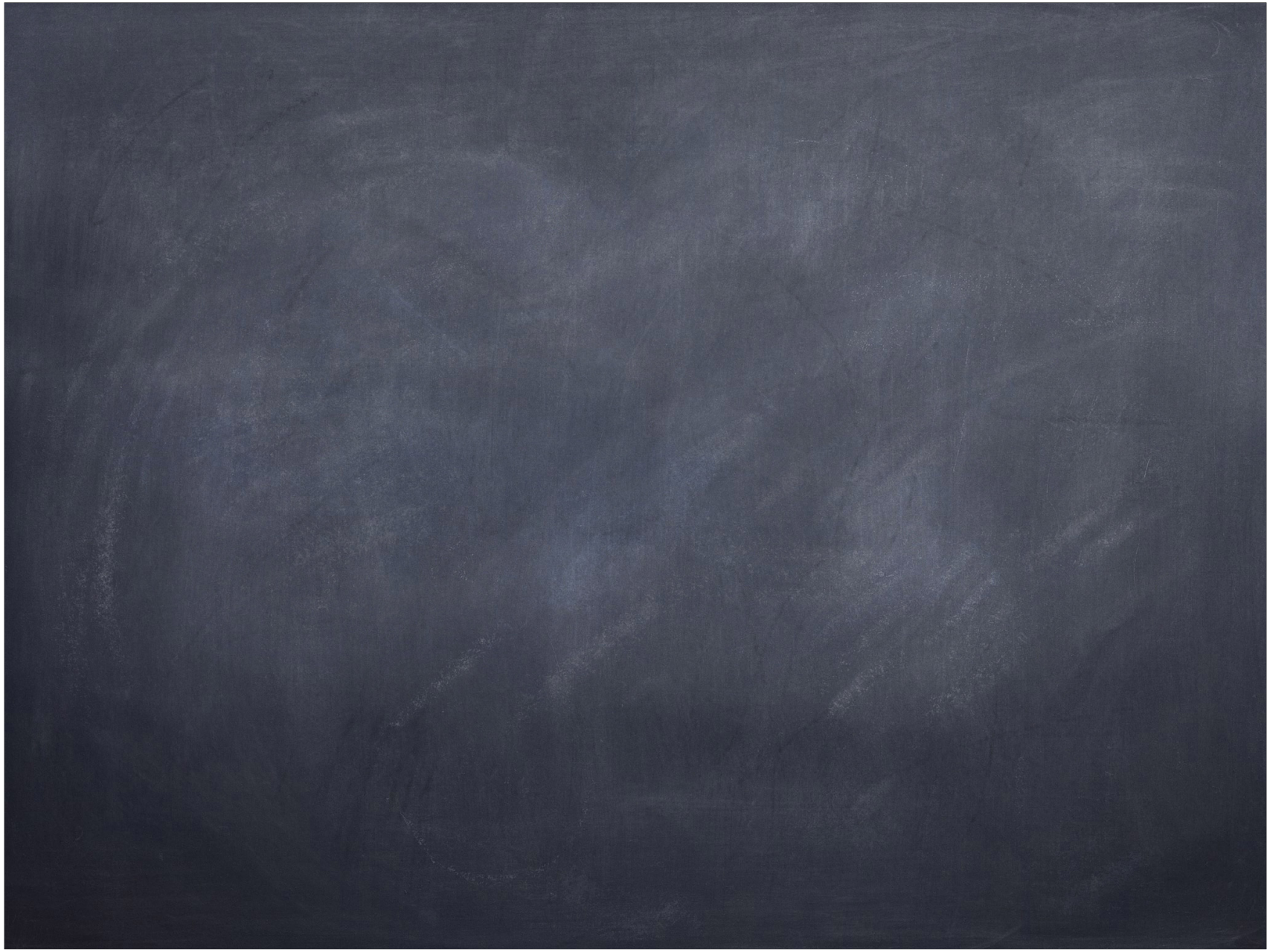
← capacitance is $C = \frac{\varepsilon_0 A}{d} = \frac{Q}{|\Delta V|}$



