EECS 16A

Intro to Circuits!

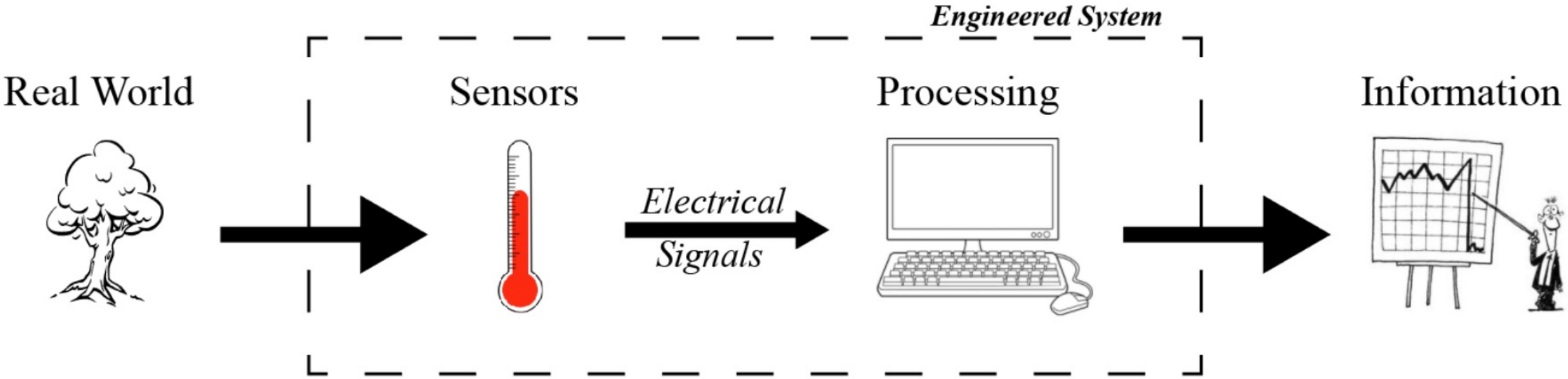
Vide source: www.afrotechmods.com
Do not try this at home (or in the EECS 16A Lab)

Admin

First Midterm Exam: Wednesday March 1, 7-9pm
Covers Module 1 Material up to 2/16 lecture.

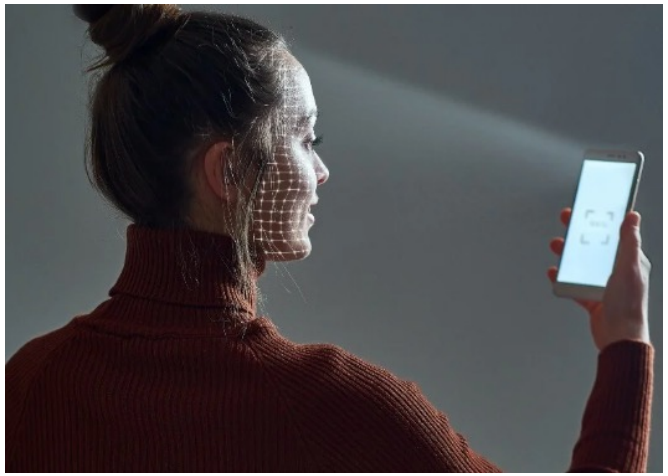
Today: We Start Module 2!

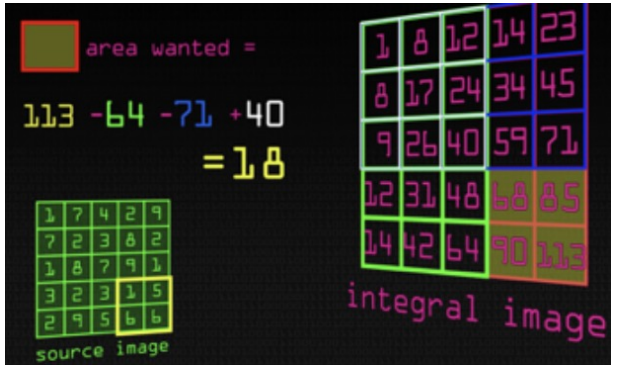
Designing Information Devices and Systems

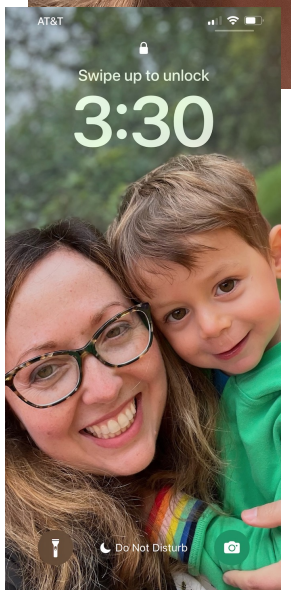


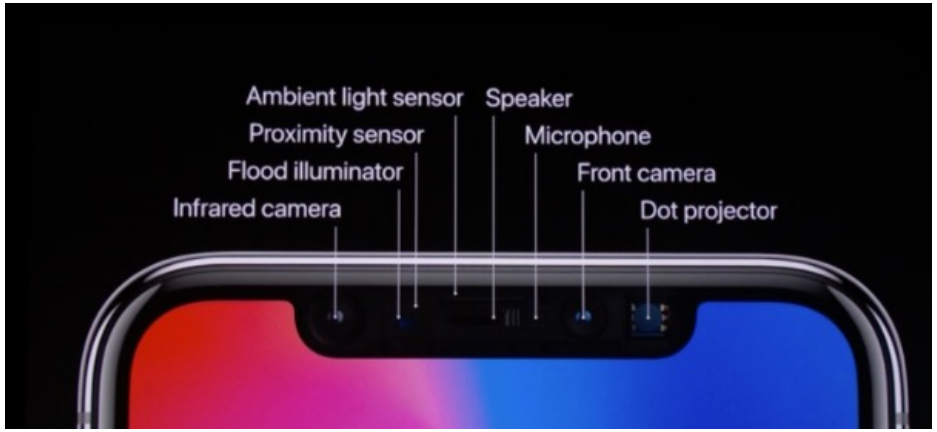
System Example – Face ID

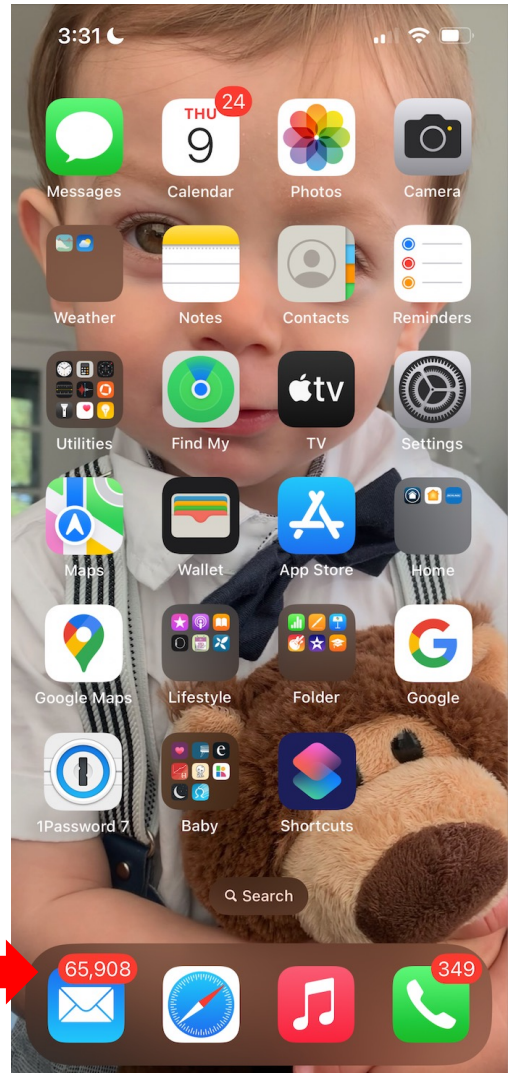
Analog World | Sensor | Processing | Actuation





