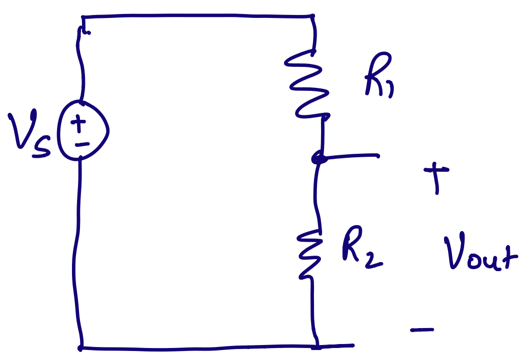
EECS16A Module 2, Lecture 3

Logistics:
1. Call me maybe
   → Advising. – Help w/ choosing courses.
   → Oct 15th.
2. Trivia night (Stat)

- HW6

Today.
- 1D Touchscreen –
- Power

Last time
1. Voltage Divider



$$V_{out} = \left(\frac{R_2}{R_1+R_2}\right) \cdot V_s$$

Node Voltage Analysis

1. Labeling all currents, voltages.
2. ~~Solving~~ Setting up and solving a system of linear equations

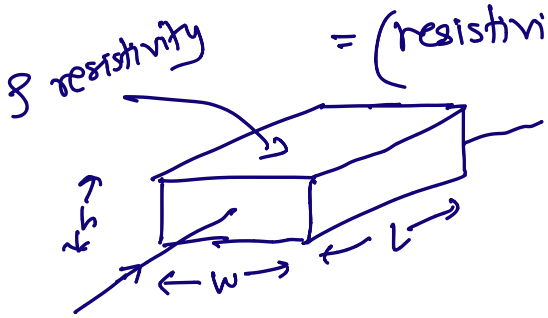
3V, 5V $\quad \boxed{(5V) \times \frac{3}{5} = 3V}$

2. **Resistivity**: Property of a material. $\boxed{(\rho) \text{ rho.}}$

copper: 1.7×10^{-8} Ωm. ←
aluminum: 2.7×10^{-8} Ωm.
Silicon: 2.3×10^{3}. Ωm. ←

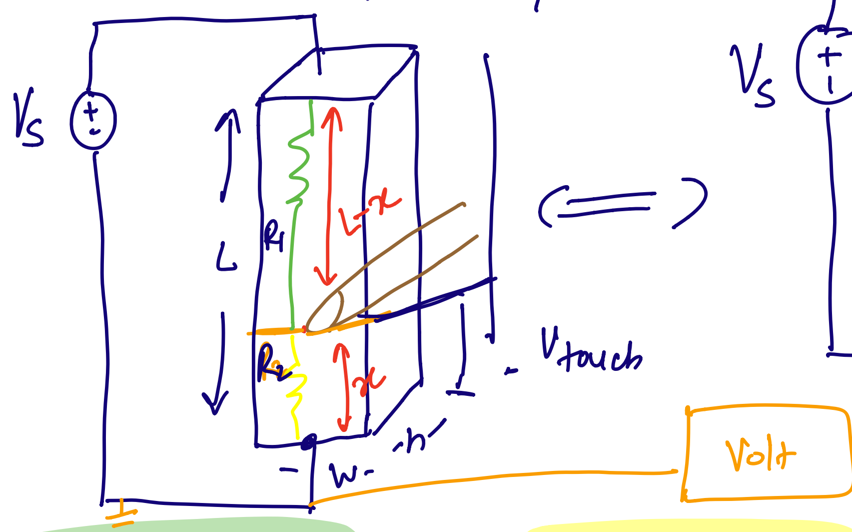
(R) **Resistance** $= \rho \cdot \frac{L}{W \cdot h}$

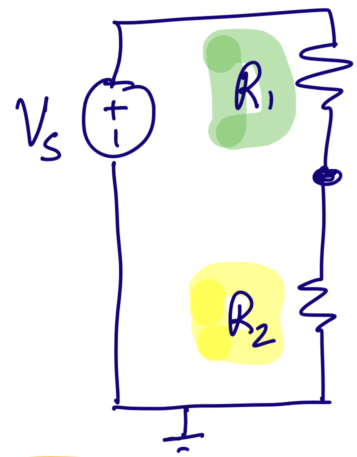
$$= (\text{resistivity}) \times \frac{\text{Length}}{(\text{Width})\cdot(\text{Height})}$$



③ 1D Touch.

Long Resistor
Resistivity ρ.





