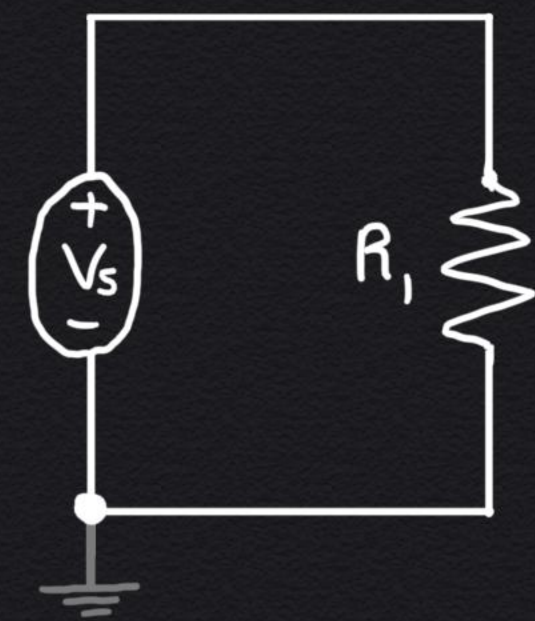
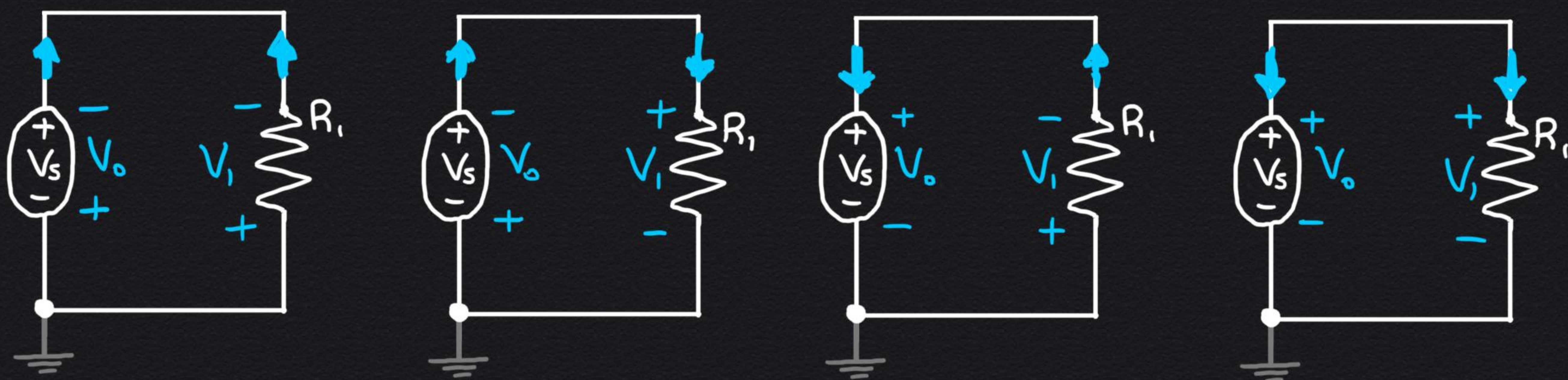
① Passive Sign Convention

Suppose we have the circuit as shown:

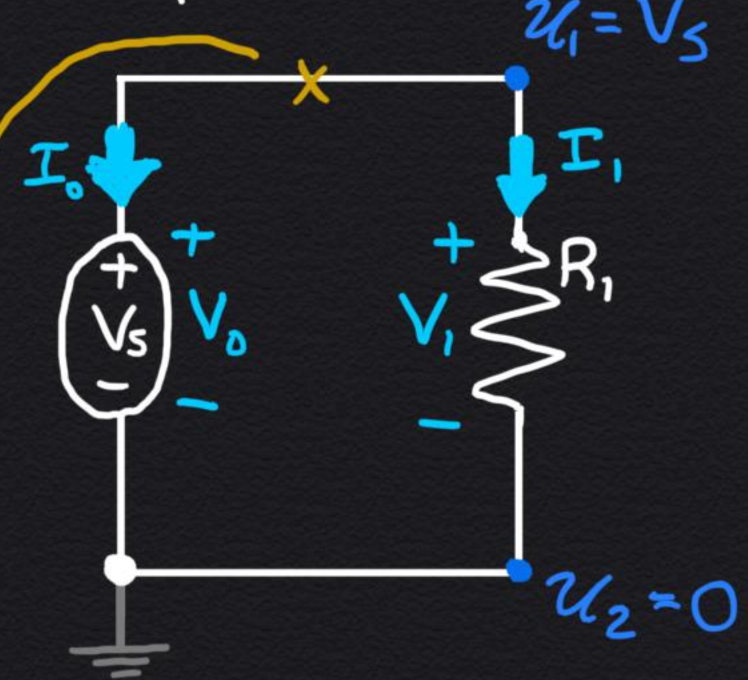


a) How many convention choices do have?
Can you label each one?



Technically, if we were free to set ground there would be $2 \times 4 = 8$ options, since there are 2 nodes we could have chosen for ground.

b) Suppose we know that $V_s = 5V$ and $R_1 = 5\Omega$. Given the convention below, find the power dissipated through each element:



$$P = \boxed{IV} = \frac{V^2}{R} = I^2 R$$

$$-I_0 - I_1 = 0 \Longrightarrow I_0 = -I_1$$

$$V_1 = u_1 - u_2 = V_s$$
$$V_0 = u_1 - u_2 = V_s$$
$$I_1 = V_s / R = 1A$$

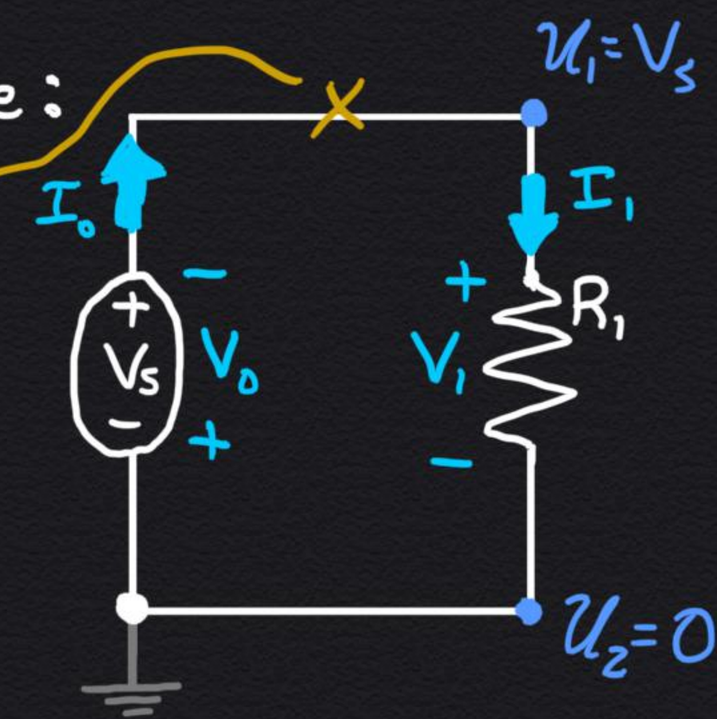
$$P_1 = V_1 I_1 = 5V \cdot 1A = 5W$$

$$P_0 = V_0 I_0 = 5V \cdot (-1A) = -5W$$

⊖sign on current

means battery inputs power!

c) Repeat (b) for this convention choice:



KCL: $I_0 - I_1 = 0 \rightsquigarrow I_0 = I_1$

$$V_1 = V_s$$
$$V_0 = u_2 - u_1 = -V_s$$
$$I_1 = V_s / R = 1A$$

since this convention places ⊖ terminal at $u_1 = V_s$

$$P_1 = V_1 I_1 = 5W$$

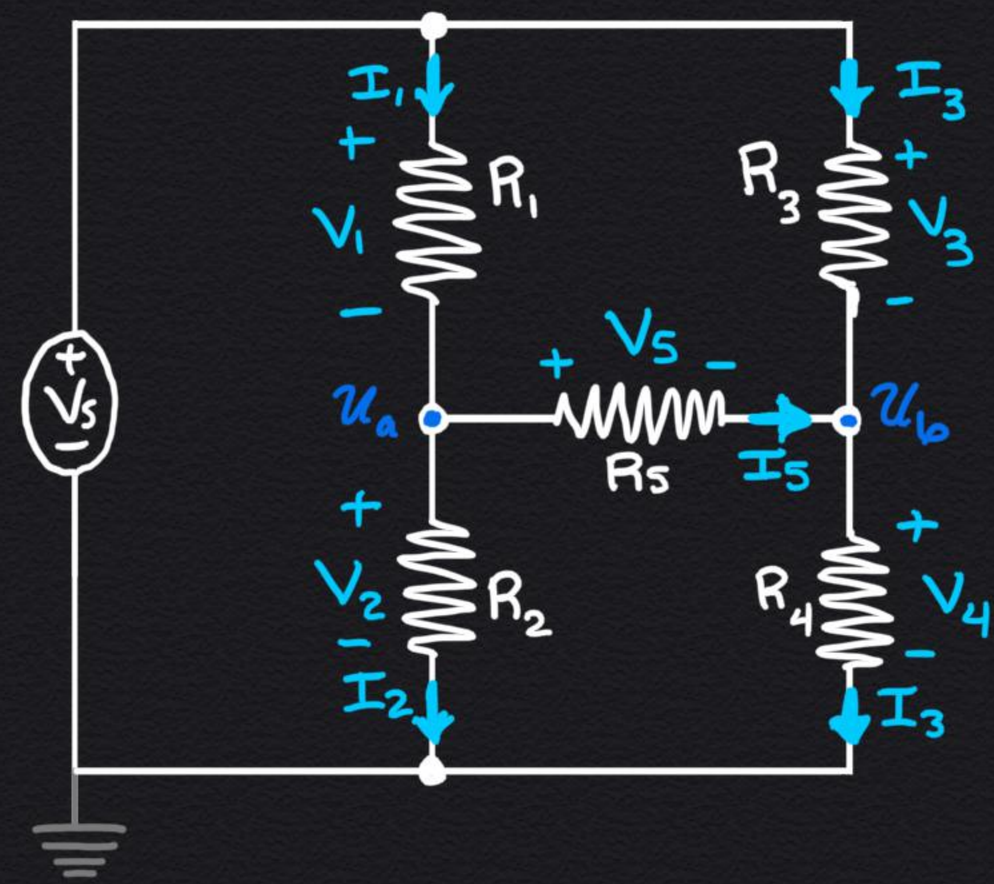
$$P_0 = V_0 I_0 = (-5V)(1A) = -5W$$

Still contributes power! ☺

⊖ sign on voltage.

Ultimately our choices do not alter the physics!

② Consider this circuit (note NVA equations given):



$$I_1 = I_2 + I_3 \qquad I_3 + I_5 = I_3$$

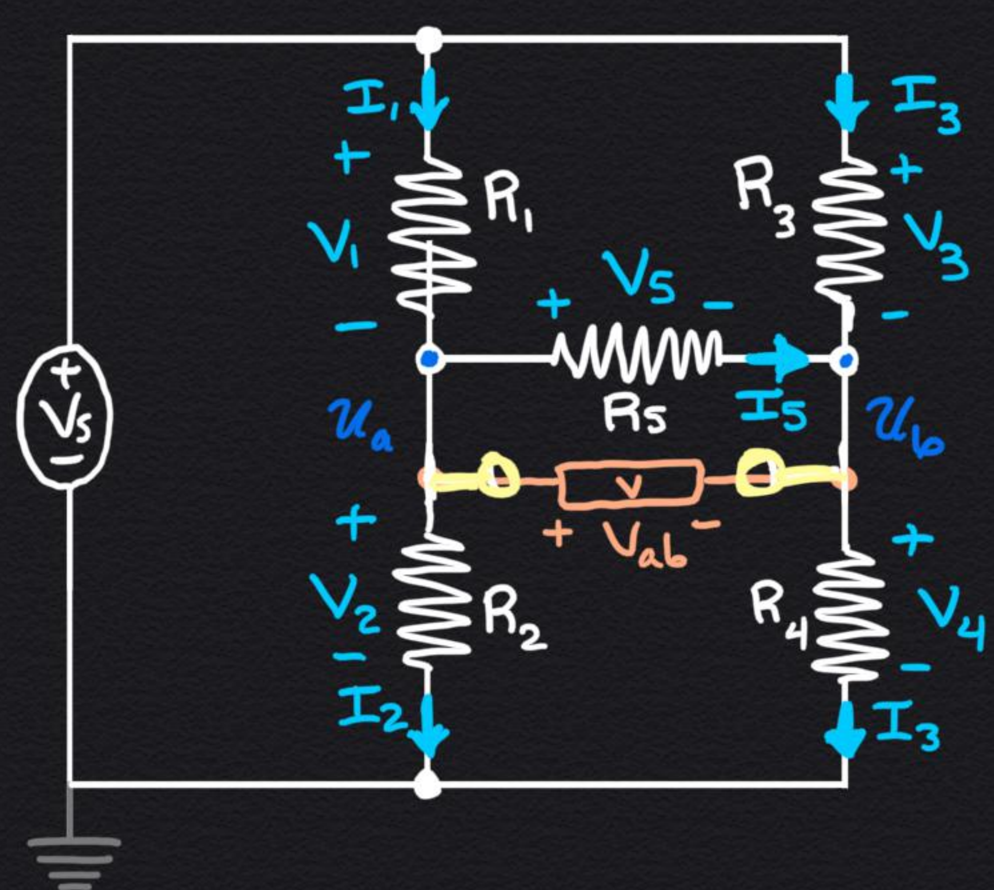
$$I_1 = \frac{V_s - u_a}{R_1} \qquad I_2 = \frac{u_a}{R_2} \qquad I_3 = \frac{V_s - u_b}{R_3}$$