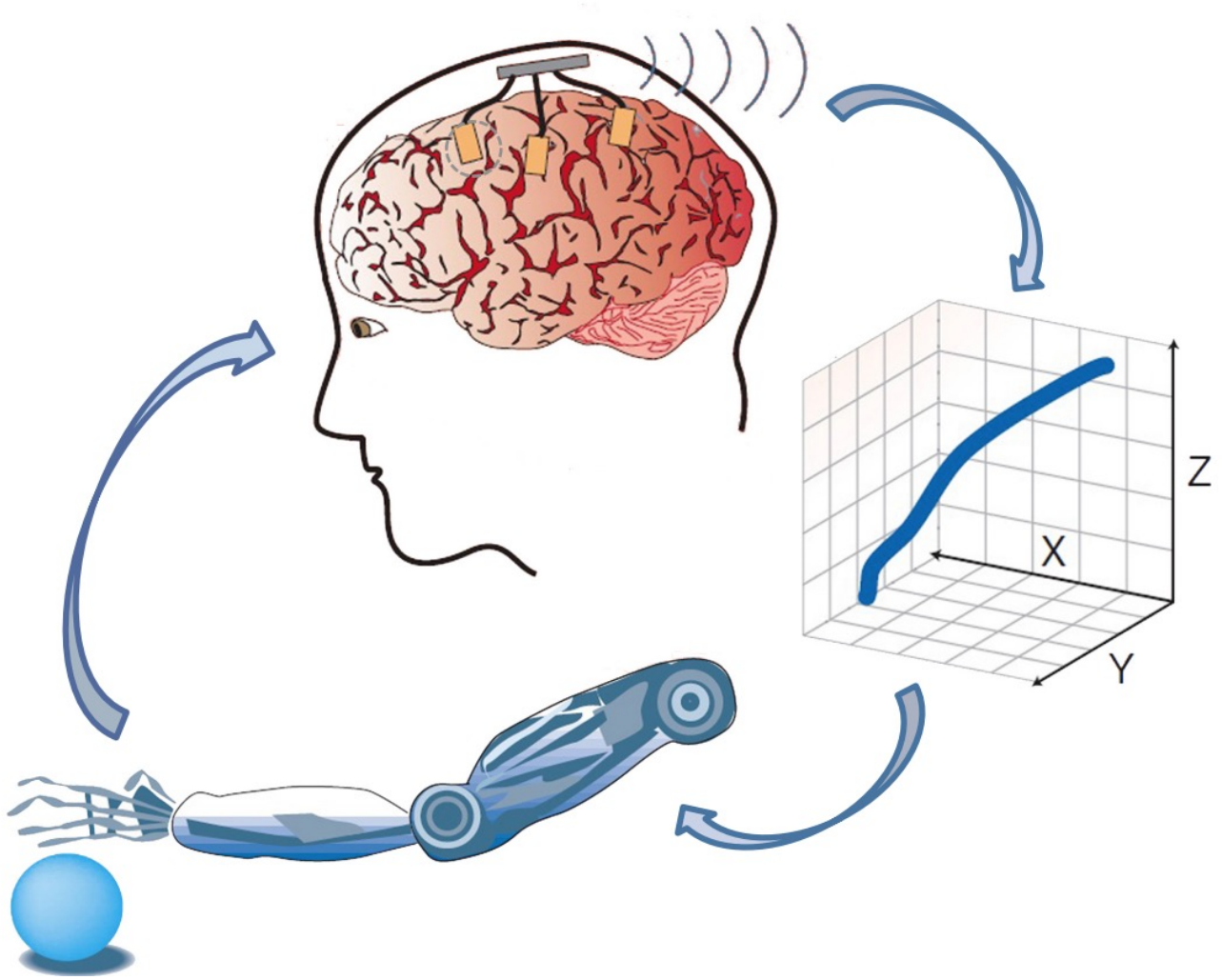






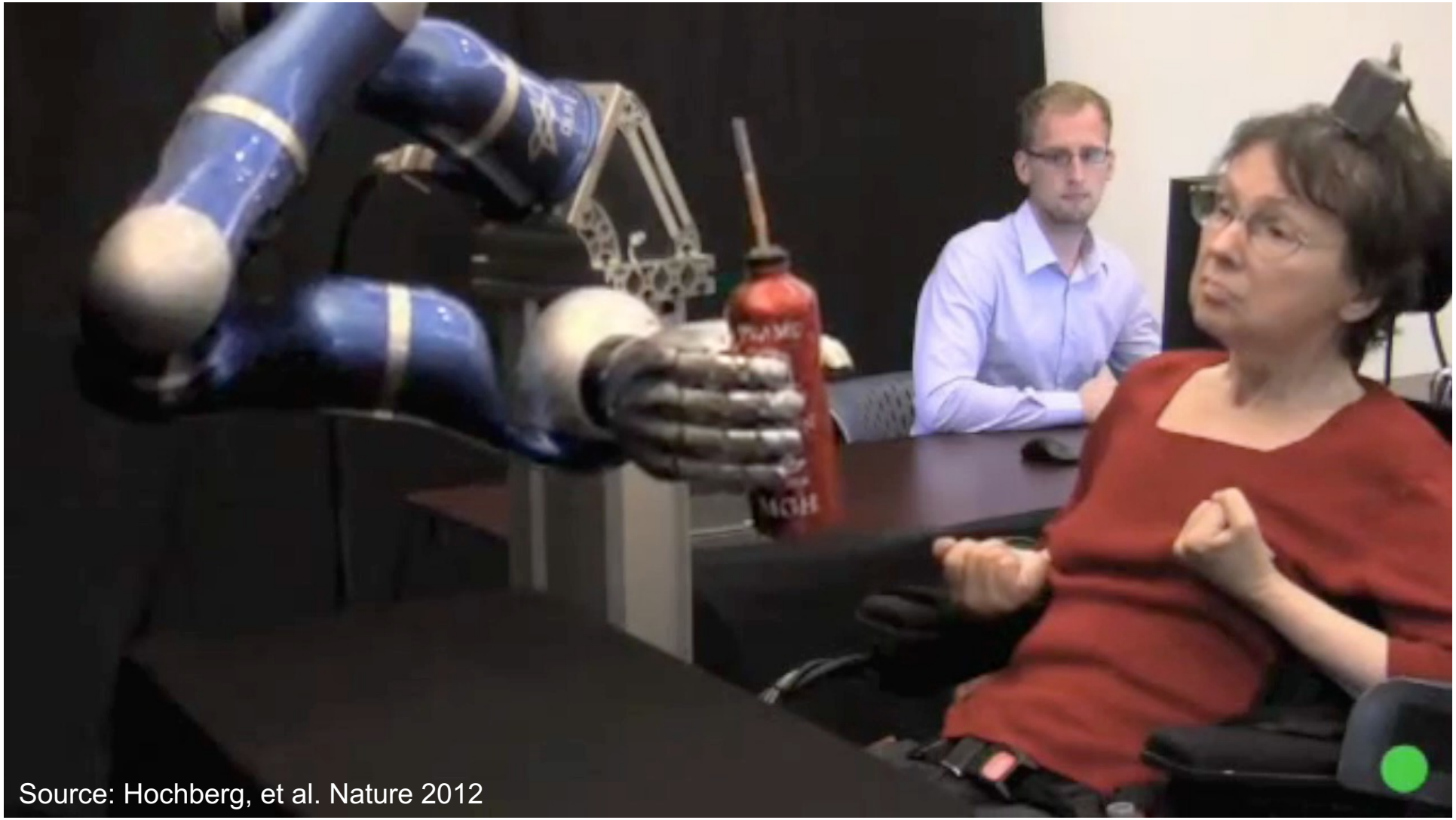
System Example – Brain Machine Interface

Analog World | Sensor | Processing | Actuation



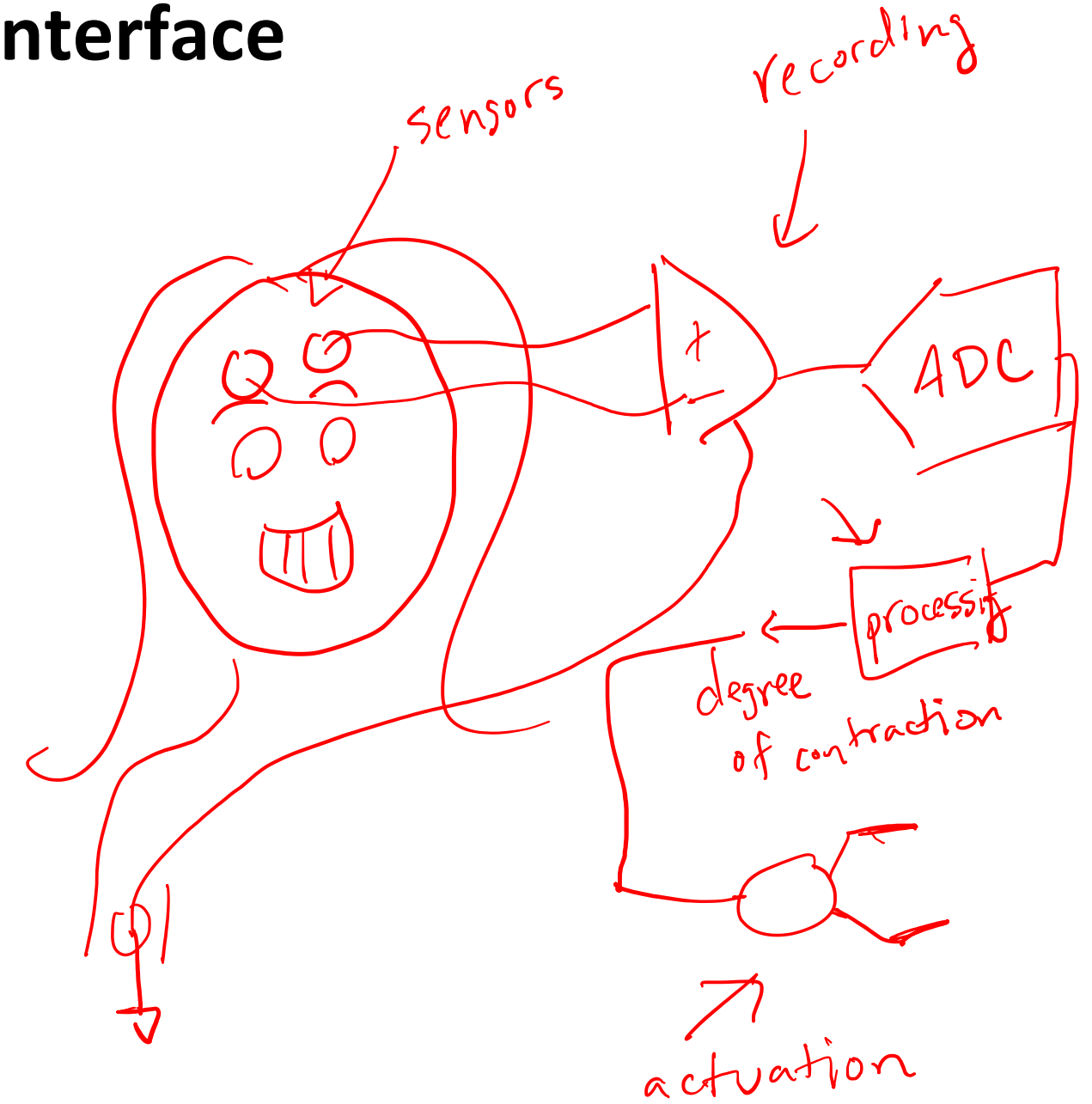
System Example – Brain-Machine Interface

Analog World | Sensor | Processing | Actuation



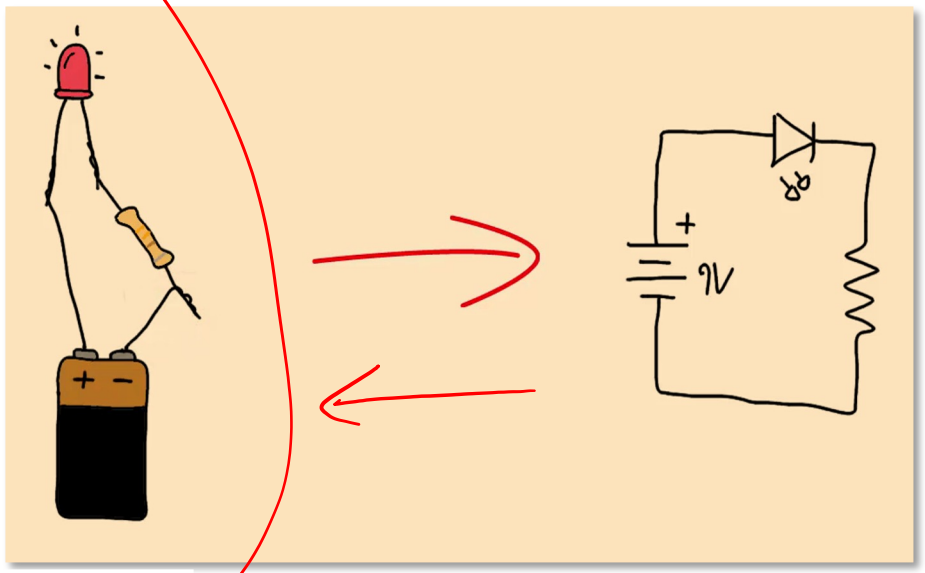
Source: Hochberg, et al. Nature 2012

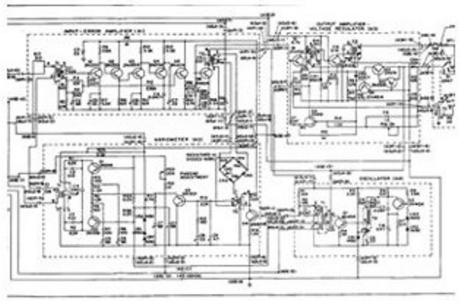
My Own “Brain-Machine” Interface



In Module 2 we will learn how to analyze circuits

We need to be able to go from a real-world circuit, to a circuit model, and vice versa.