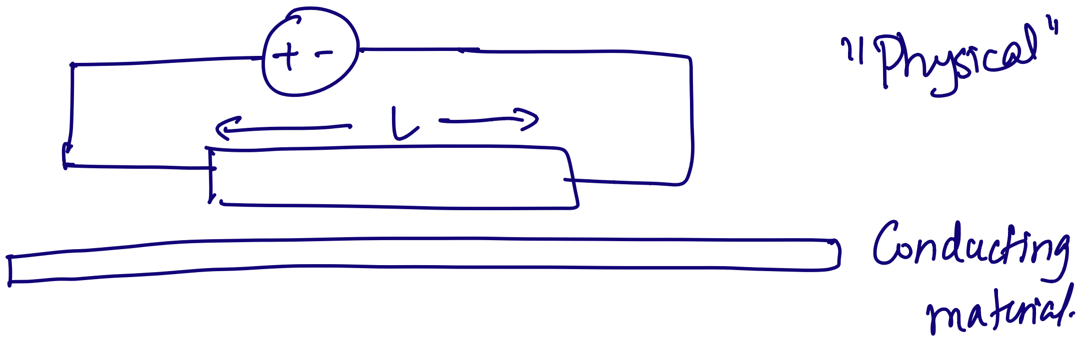
$$R_1 = \frac{\rho(L-x)}{w\cdot h} \quad , \quad R_2 = \frac{\rho\cdot x}{w\cdot h}$$

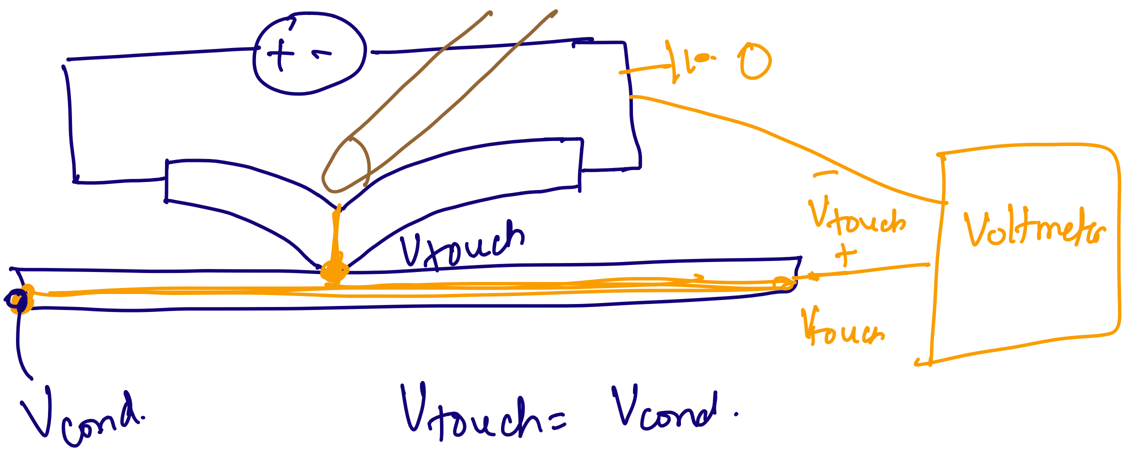
$$V_{touch} = V_s \cdot \left(\frac{R_2}{R_1+R_2}\right)$$

$$x = \frac{V_{touch}\cdot L}{V_s}$$

"Side-view" of the touchscreen

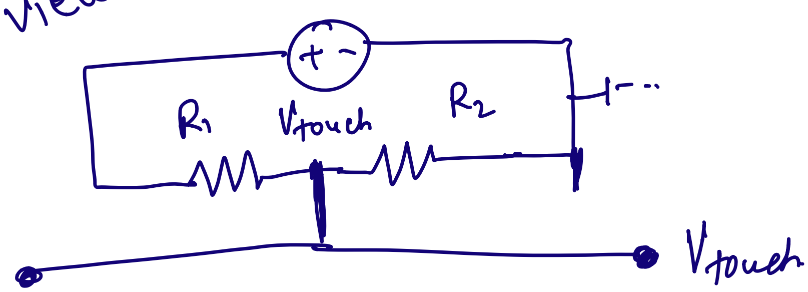
"Physical"