$$I_4 = \frac{u_b}{R_4} \qquad I_5 = \frac{u_a - u_b}{R_5}$$

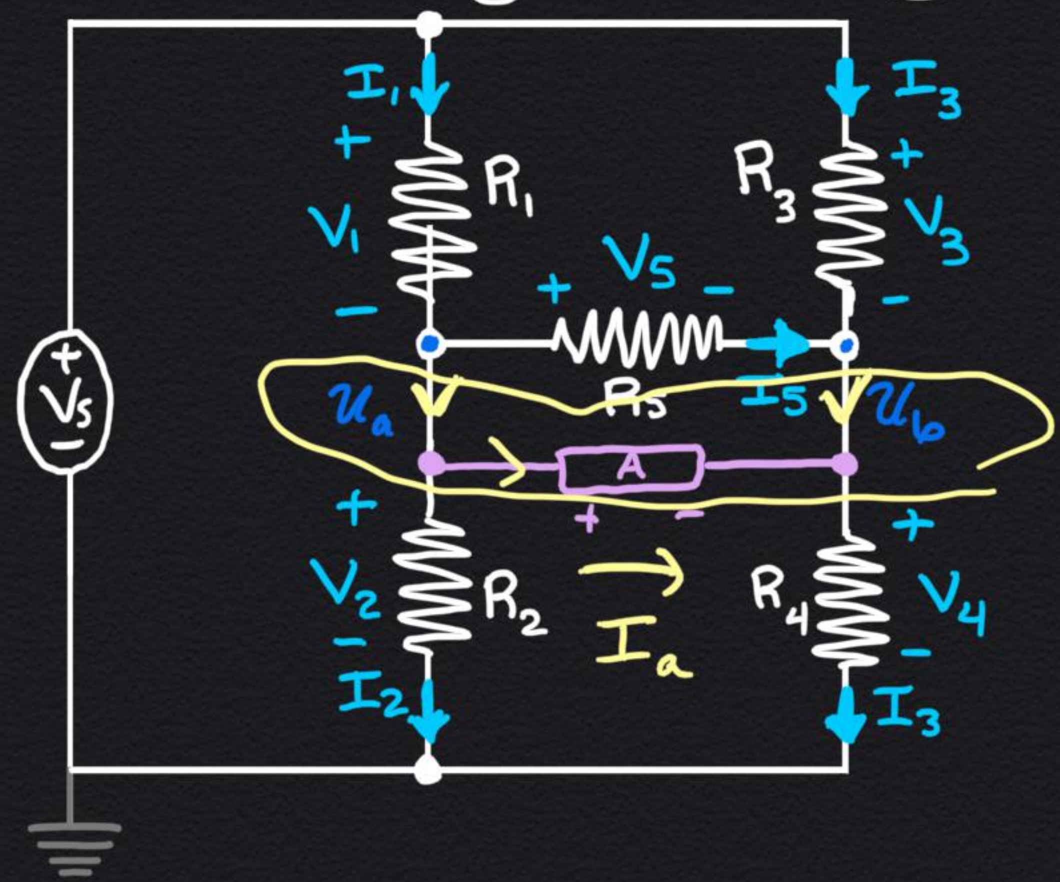
- Ideal Voltmeters are modelled as <u>open</u> wires.
- Ideal Ammeter are modelled as <u>connected</u> wires.

