Physics 114 — February 24, 2015

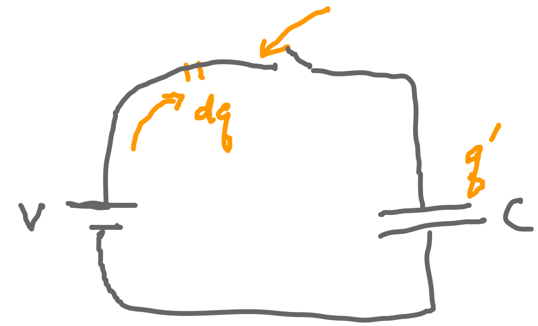
- IF you've not yet picked up your exam
  They are here .... ↓

Last Time

$$dW = v' \, dq'$$

$$dW = \frac{q'}{C} \, dq'$$

$$W = \int dW = \int_0^Q \frac{1}{C} q' \, dq' = \frac{1}{2C} Q^2$$

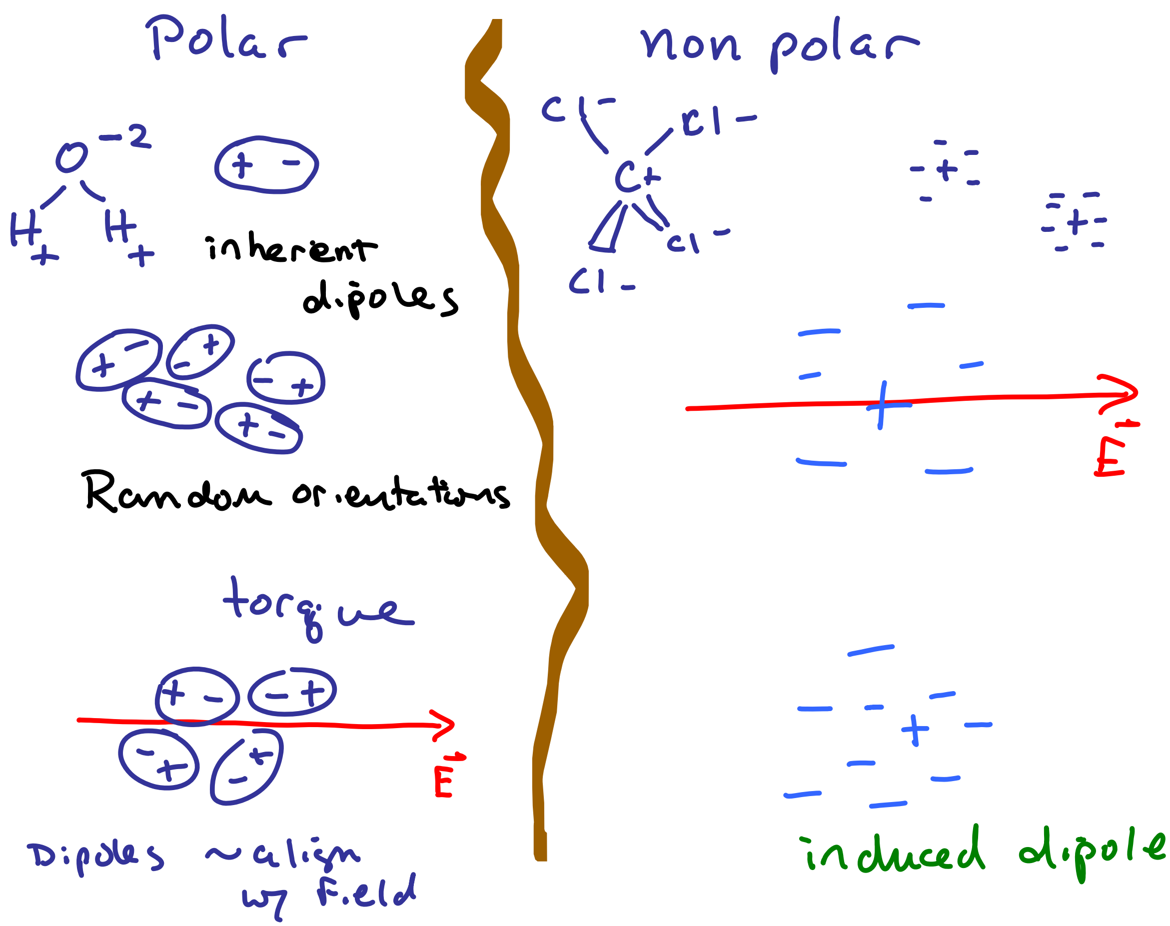


Energy required (stored) to charge capacitor $= \frac{Q^2}{2C} = \frac{1}{2} C V^2 = \frac{QV}{2}$

$$u_E = \frac{\epsilon_0}{2} E^2$$

Energy density in electric field

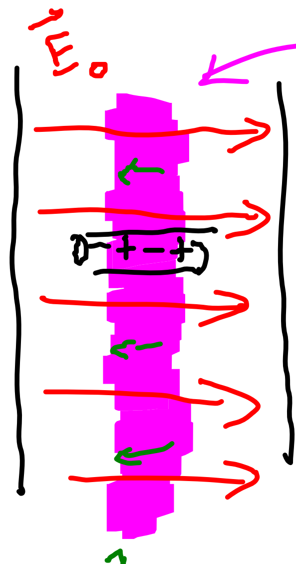
$\vec{E}$ in materials – "dielectric" (nonconductor)



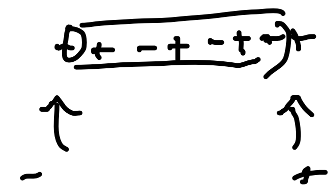
linear Dielectric