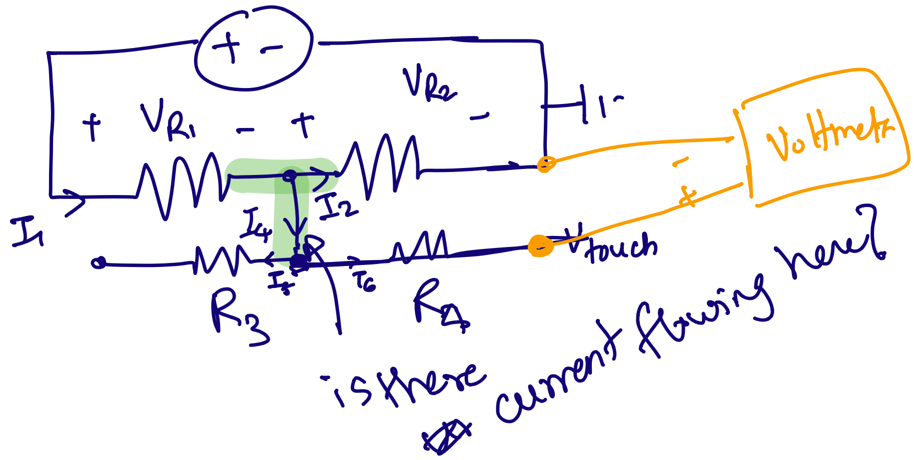




$V_{touch} = V_{cond}$.

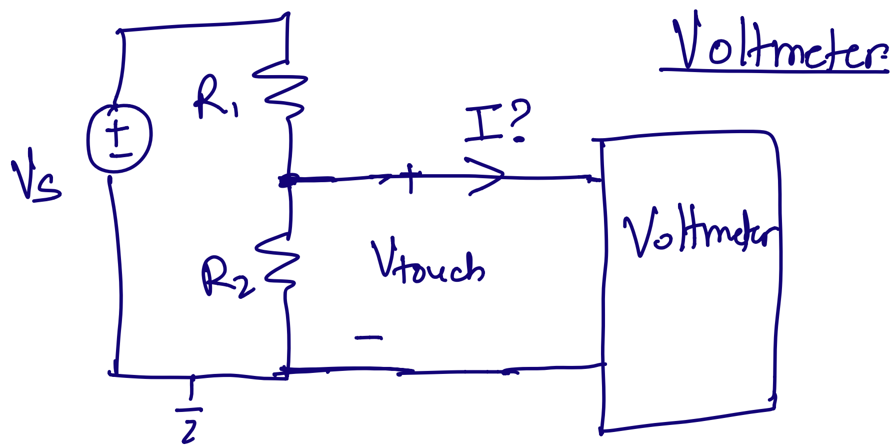
"Model view"





"Dangling resistor"

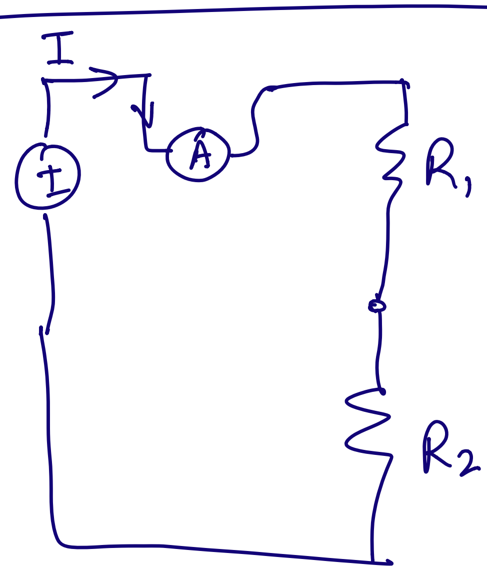
How do we measure voltage?



For $I = 0$, you need very high resistance for the voltmeter.
"Open circuit"

How to measure current?

"Ammeter"



"Short circuit"

$R = 0$ for the ammeter

Energy and Power in a circuit

Good measurement: does not draw power.

- Charge : Positive or Negative

  Units of Coulomb.

  Symbol : Q.

- Current: Amount of charge crossing per unit time.

$$I = \frac{dQ}{dt}$$

- Voltage : Energy required to move a unit charge from point A. to B.

$$V_{AB} = \frac{dE_{AB}}{dq}$$

- Power: Change in energy per unit time

$$P = \frac{dE}{dt}$$ (Energy per time).

Unit: Power : Watts

Energy : Joules.

Light bulb: 10W , 1 hour

E = Power x time

= 10W x 1 hour = 10 Watt-hours

$= 10\,W \times 3600$ seconds

$= 36{,}\underbrace{000}$ Ws (Joule).