CLASS	HOPES	REALITY
Introduction to Electrical Engineering		

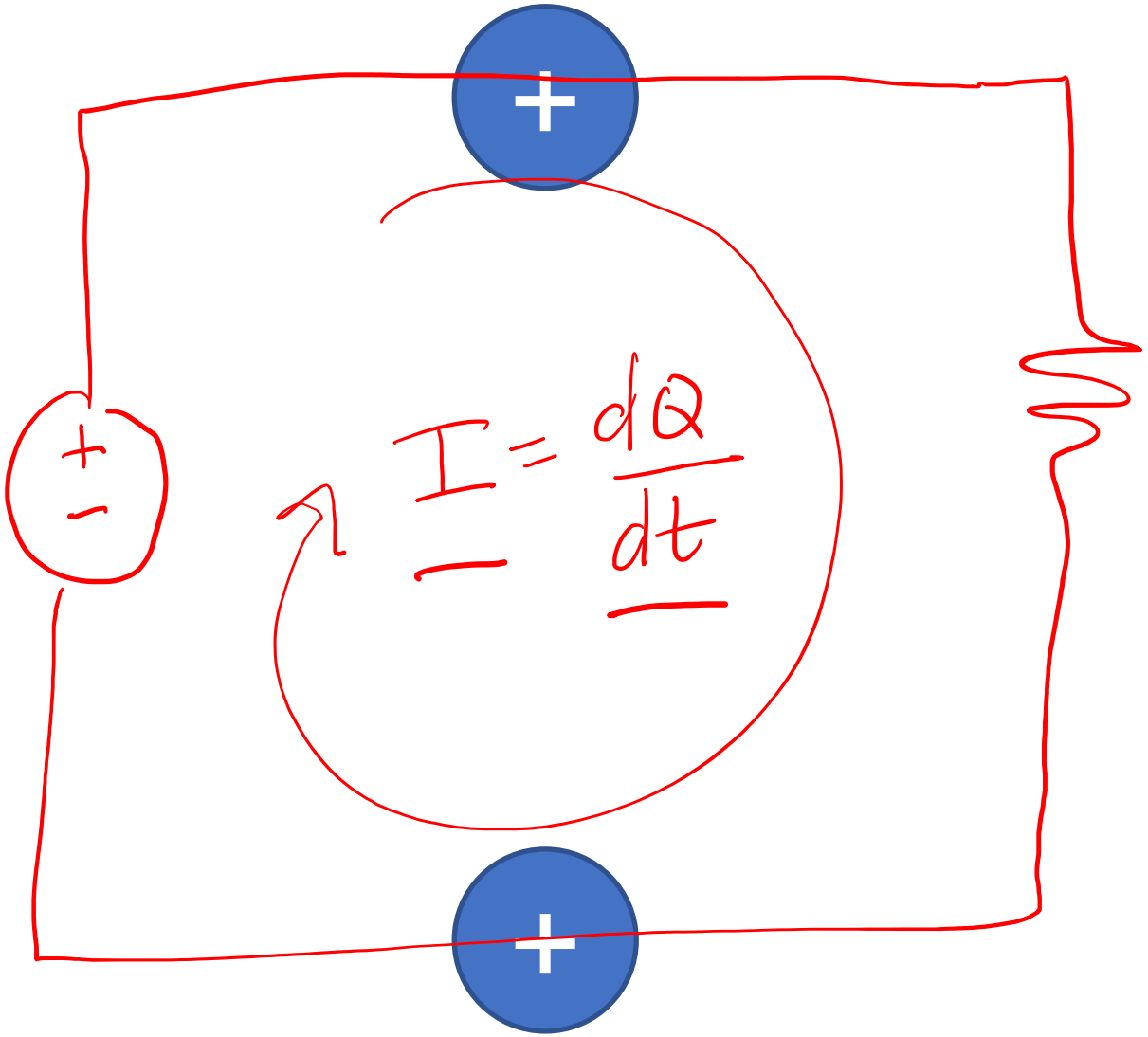
Then we need to know how to solve the model…

Note: the tool used by computers to analyze circuits is *linear algebra*!

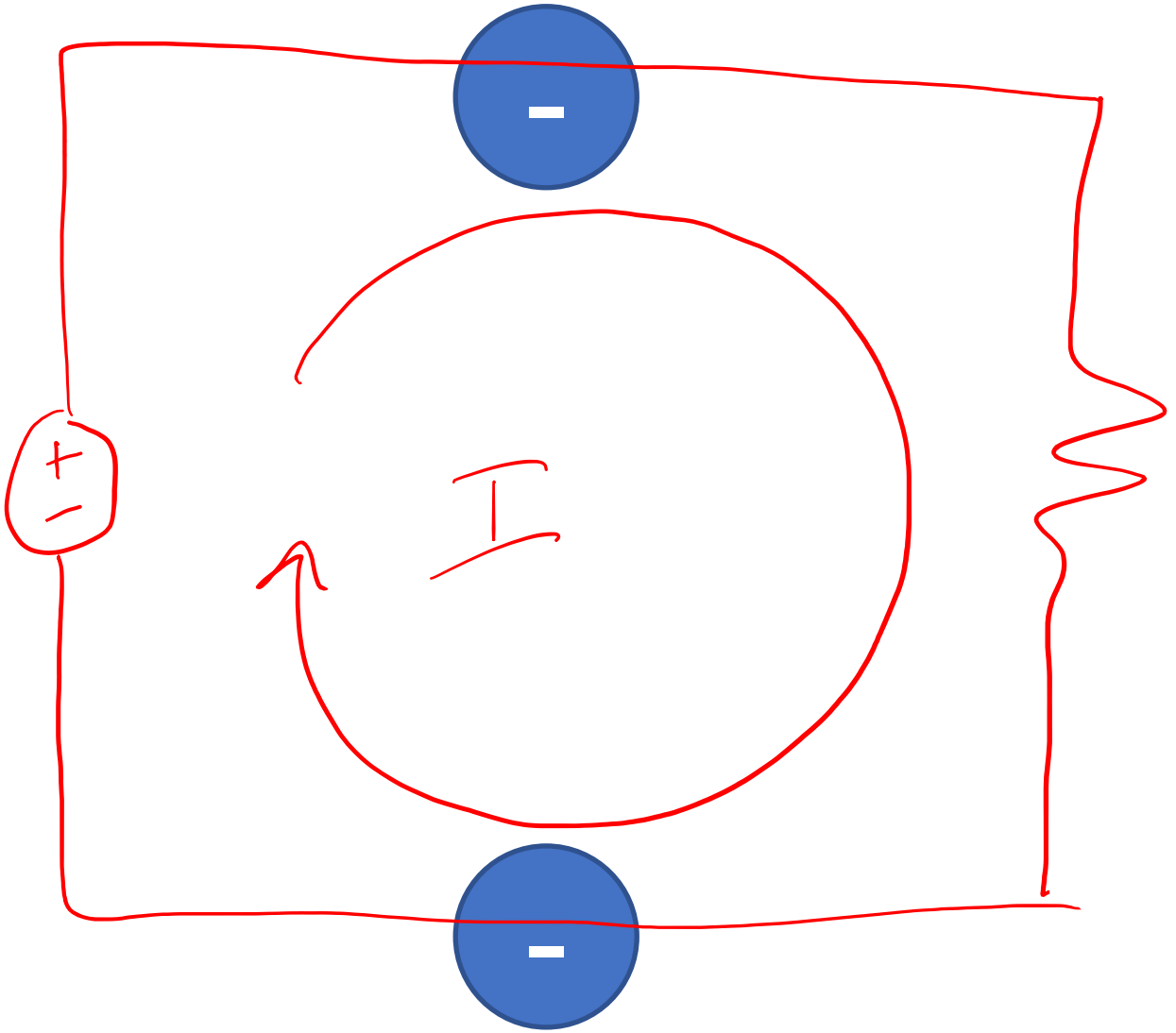
Electronic Devices depend on movement of charges

Electric Current

Q = charge

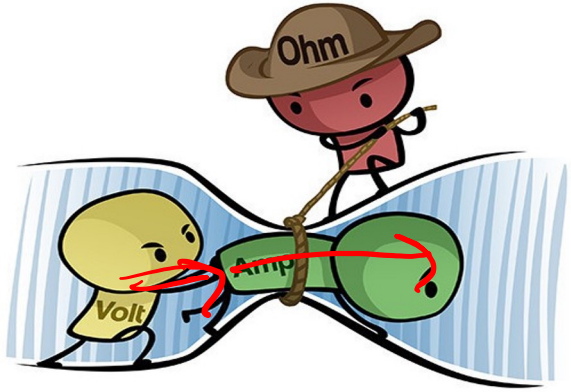


Electronic Devices depend on movement of charges

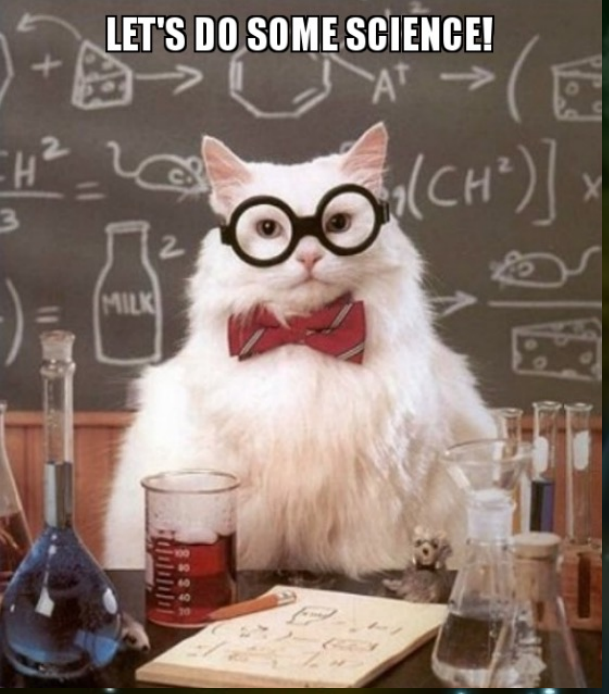


Electrical Quantities

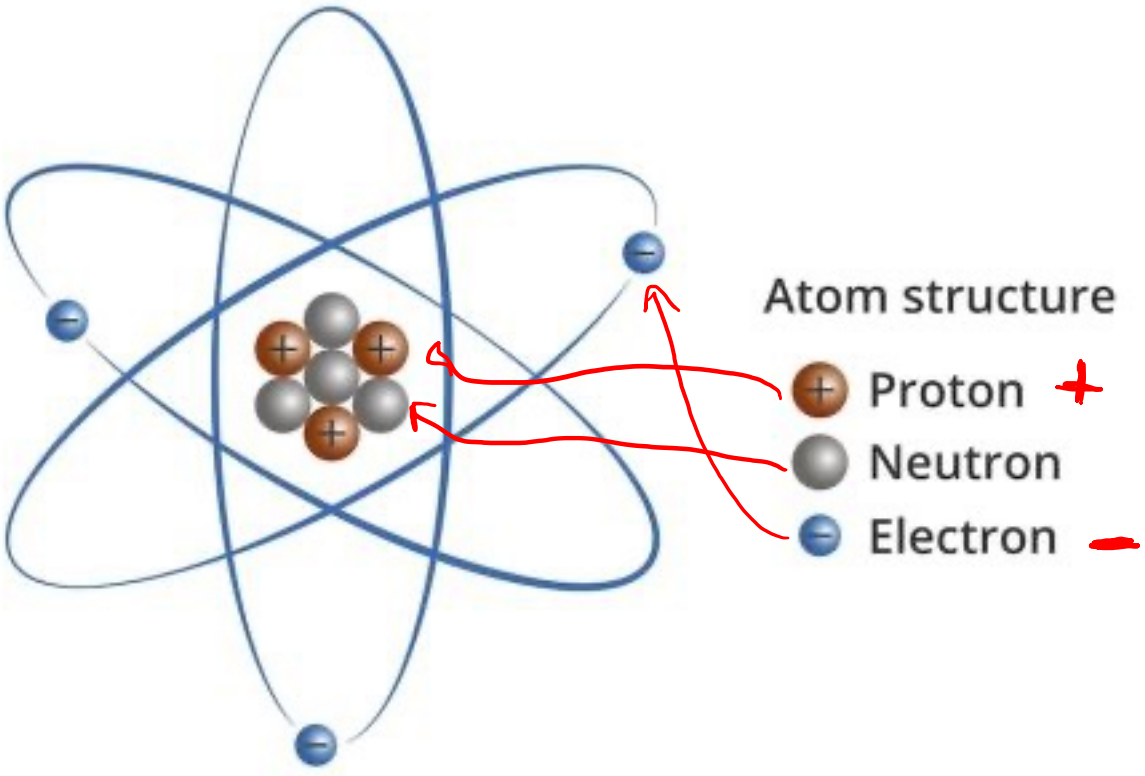
Quantities	Analytical Symbol	Units
Charge	Q	Coulombs [C]
Current	I	Amperes [A] = [C/s]
Voltage	V	Volts [V]
Resistance	R	Ohms [Ω] = [V/A]