$$\vec{E} \propto \vec{E}_0$$

$$\vec{E} = \frac{\vec{E}_0}{K}$$



Dielectric Materia



$K \equiv$ Dielectric constant

← : E from induced dipole charge sep inside dielectric

$K > 1$

$\vec{E}_0 \to \vec{E}$ which is weaker than $\vec{E}_0$

$K_{water} = 80.4$

$K_{air} = 1.00054$

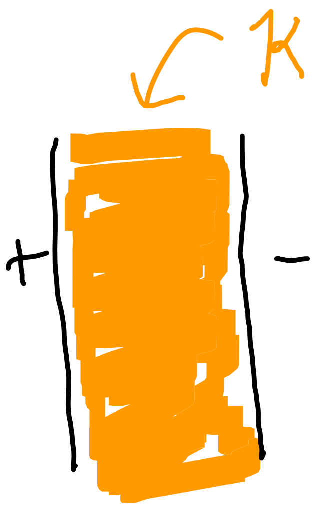
$K_{vacuum} = 1$

$K_{oil} = 4.5$

$$k\epsilon_0 \equiv \epsilon$$

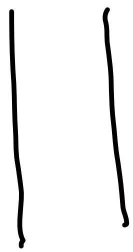
Permittivity of free space (ϵ_0)

Permittivity (ϵ)



$$\vec{E}_0 = \frac{\sigma}{\epsilon_0}$$

$$\vec{E} = \frac{\vec{E}_0}{k} = \frac{\sigma}{k\epsilon_0} = \frac{\sigma}{\epsilon}$$