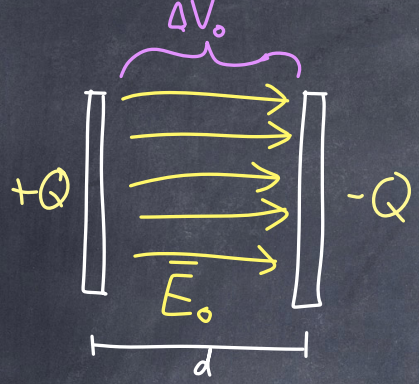
Dielectrics - In a non-conducting material, we know that dipoles tend to align opposite to the ϵ-field

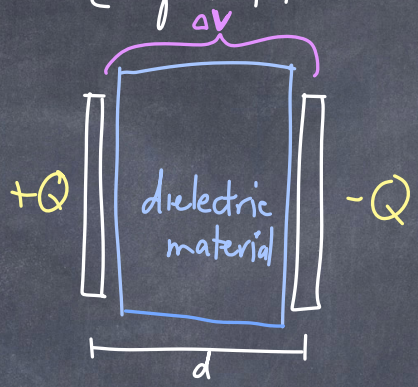


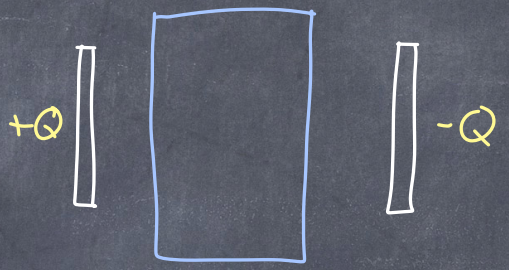


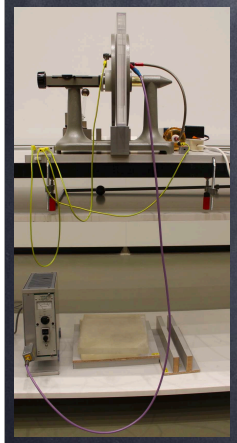


Parallel-plate capacitor with a dielectric









In general:

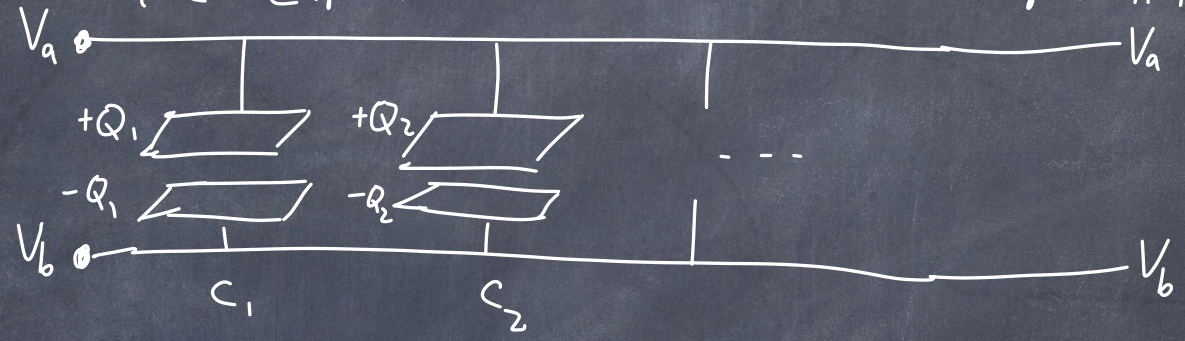
$C = Q/V$

$Q = CV$

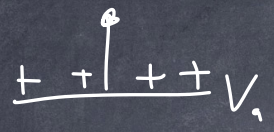
Combining capacitors:

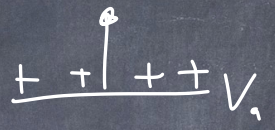
when we combine capacitors in parallel, the capacitors are at the same potential