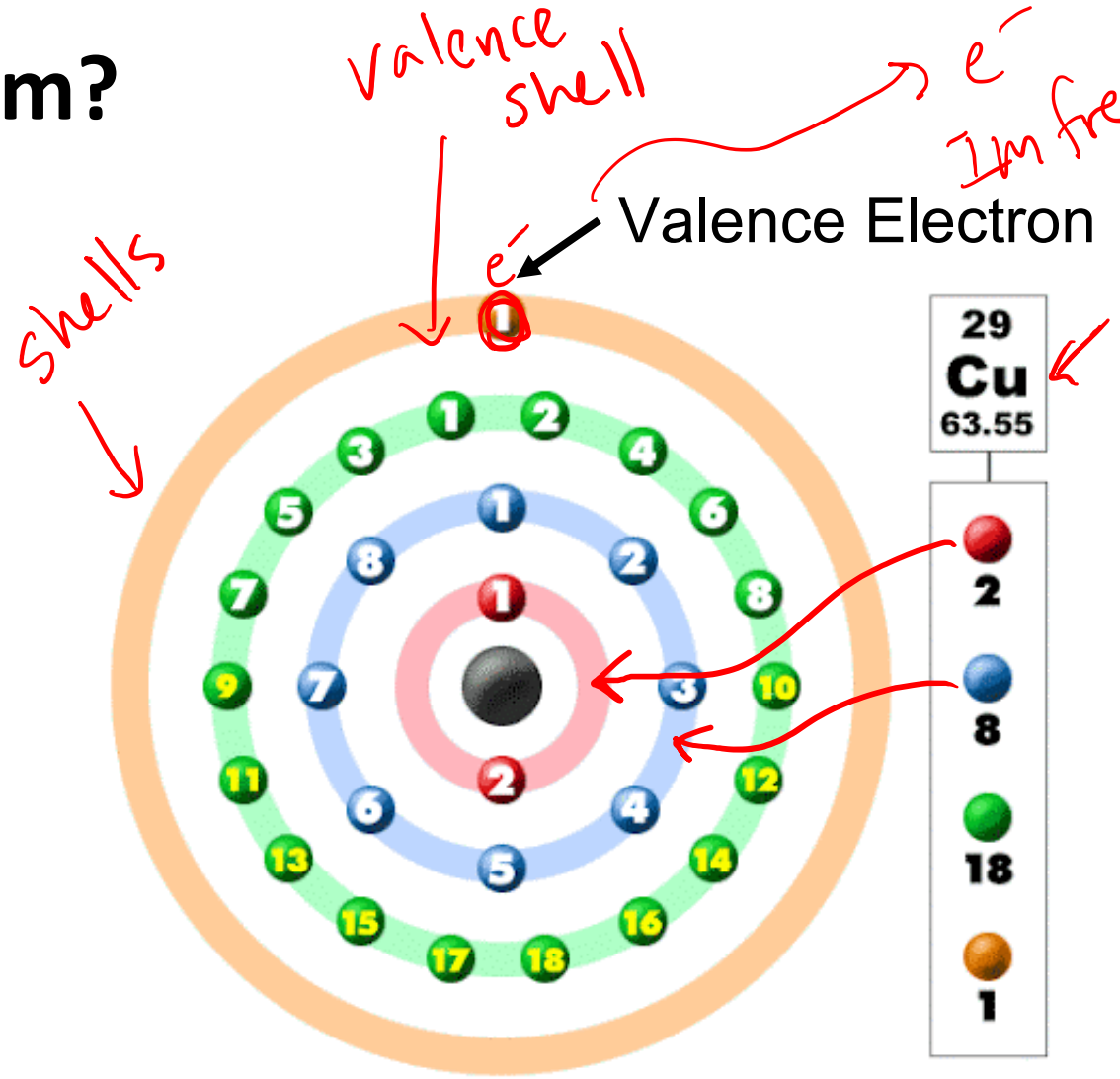


$V = IR$


LET'S DO SOME SCIENCE!

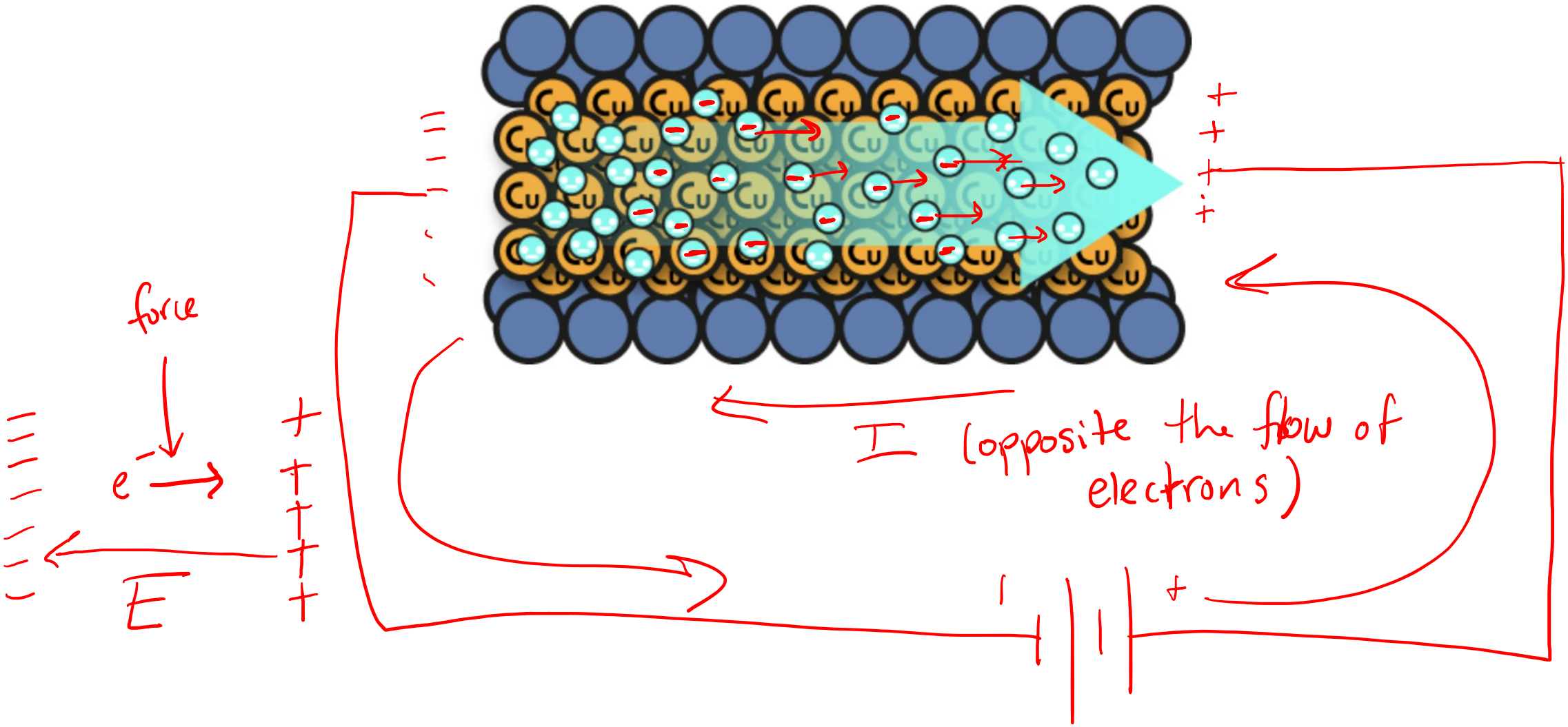
Where does charge come from?



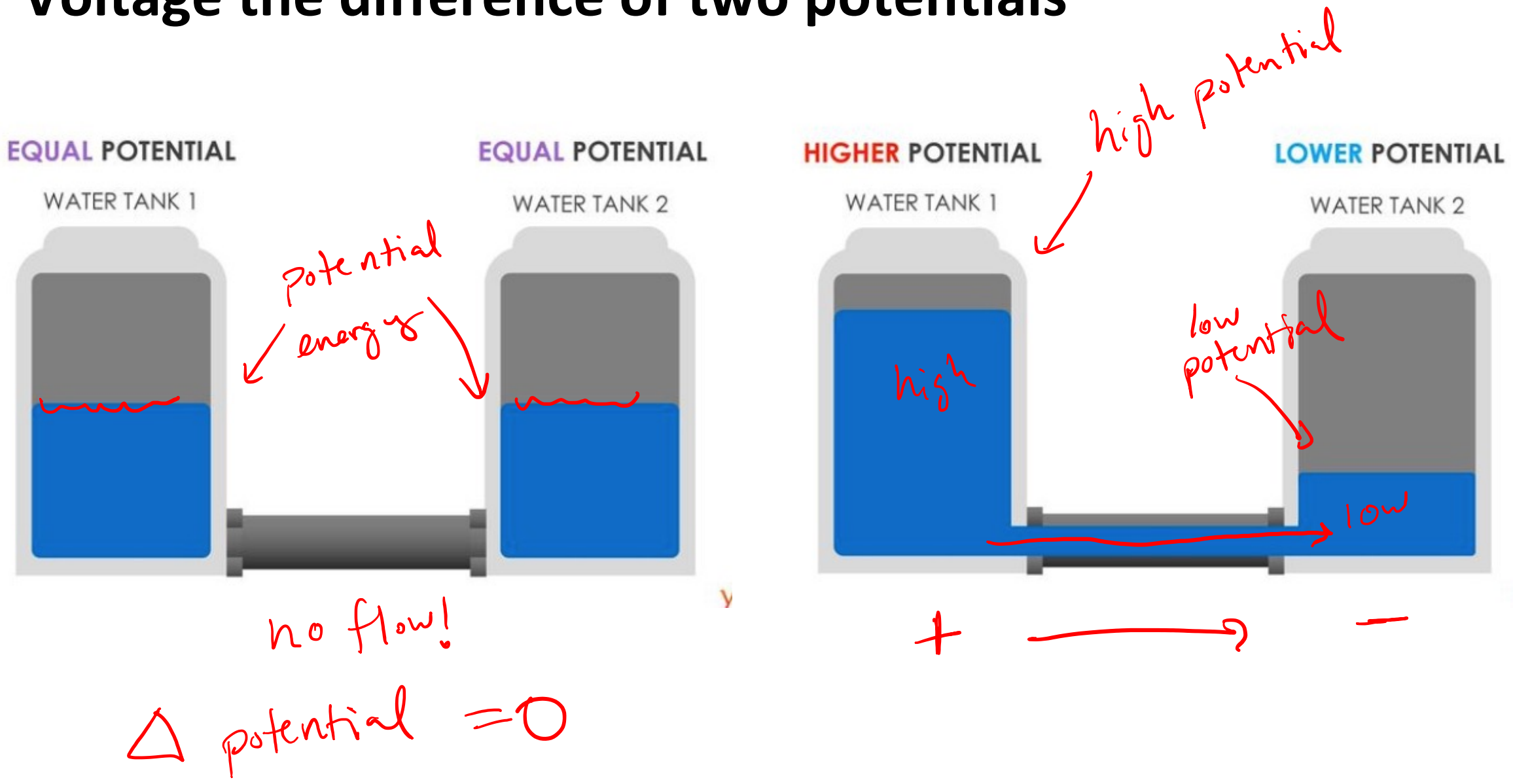


The charge of an electron q_e = -1.6 x 10^{-19} C (Coulombs)

Where does current come from?