$Q = CV$

No Dielectric

Have dielectric

$V \longrightarrow V/K$

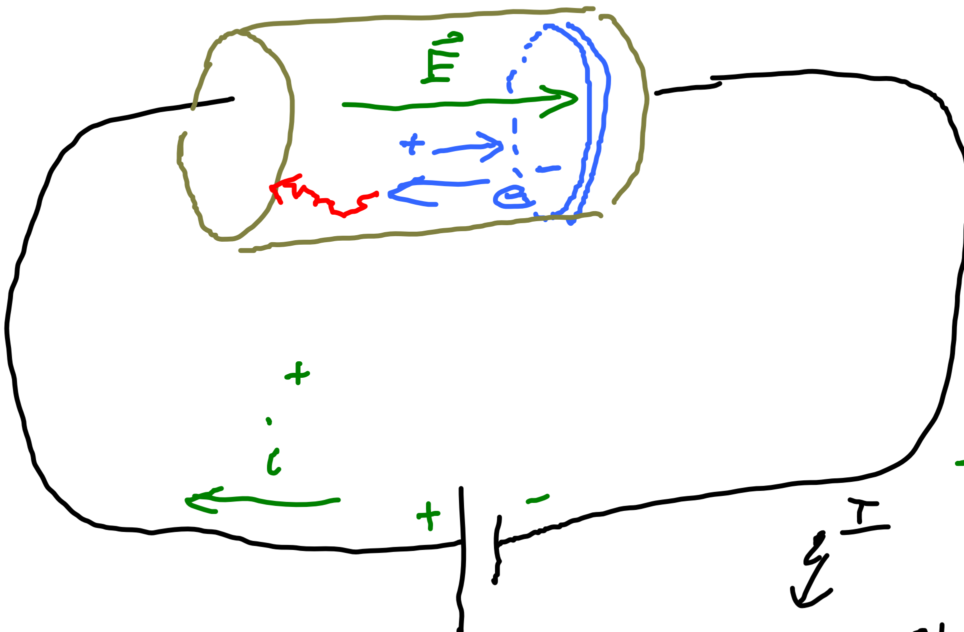
$C \longrightarrow C' = KC = K\frac{\epsilon_0 A}{d} = \frac{\epsilon A}{d}$

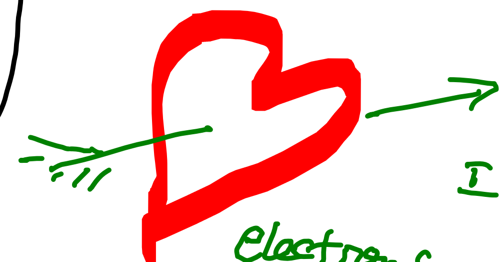
$Q = C'\frac{V}{K}$

C

$\boxed{\frac{Q}{V}} = \frac{C'}{K}$

Resistance to movement of the electrons





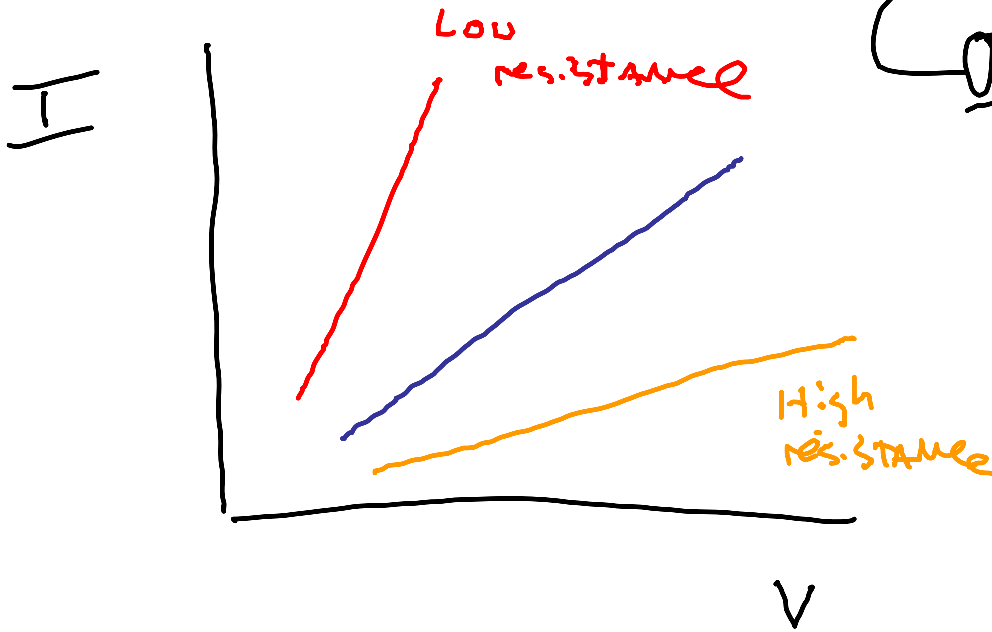
+i is direction of + charge flow

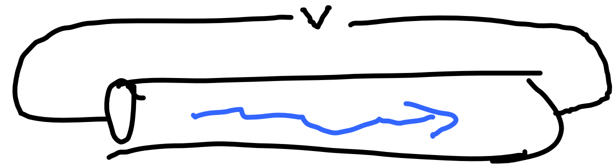
charges will flow $= \dfrac{dq}{dt} = i \equiv$ electric current

units of $\dfrac{\text{Coulombs}}{\text{Second}} \equiv$ Ampers

André Marie Ampère
(1775 - 1836)