<u>a</u>] Suppose we hook up the voltmeter as shown. What changes (if anything)?

<u>Nothing Changes!!!</u>



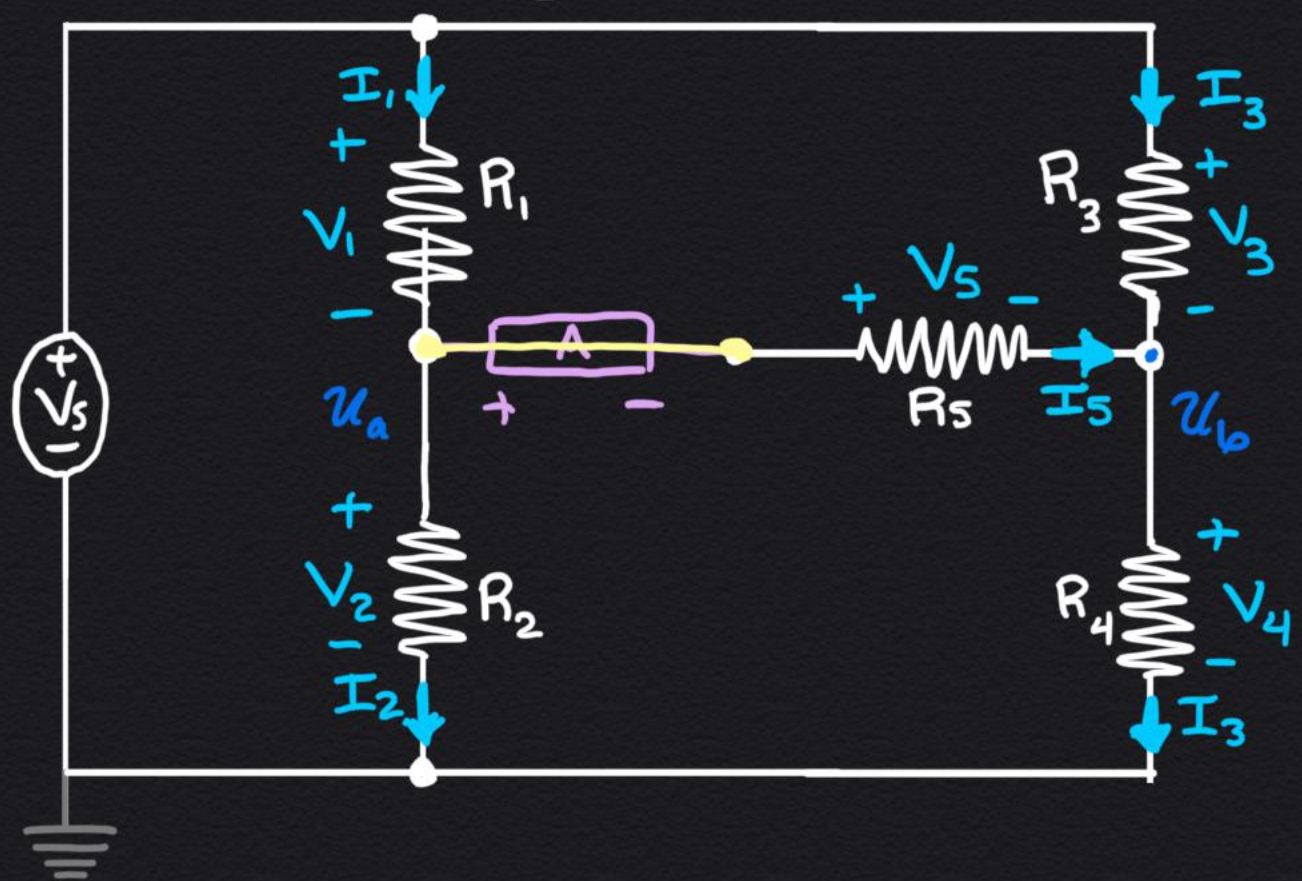
b) Suppose we hook up an ammeter as shown. What changes (if anything)?