$= 36$ kiloJoules.

How do we think about power in circuits?

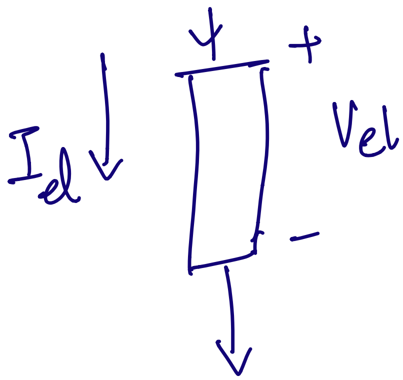
$\boxed{V = \frac{dE}{dq}}$, $\boxed{I = \frac{dq}{dt}}$

energy / charge   charge / time.

Power (P) = Energy per time $= \frac{dE}{dt}$

$= \boxed{\frac{dE}{dq}} \cdot \boxed{\frac{dq}{dt}} = V \cdot I.$

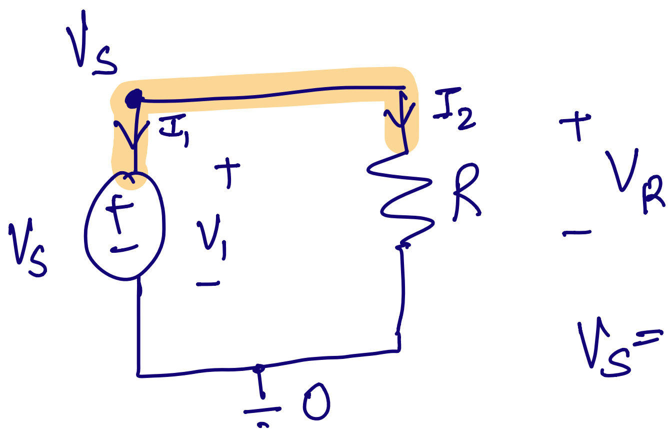
Passive sign convention



Power dissipated by the element:

$$P_{el} = V_{el} \cdot I_{el}$$

Example:



$V_s = 5V$

$R = 1\Omega$

$$V_1 = V_R = V_s$$

$$V_R = I_2 \cdot R$$

I_2 ?

$$I_2 = \frac{V_R}{R} = \frac{V_s}{R}$$

Power dissipated by R (P_R) $= V_R \cdot I_2 = V_s \cdot \frac{V_s}{R}$

$= V_s^2/R$

$$= \frac{25\,(V)(V)}{1\,\Omega}$$

<u>KCL:</u> $I_1 + I_2 = 0$

$I_1 = -I_2$.

Power dissipated by the voltage source: (P_{VS})

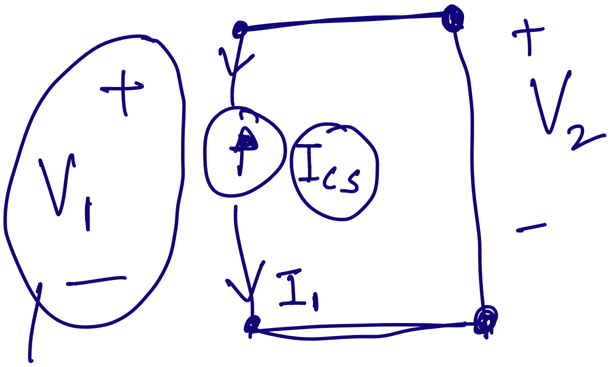
$$= I_1 \cdot V_1 = -I_2 \cdot V_S$$

$$= -\frac{V_S}{R} \cdot V_S = \frac{-V_S^2}{R}$$

$$P_{VS} + P_R = 0$$

Voltage source <u>delivers</u> power.

Short circuit ?



$V_1 = V_2$

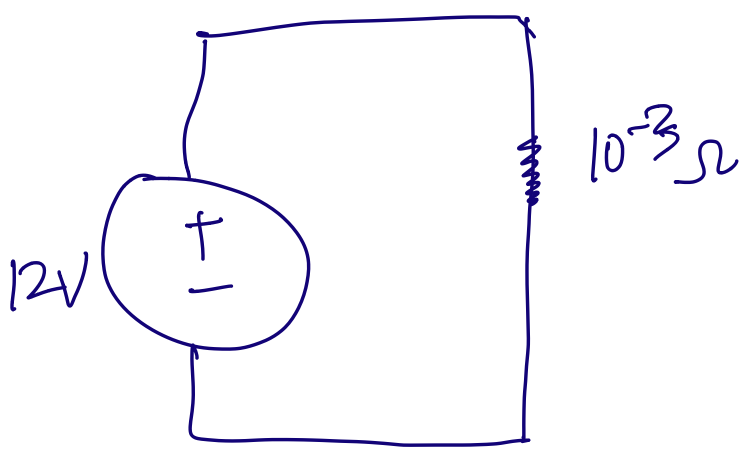
$V_{current\ source}$

$= V_{short\ circuit} = 0$

$V_2 = 0$.