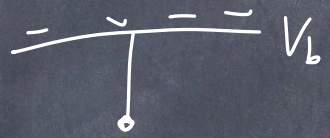
$V \equiv V_a - V_b$

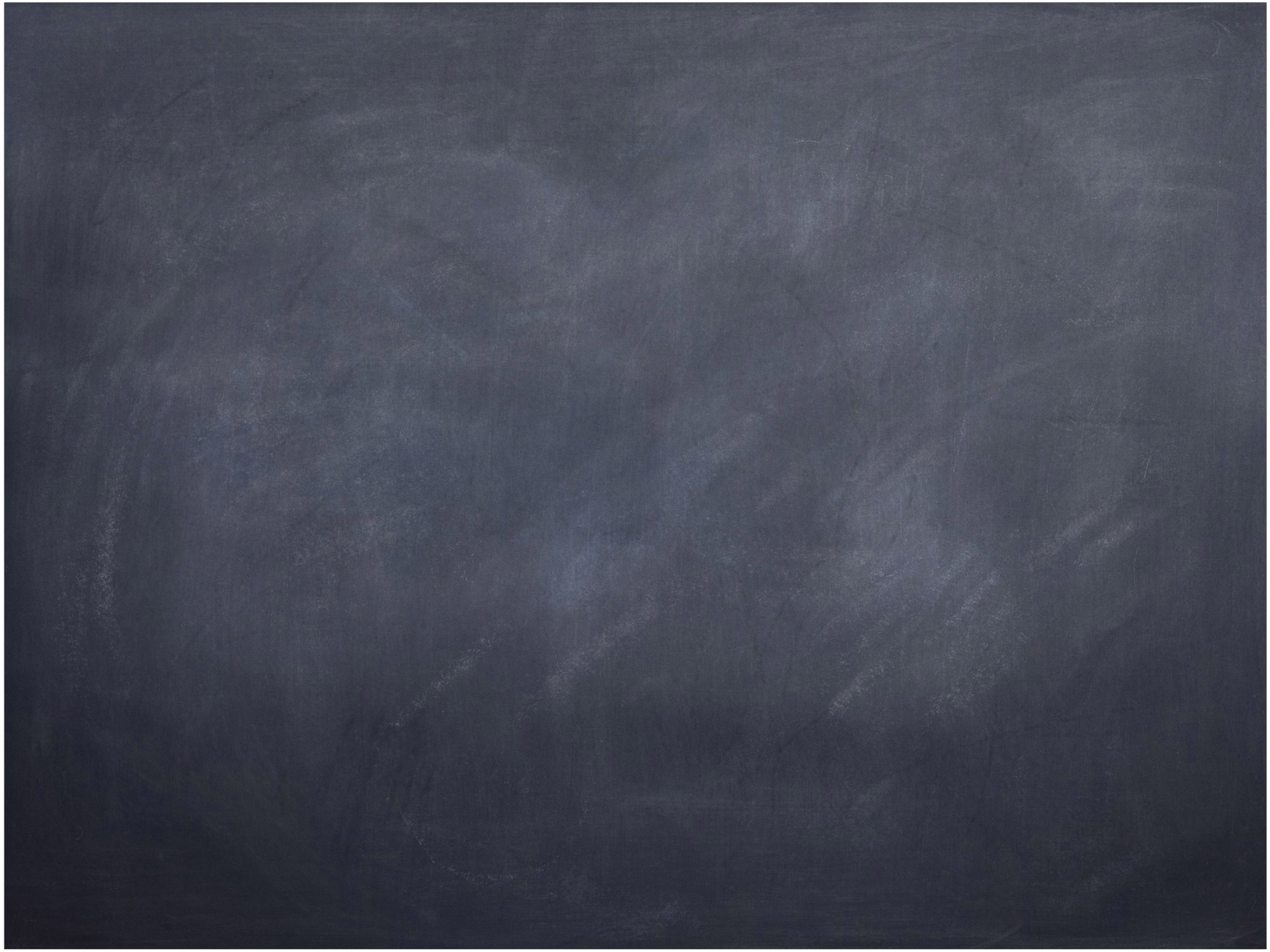


Combining capacitors in series:










0 2 3 4 5 6 7
kV
PHYWE

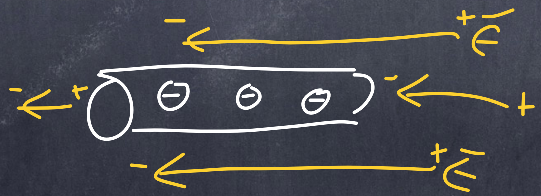
Electrostatics: $E = 0$ in a conductor, V is the same everywhere in a conductor.
(static charges)

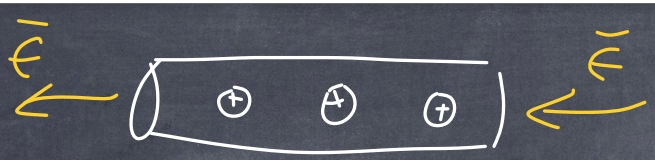
Electrodynamics:
(moving charges)

Define **Current**: rate of flow of electric charge.

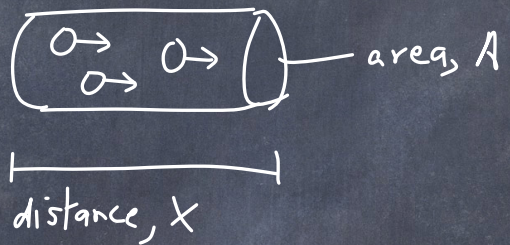
Consider a conductor

$\bar{E} = 0$ 

$\bar{E} \neq 0$ 

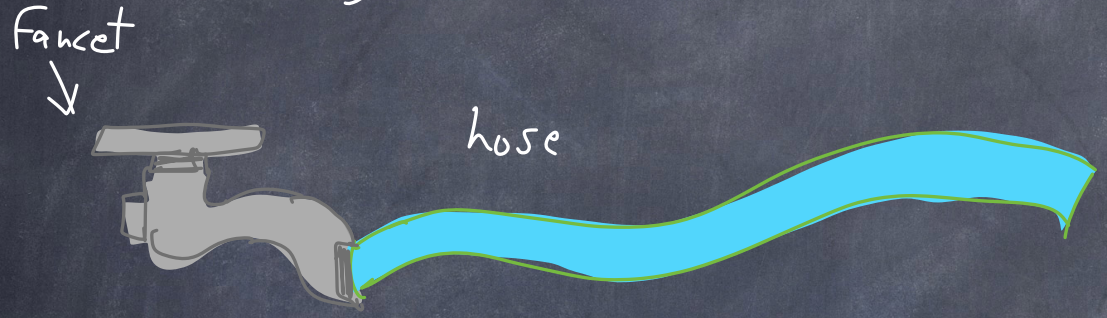


Calculate speed of charge carriers:

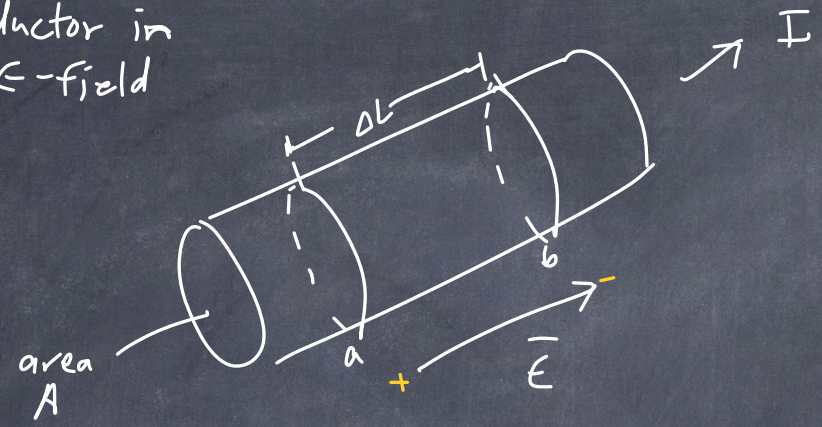


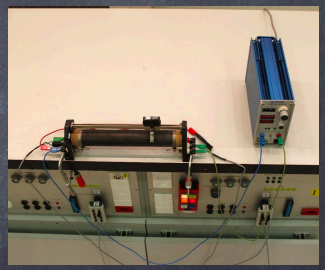
If V_d is so slow, why does electricity seem so fast?