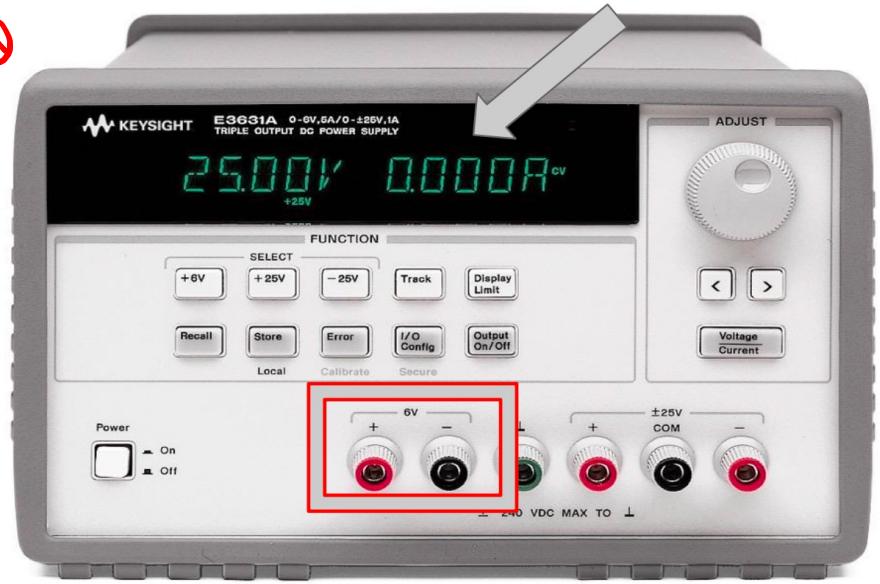


Voltage the difference of two potentials

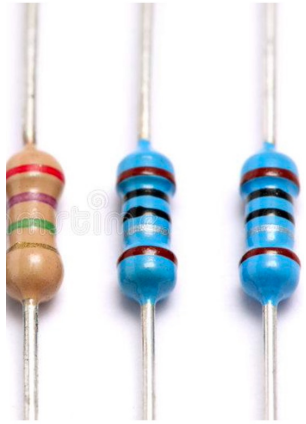


In the Lab

power supply



wires

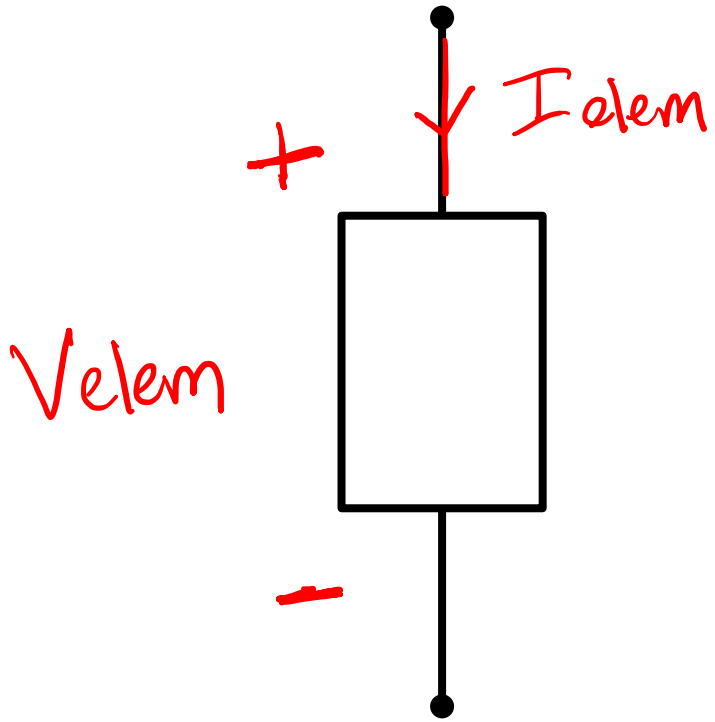


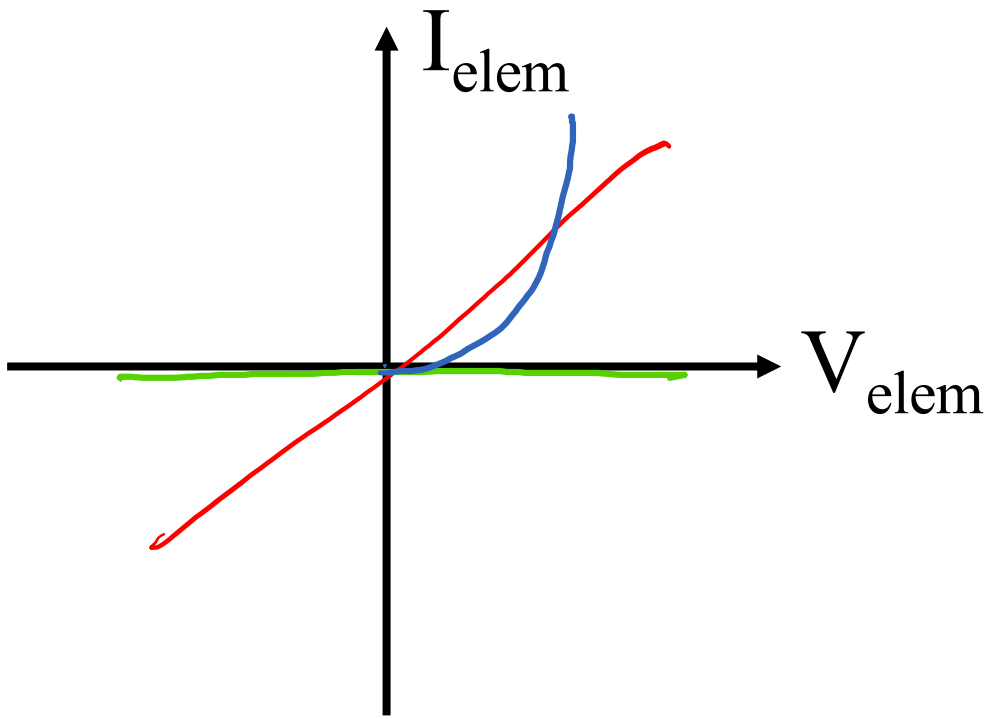
R

light

Definitions needed to analyze a circuit: Circuit Element

An element has some voltage across it and some current through it



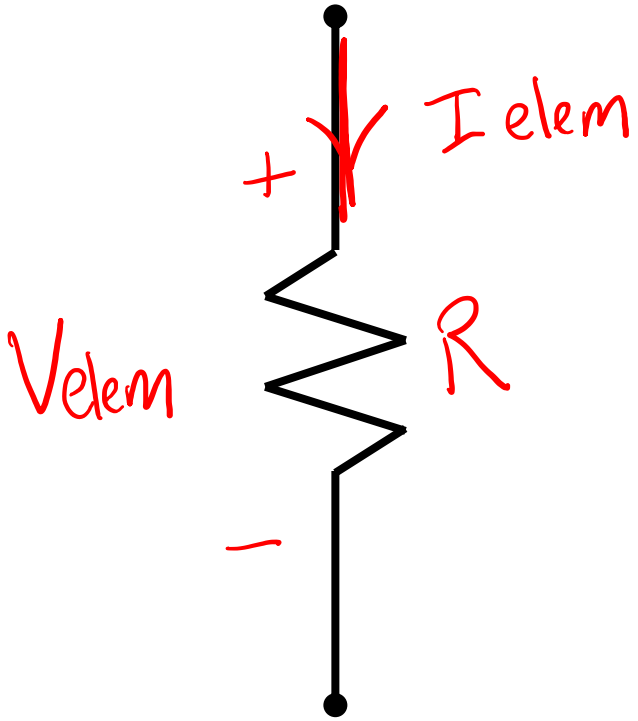


Velem: Voltage across the element

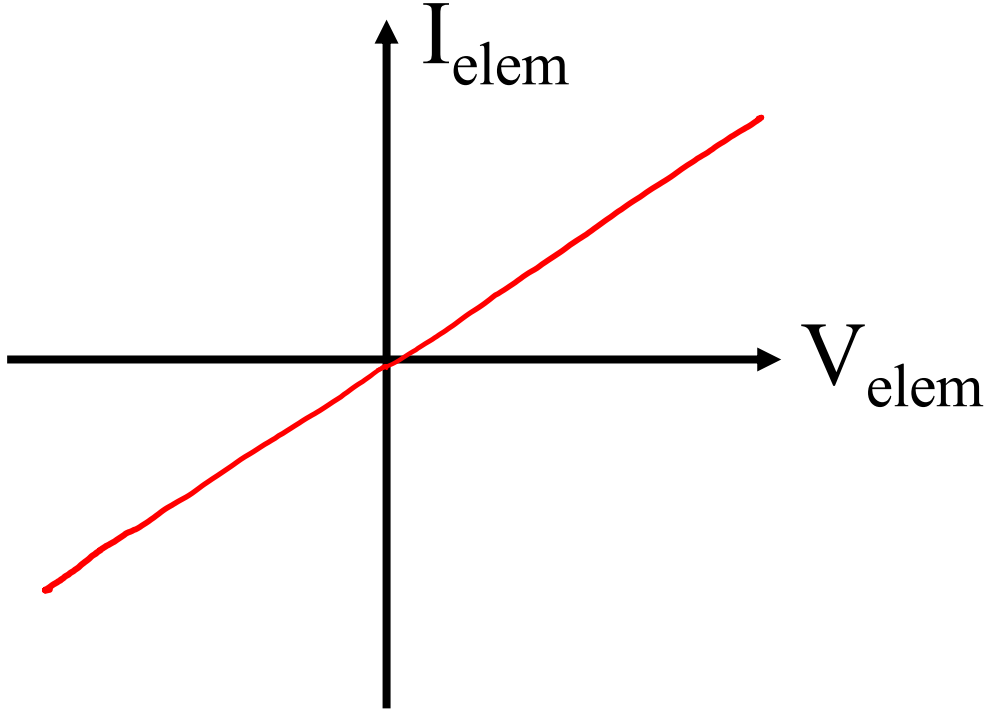
Ielem: Current through the element

Key circuit elements: Resistor (passive)

does not introduce new energy into the circuit

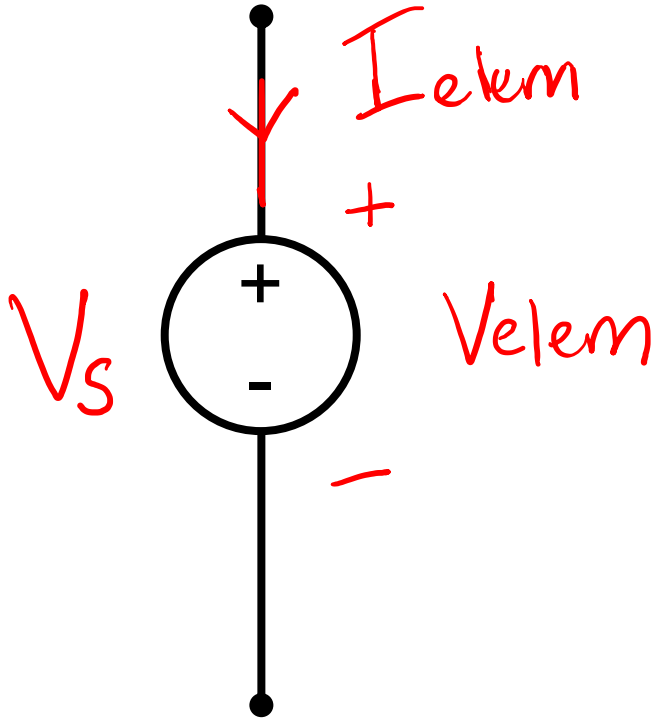


$V_{elem} = I_{elem} R$



Key circuit elements: Voltage Source (active)

