EECS 16A Designing Information Devices and Systems I
Fall 2021 Discussion 6B

1. Material Resistivity

(a) Recall the 1D resistive touch screen model introduced in class. In this model, the top layer can be thought of as a resistor, while the bottom layer can be thought of as a wire. When the top layer is touched, it flexes at the touch point and makes contact with the bottom layer. This results in a voltage divider.

Material	**Resistivity ρ (Ω cm)**	**Conductivity 1/ρ (Ω^{-1} cm^{-1})**
Silver	1.6×10^{-5}	6.3×10^{4}
Aluminum	2.7×10^{-5}	3.7×10^{4}
Carbon (graphite)	10×10^{-2}	10
Rubber	100×10^{12}	1×10^{-14}

Given the following list of materials and their resistivity/conductivity, which materials would be good to use as a top layer, and which would be good to use as a bottom layer? Why?

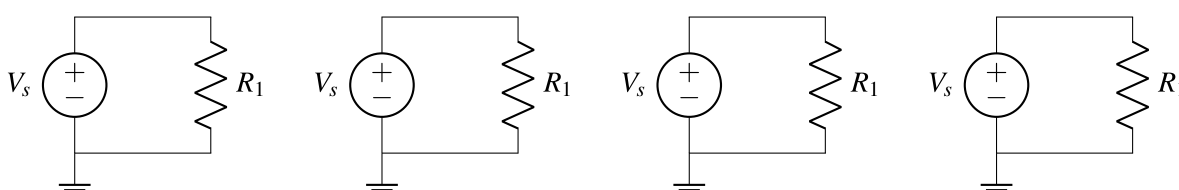
(b) Let's say you want to make your own **10 cm** long resistor out of **graphite**. You need the resistance to be **1** Ω. Recall the equation for resistance: $R = \rho \frac{L}{A} = \rho \frac{L}{W*H}$

i. What are some possible widths and heights of your resistor?

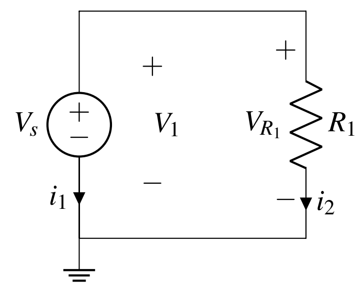
ii. Can you think of advantages of having a wide and thin resistor? How about advantages of a narrow and thick resistor?

2. Passive Sign Convention and Power

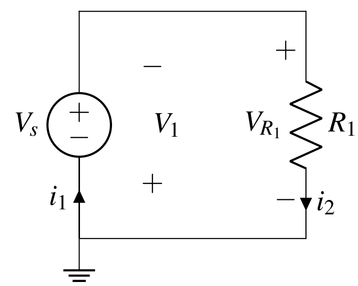
(a) Below are four copies of a the same single-resistor circuit. On each copy, provide a distinct choice of labels for each circuit's voltage polarities and current directions (there should be 4 possible choices in total!) while keeping with passive sign convention.



(b) Suppose we consider one of the possible labelings you have found above. Calculate the power dissipated or supplied by every element in the circuit. Let $V_s = 5\,\text{V}$ and let $R_1 = 5\,\Omega$. *Recall that the power dissipated is the rate of electric energy converted into other forms and is given by the equation $P = IV$. When the power dissipated by an element is a negative value, it signifies that element is actually supplying electrical power to the circuit.*



(c) Suppose we choose a second labeling of the circuit as shown below. Calculate the power dissipated or supplied by every element in the circuit. Let $V_s = 5\,\text{V}$ and let $R_1 = 5\,\Omega$.



(d) Did the values of the element voltages and element currents change with the different labeling? Did the power for each circuit element change? Did the node voltages change? If a quantity didn't change with a difference in labeling, discuss what would have to change for quantity to change.

3. Circuit Analysis

(a) Use nodal analysis to solve for all node voltages.

(b) Practice writing out your expressions in matrix vector form. (Recall the form $\mathbf{A}\vec{x} = \vec{b}$, where $\vec{x}$ is your vector of unknown voltages or/and currents).

(c) Find current I_{R_3} flowing through resistor R_3.