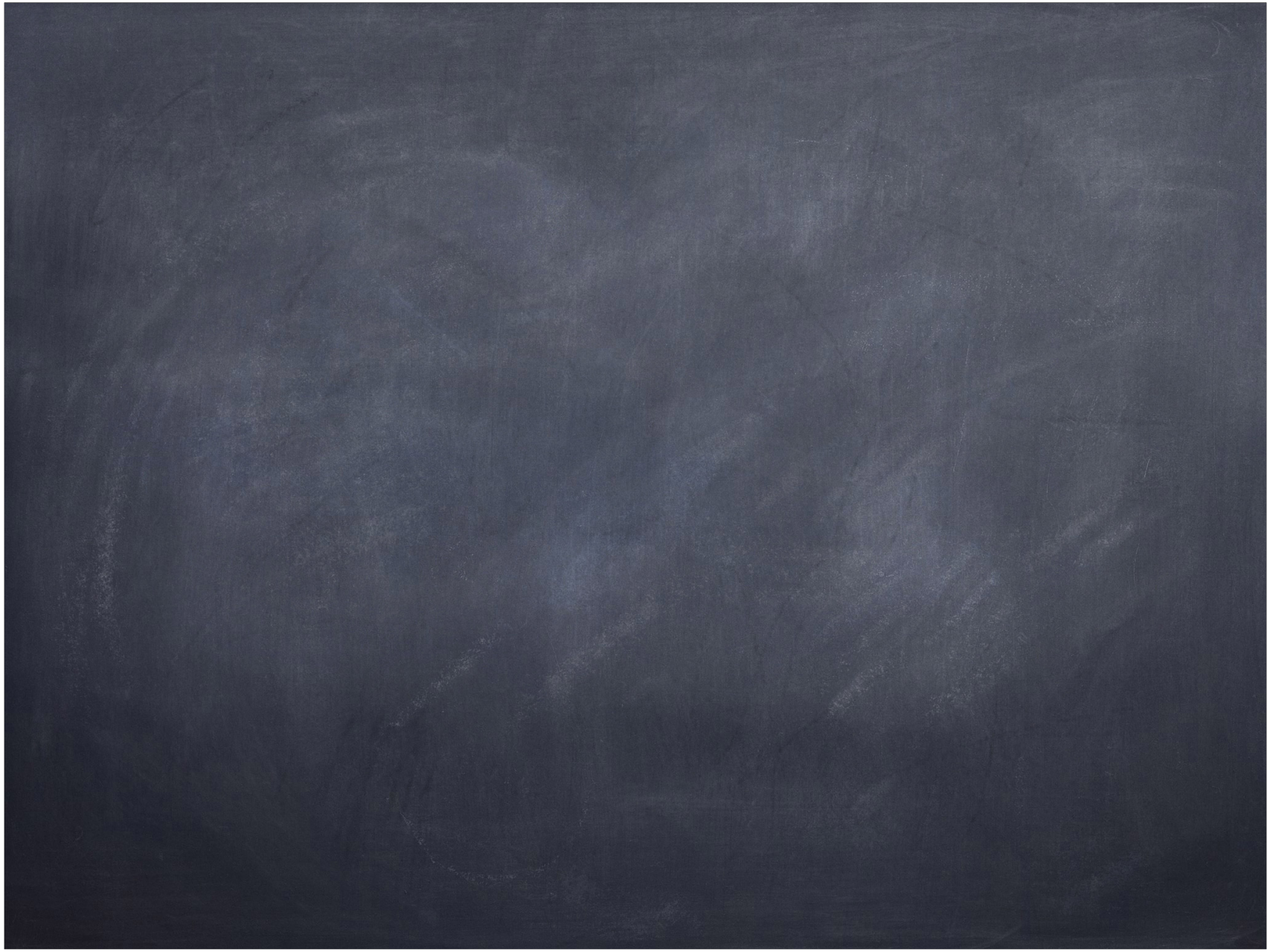
Analogy to a hose with water in it.