French { Mathematician
Chemist
physicist





$V \propto I$

$V = RI$

↑ resistance

$R = \text{ohm} = \Omega$

$V = IR$ Ohm's Law

Georg
Ohm

1789-1854
German

Resistance
Measured
in
Ohms

$1\,\text{ohm} = 1 \frac{\text{volt}}{\text{Ampere}}$

Ω

$V = iR$

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

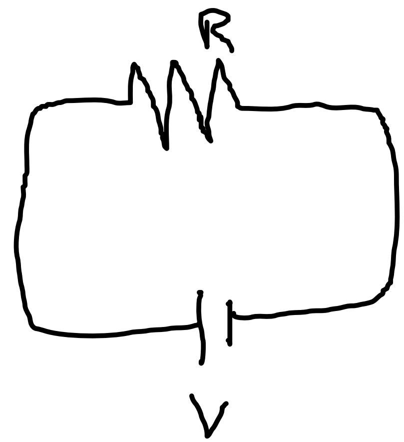
$W = qV$

$P = \frac{dW}{dt} = \frac{dq}{dt} V = iV$

↑ power

$\frac{dW}{dt}$: rate at which work is done to shove i thru resistor

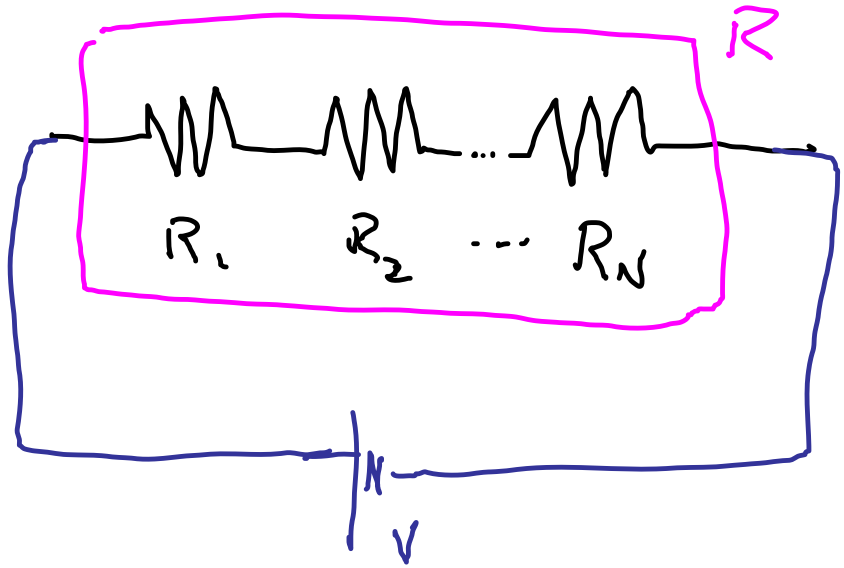
$\frac{dq}{dt}$: current



Power spent in resistor → heat
and or light

$$P = iV = i^2R = \frac{V^2}{R}$$

$V = iR$



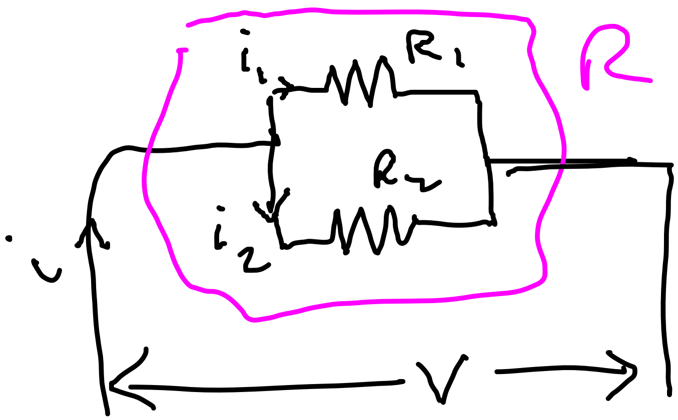
Resistors in series

$$V = V_1 + V_2 + \cdots + V_N = iR_1 + iR_2 + \cdots + iR_N$$