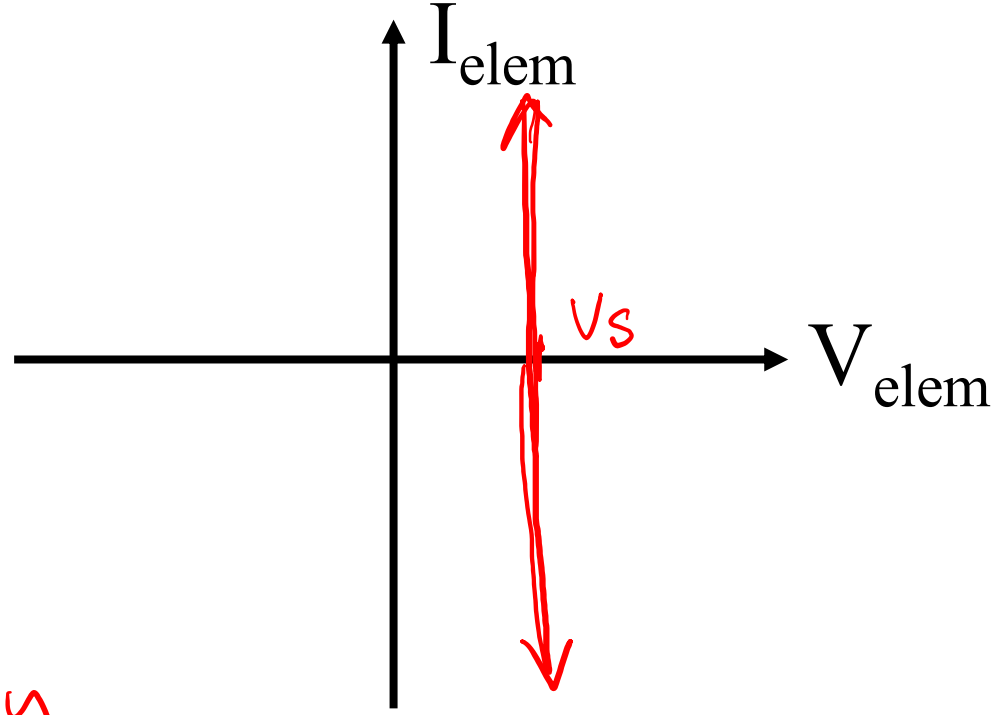
↳ source of energy!



always true

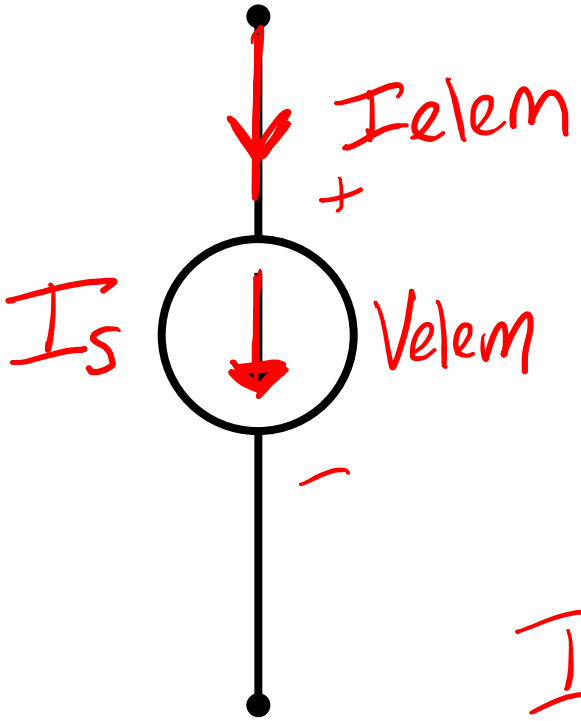
$V_{elem} = V_s$

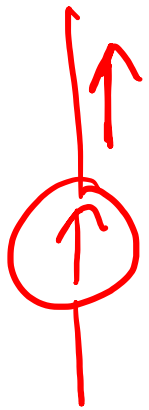
$I_{elem} = ?$ set by external circuit

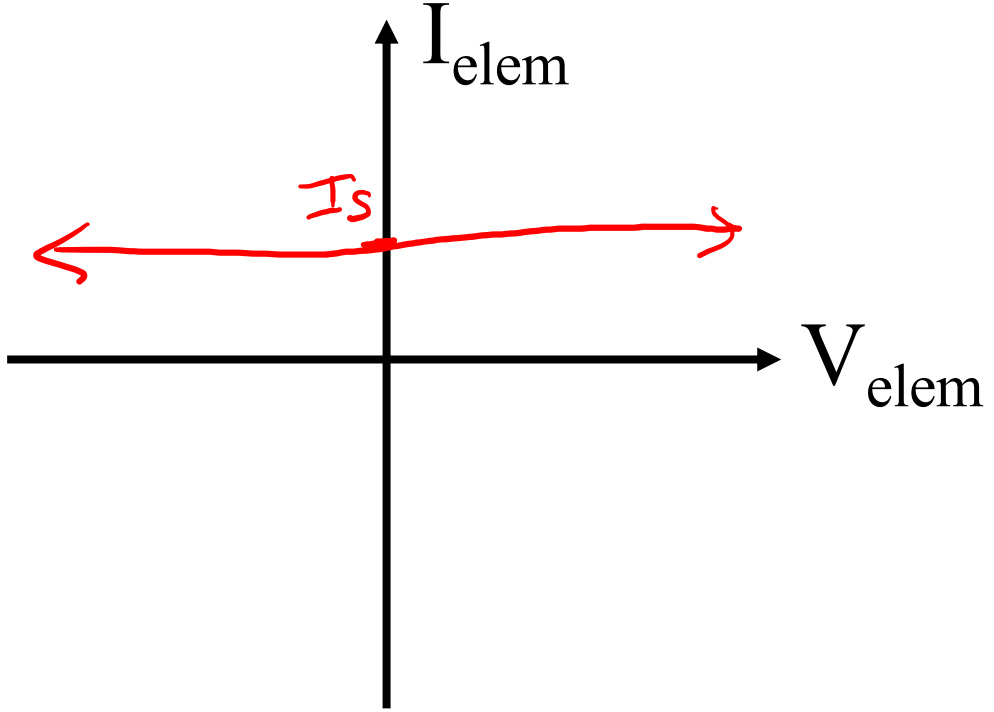


Key circuit elements: Current Source (active)

↳ source of energy!







Ielem = Is

Velem = set by external circuit

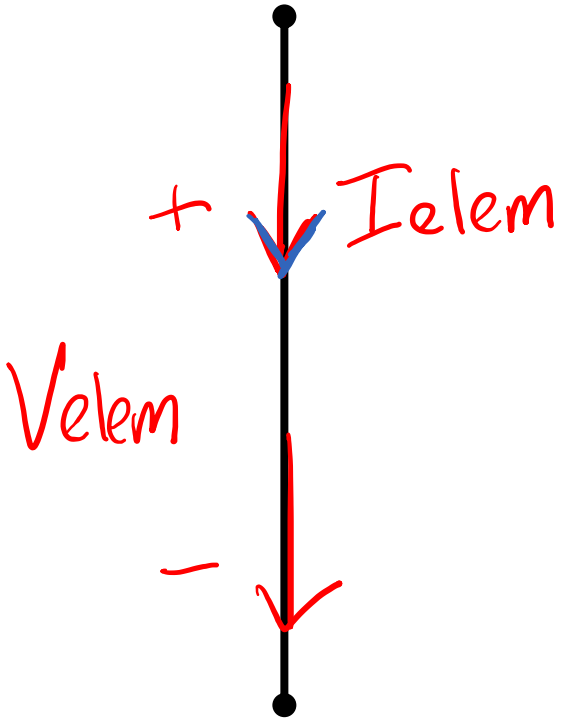
Circuit element connection: Wire

Ideal wire $R = 0\ \Omega$

$V = I R$

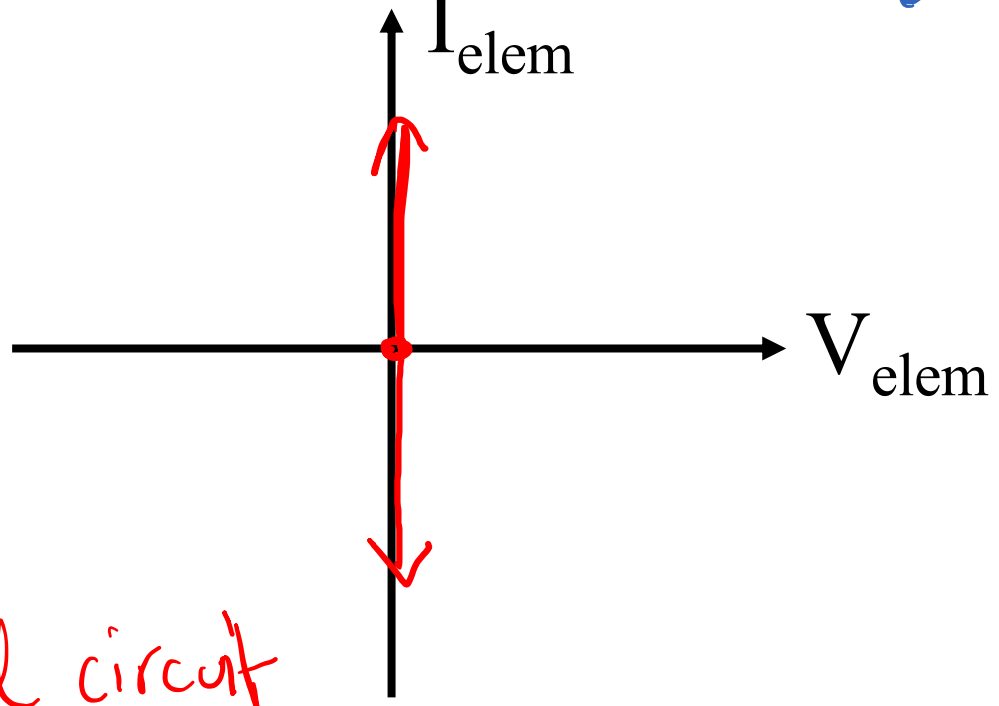
$0 = I \cdot 0$

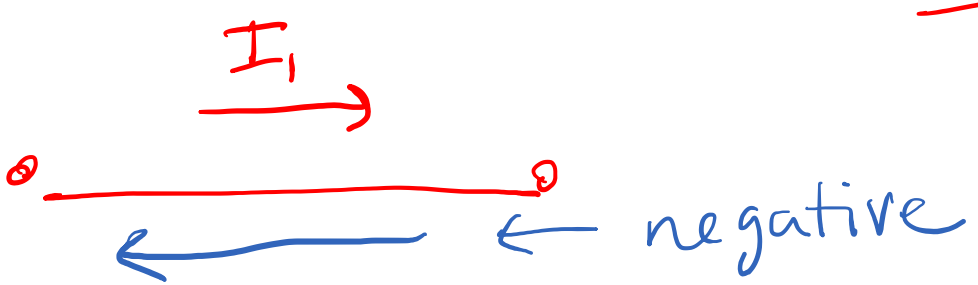
$I = ?$



Velem = 0V

Ielem = ? set by external circuit

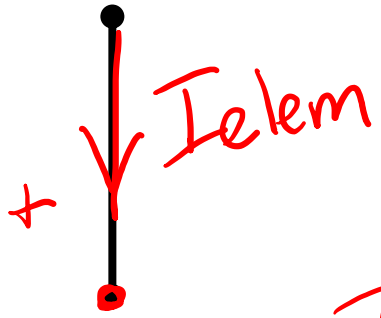




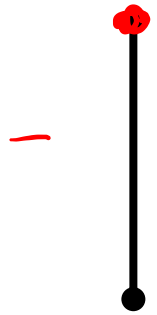
Circuit element connection: Open circuit