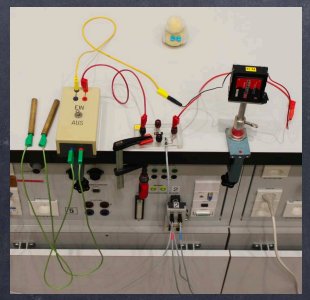
Conductor in an $\mathcal{E}$-field



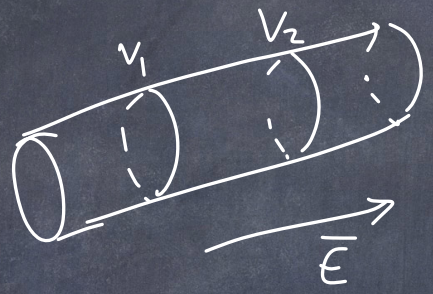


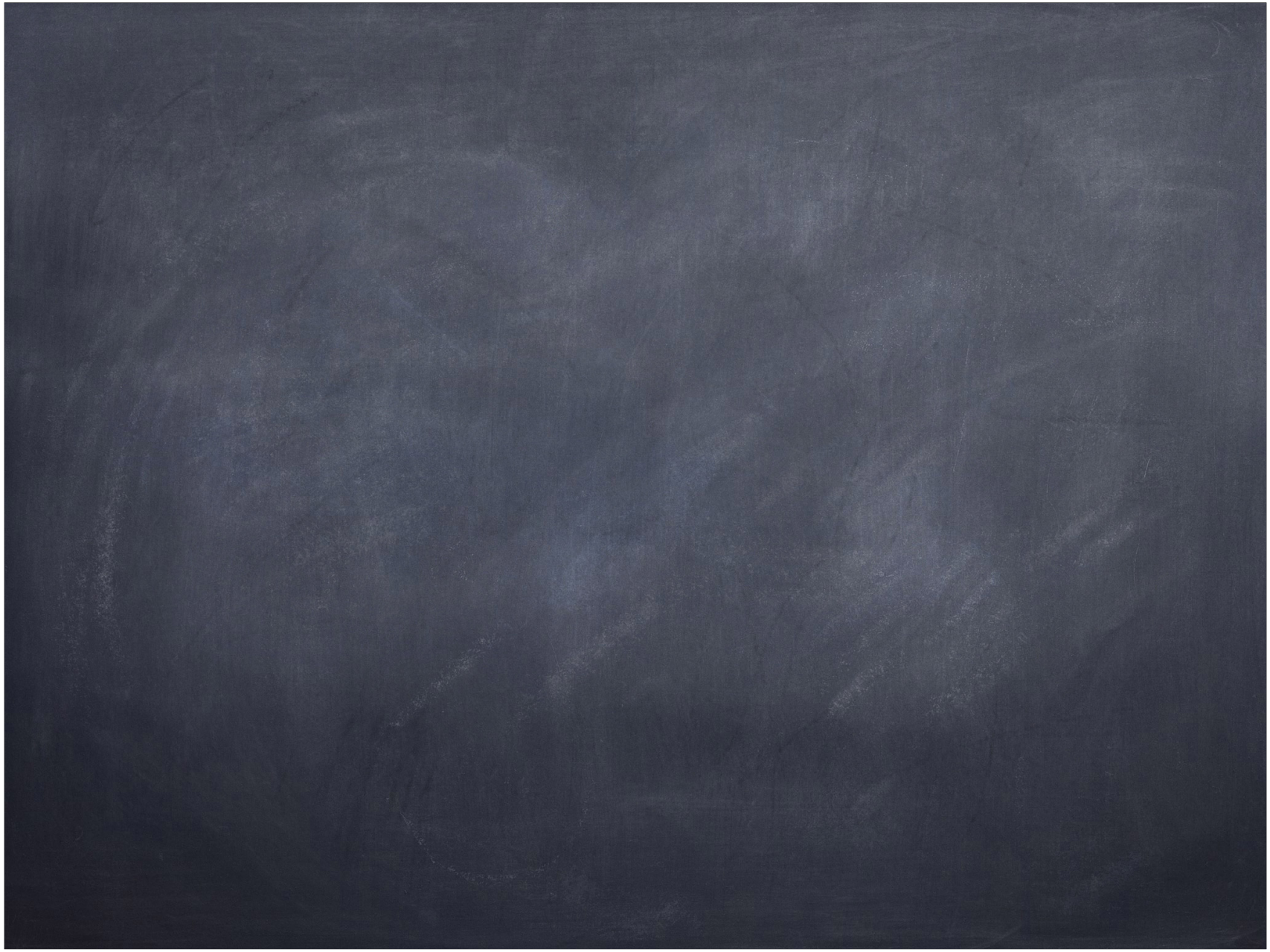


material	$\rho_{20}\,[\Omega \cdot m]$	$\alpha\,\left[\frac{1}{C}\right]$
copper	1.7 E-8	3.9 E-3
aluminum	2.8 E-8	3.9 E-3
wood	$10^{8} - 10^{14}$	
glass	$10^{10} - 10^{14}$	

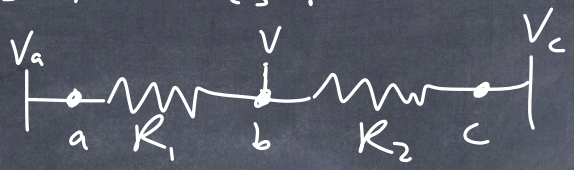