Power: $\underbrace{V_2}_{=0} \cdot I$

$\Rightarrow 0$

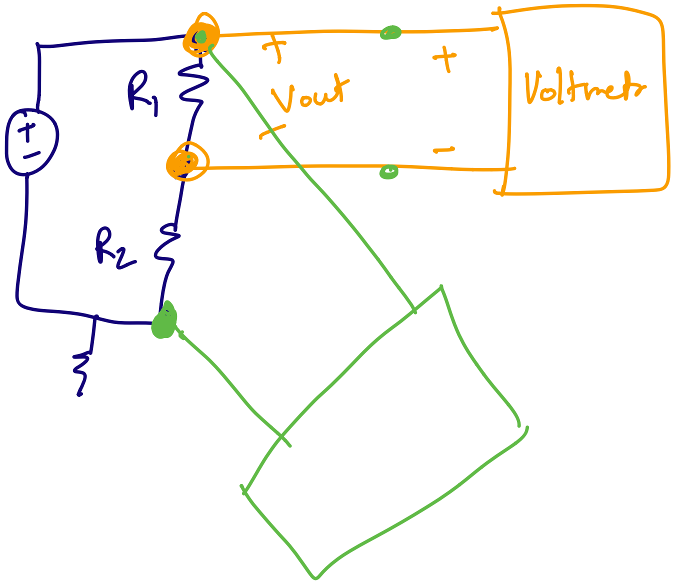


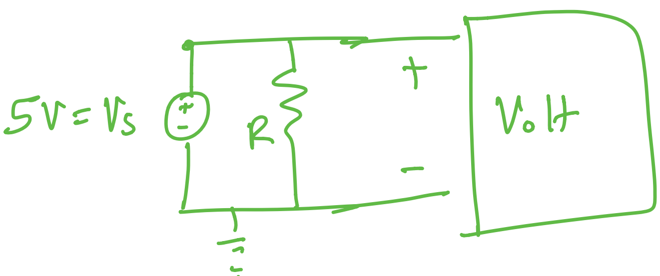
$$I = \frac{V}{R} = \frac{12V}{10^{-3}\,\Omega}$$

$= 12{,}000$ Amp

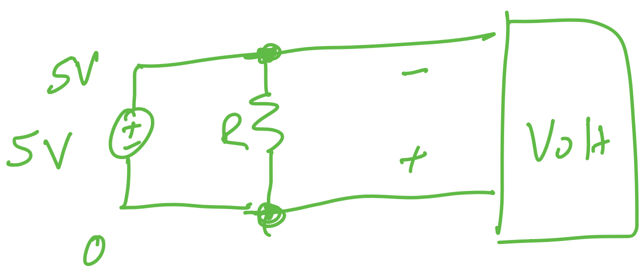
Power $= V \cdot I$

Office Hours



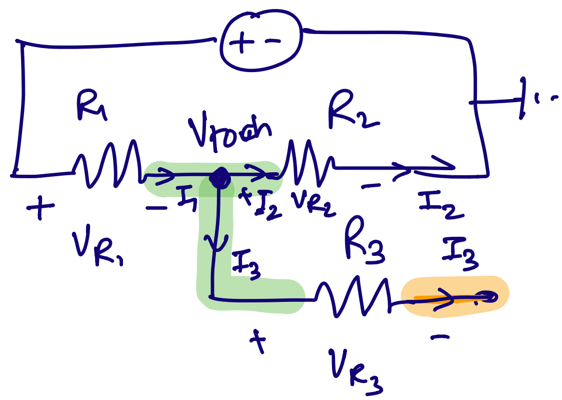


→ Out. 5V



Out = −5V

Dangling Resistor



KCL: $I_1 = I_2 + I_3$ $\Rightarrow$ $I_1 = I_2$

KCL: $I_3 = 0$