$R = \infty$

$V = \not{I}\not{R}$ ∞ 0



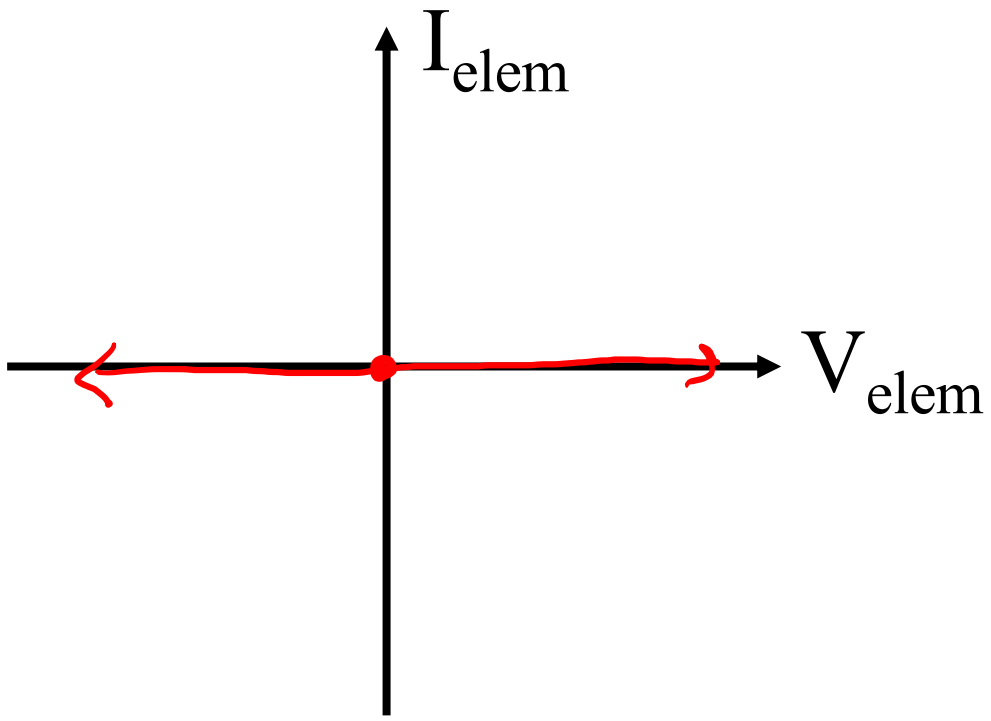
Velem



$I_{elem} = 0A$

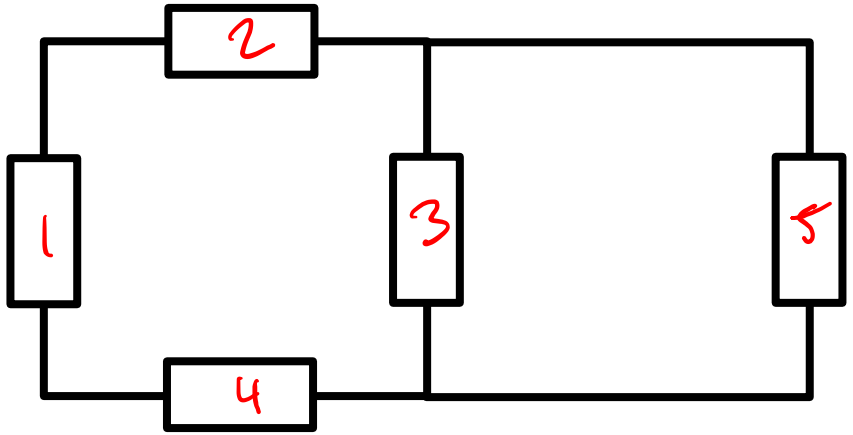
$V_{elem} = ?$

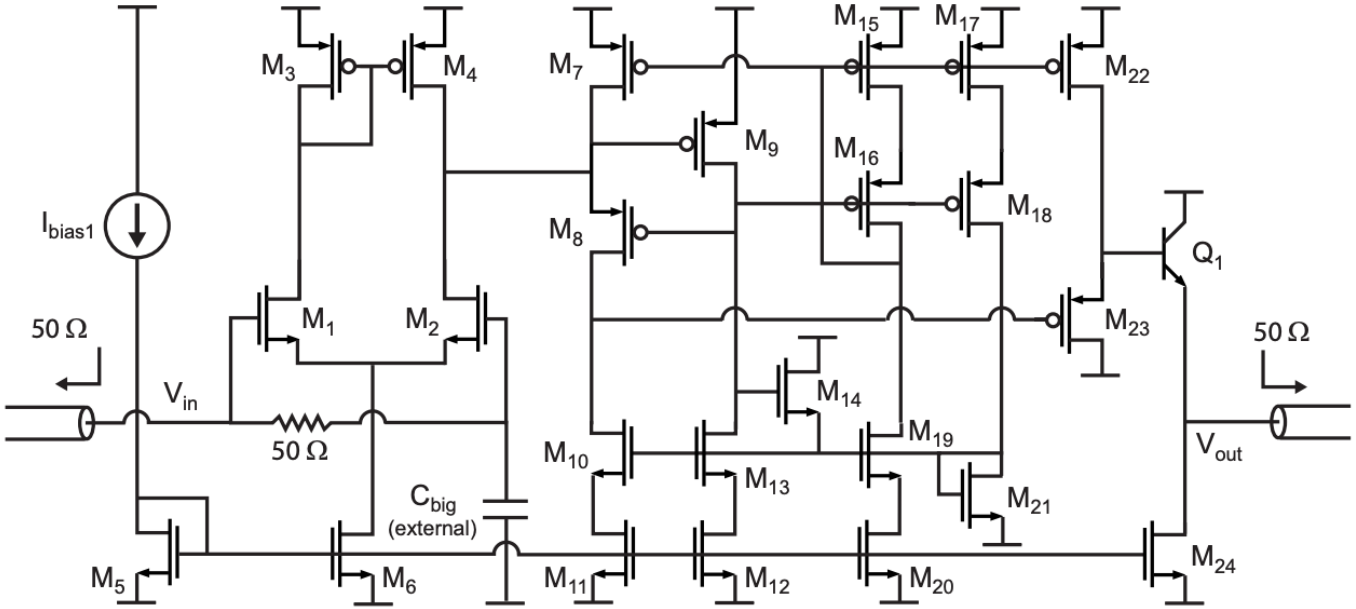
set by external circuit



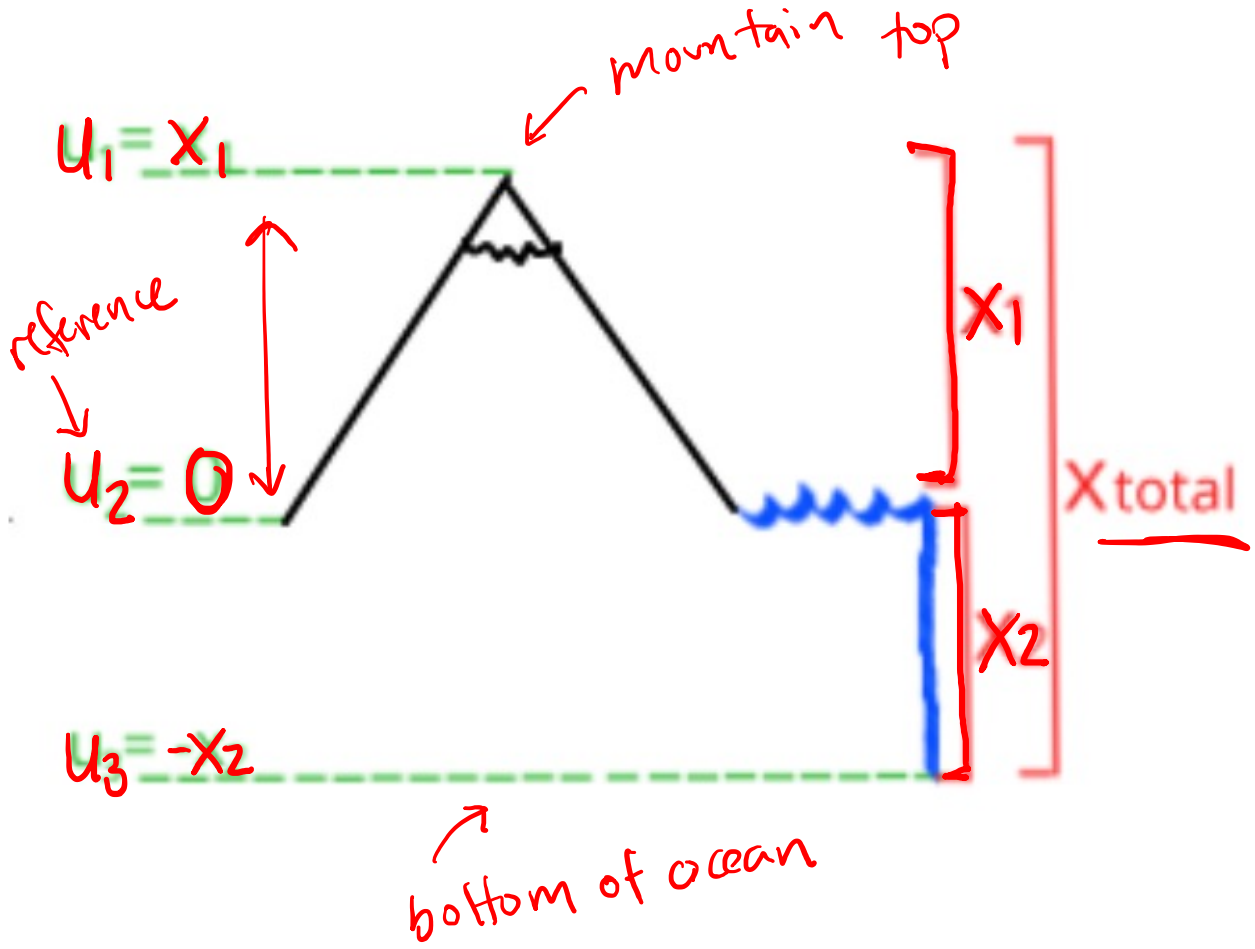
Definitions needed to analyze a circuit: Circuit Diagram

Collection of elements, where each element has some voltage across it and some current through it