Energy is lost in a conductor as electrical energy is converted into thermal energy.

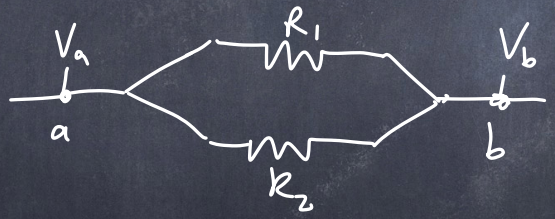


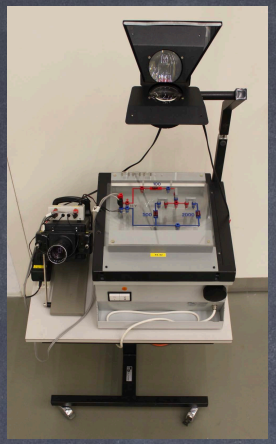


Resistors in series:



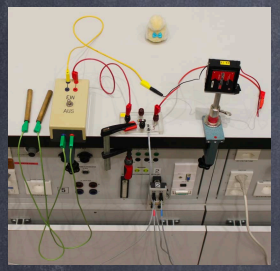
Resistors in parallel:



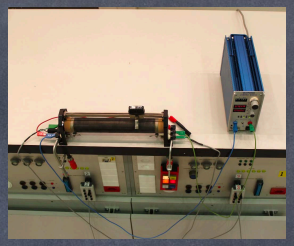


ES62

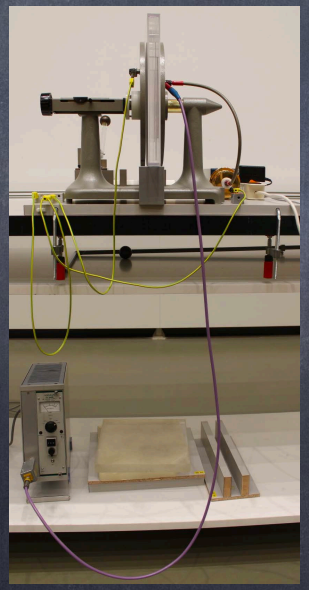
ES28



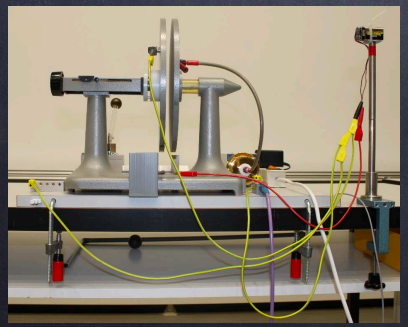
ES70



ES61



ES44



ES34