$$V = i\,(R_1 + \cdots + R_N)$$

$$V = i\left[\sum_j R_j\right]$$

$$R = \sum_j R_j$$



Resistors in ∥

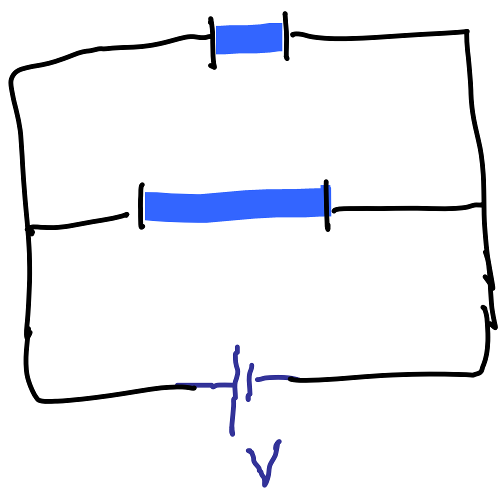
$$i = i_1 + i_2$$

$$\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2}$$

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R} = \sum_j \frac{1}{R_j}$$

	Capacitors	Resistors
Parallel	$C = \sum_i C_i$	$\frac{1}{R} = \sum_i \frac{1}{R_i}$
Series	$\frac{1}{C} = \sum_i \frac{1}{C_i}$	$R = \sum_i R_i$



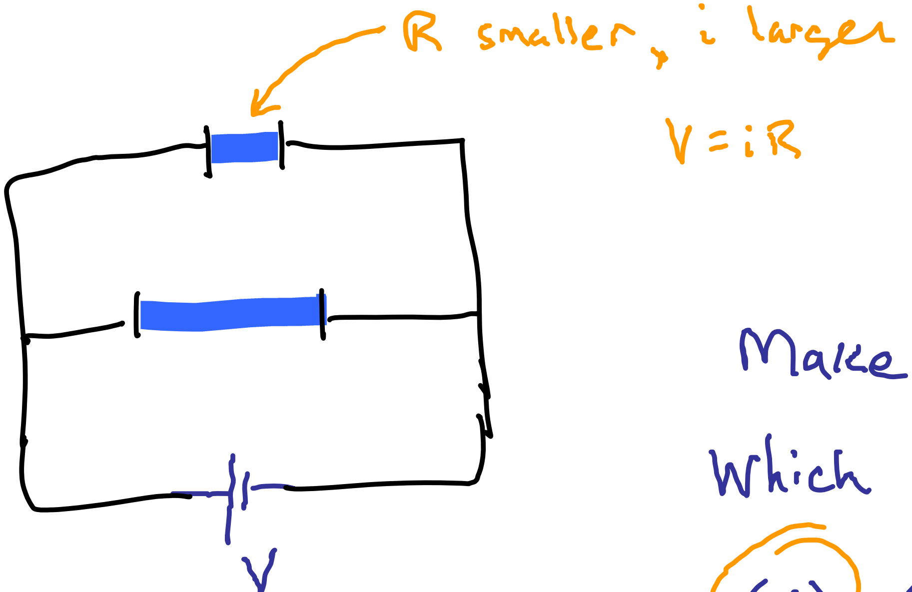
Make V large.

Which nail melts first?

(a) Short

(b) long

(c) Both at same time



$V = iR$

$P = i^2 R$

Resistive heating ~ Power

Make V large.

Which nail melts first?

(a) Short

(b) long

(c) Both at same time