Voltage is the Difference of Two Potentials

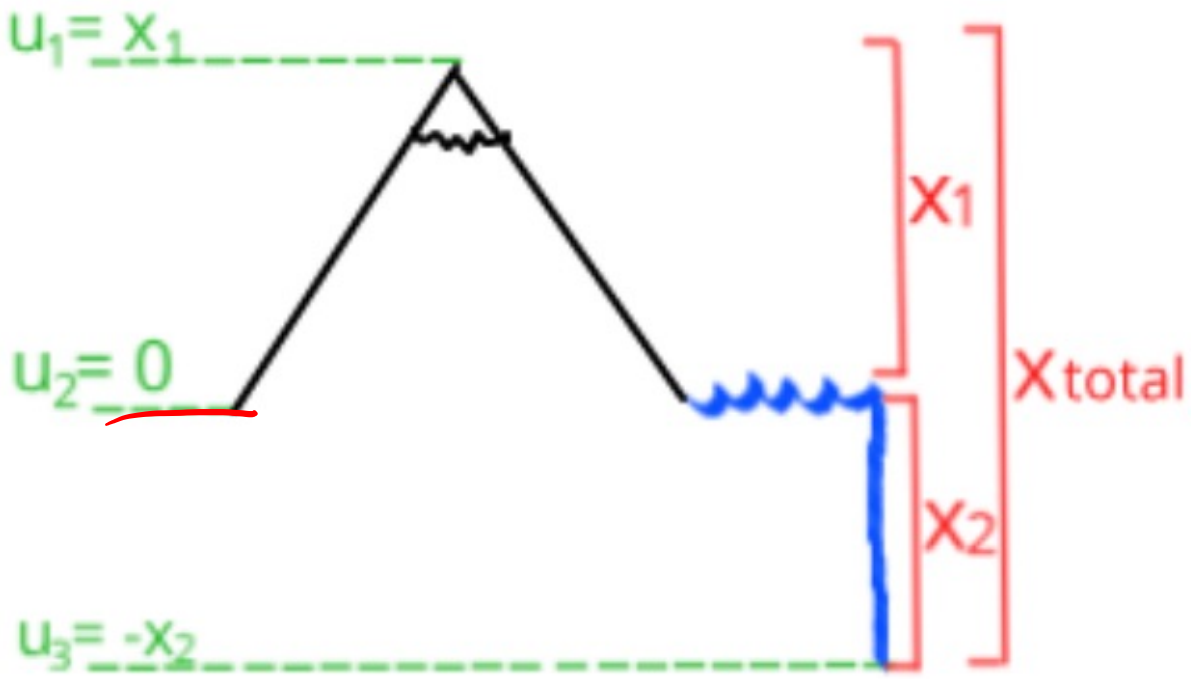


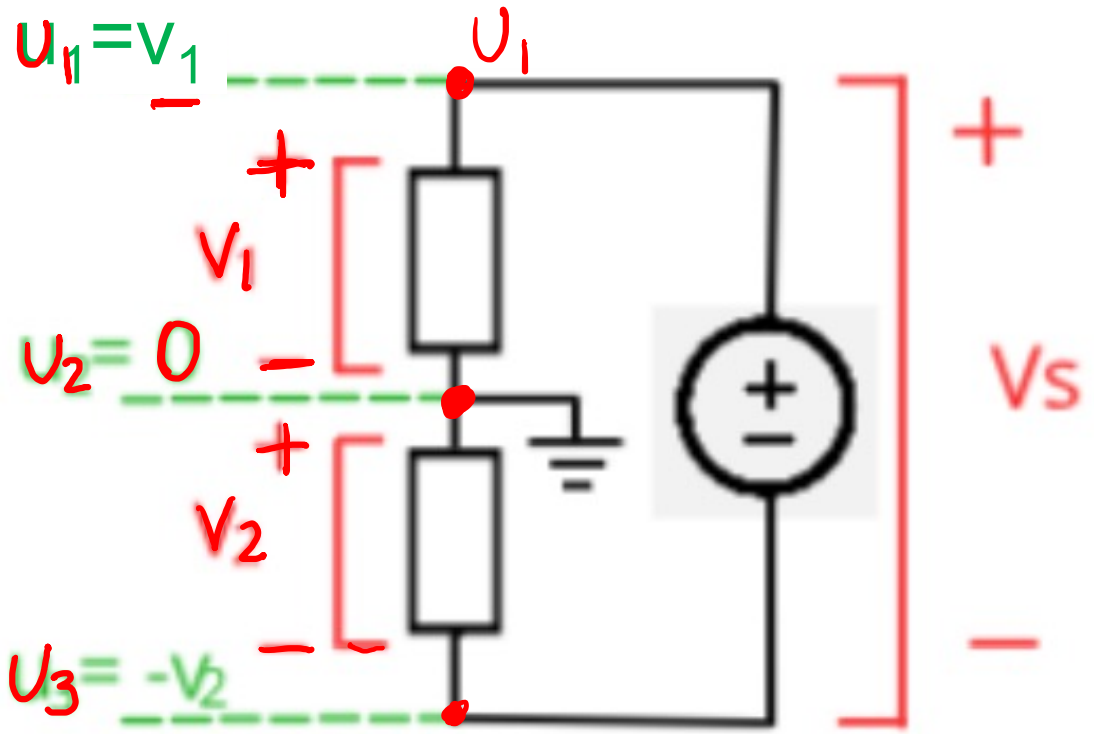
$$X_{total} = X_1 + X_2$$

$$X_1 = U_1 - U_2 =$$

$$X_2 = U_2 - U_3 = 0 - (-X_2)$$

Voltage is the Difference of Two Potentials (u)



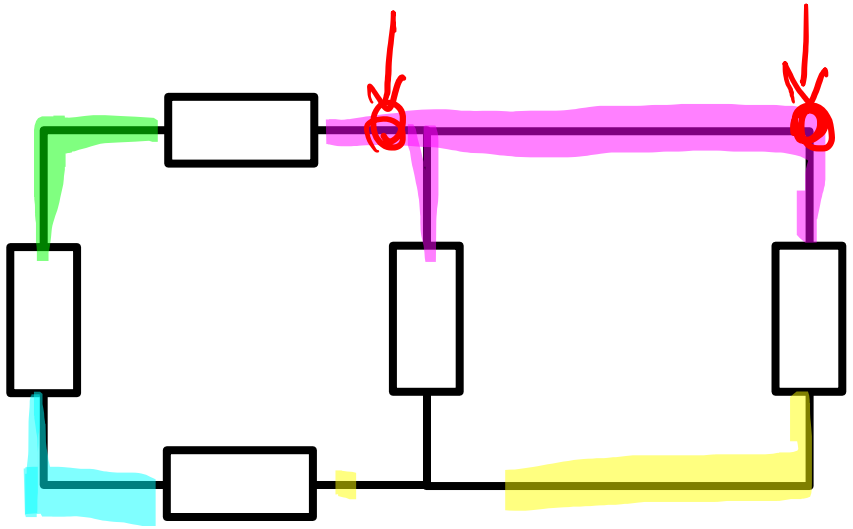


$V_S = V_1 + V_2$

$V_1 = U_1 - U_2 = V_1 - 0$

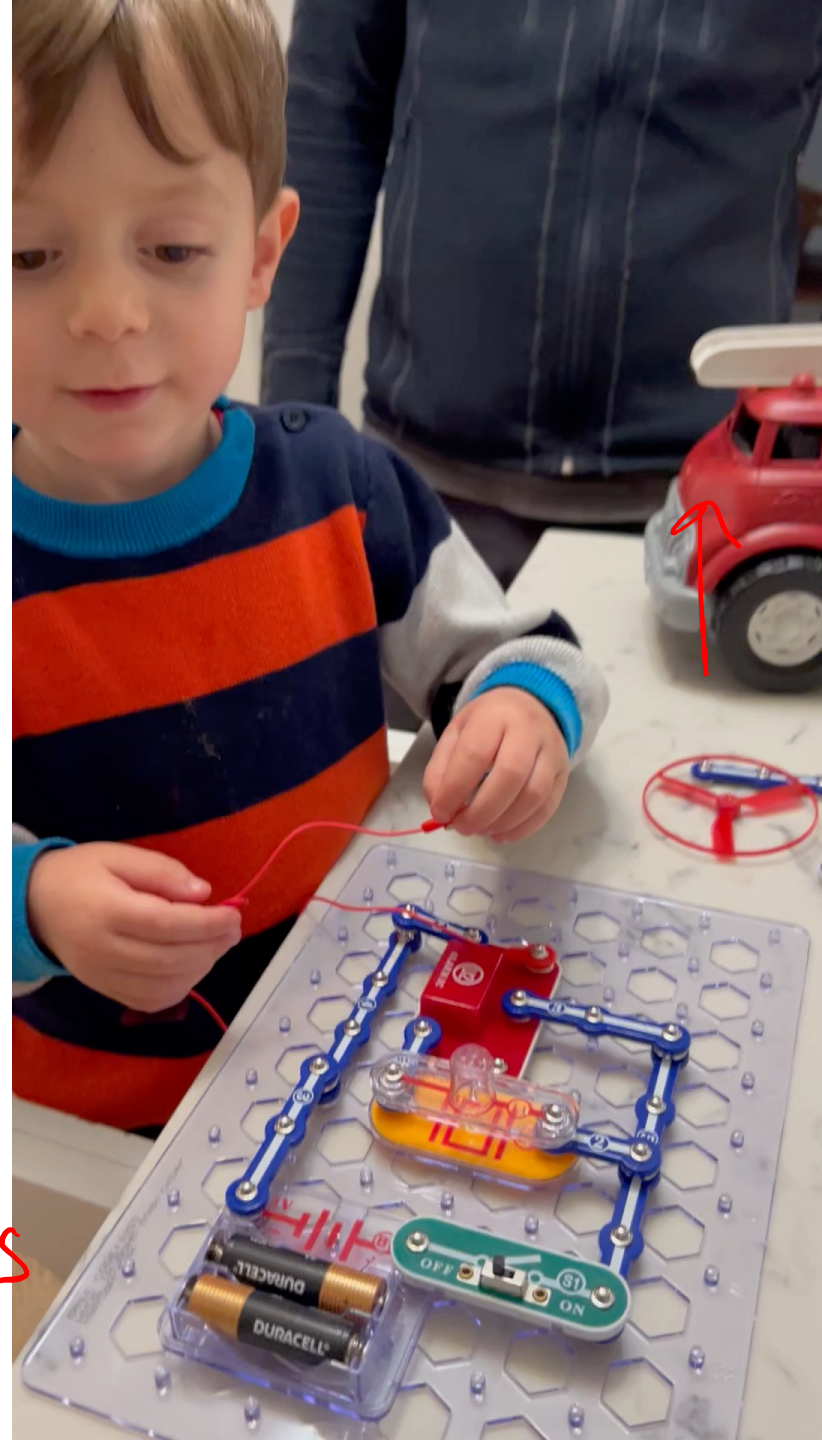
$V_2 = U_2 - U_3 = 0 - (-V_2) = V_2$

Definitions needed to analyze a circuit: Nodes

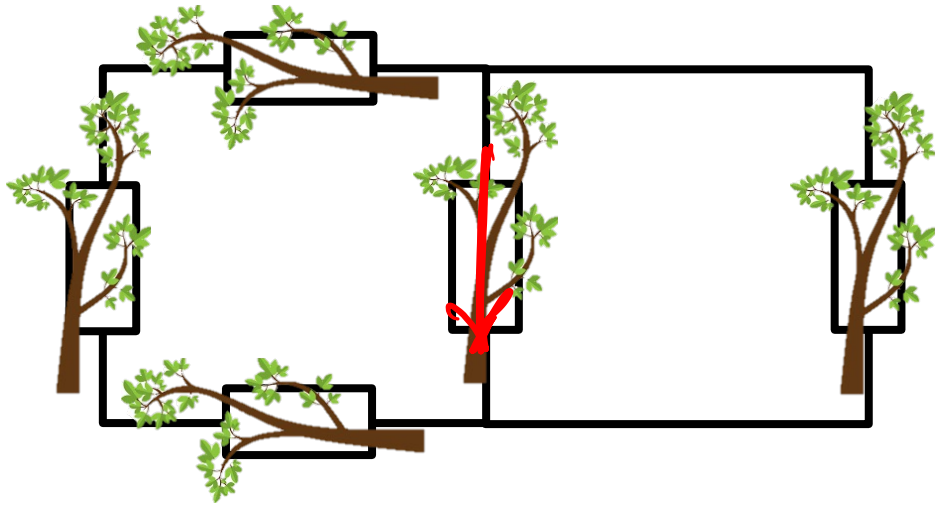


Nodes: point where elements meet

How many nodes in this circuit? 4 nodes



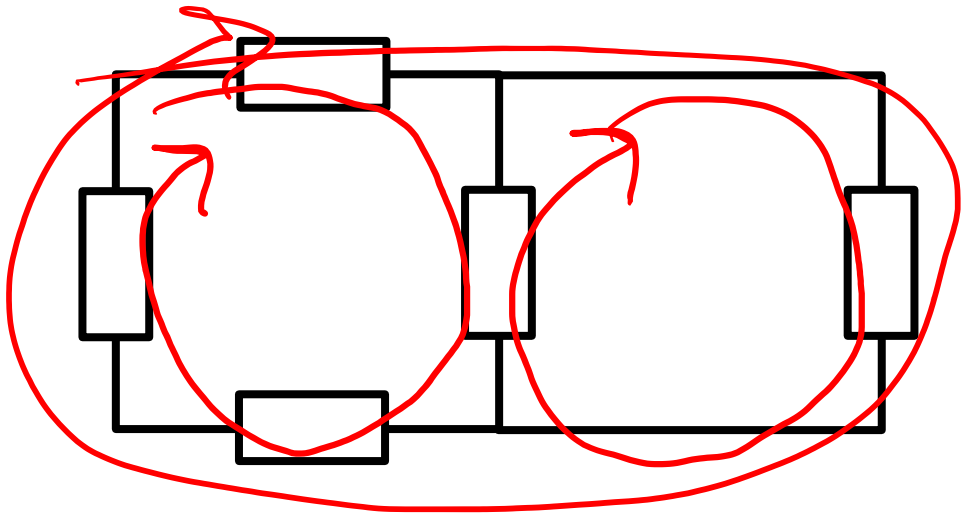
Definitions needed to analyze a circuit: Branches



Branches: the connections between nodes

How many branches in this circuit? 5

Definitions needed to analyze a circuit: Loops



Loops: any closed path going through circuit elements

How many loops in this circuit? 3