Changes!!

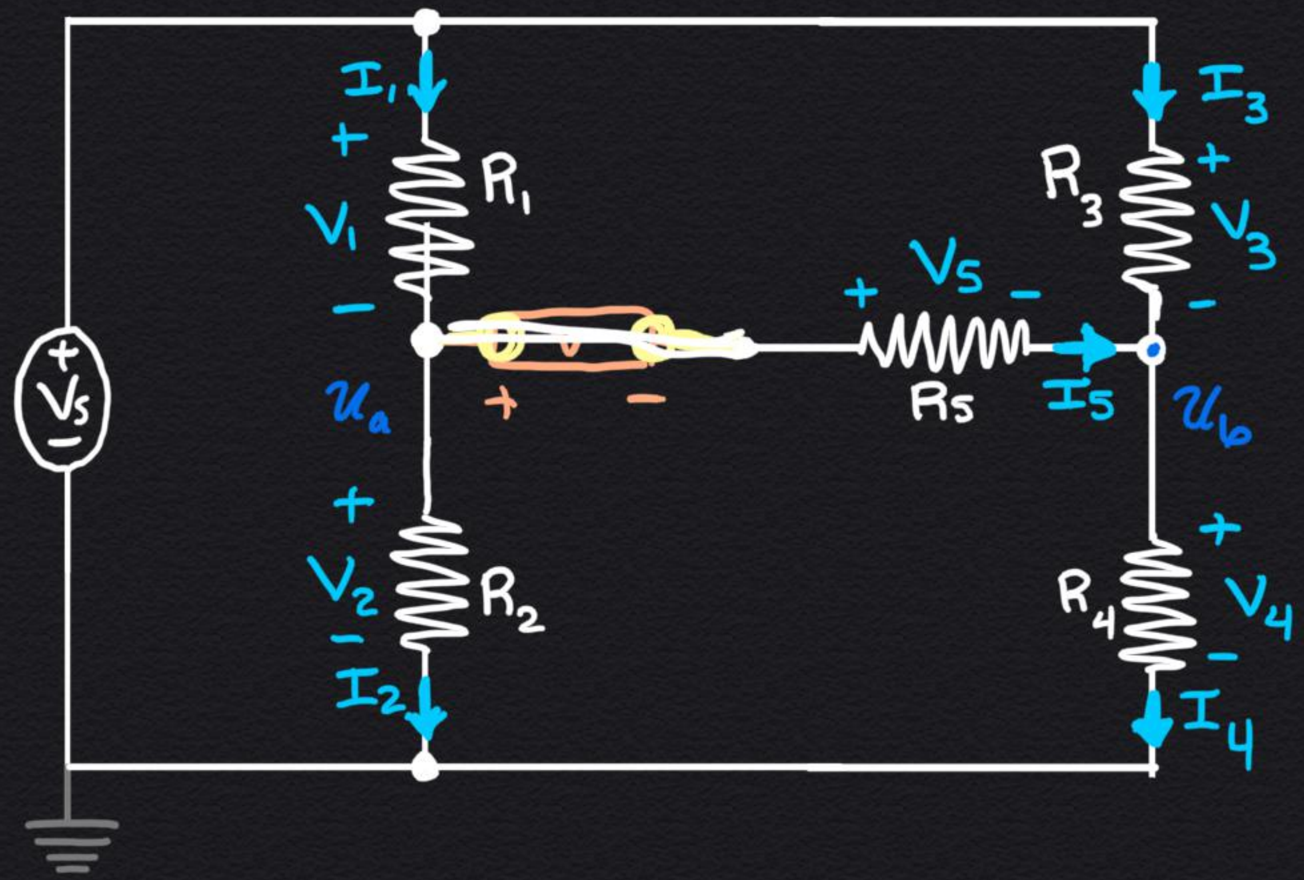
(Could produce the same characteristics if $u_a = u_b$)

c) Suppose we hook up an ammeter as shown. What changes (if anything)?



Nothing Changes!!

d) Suppose we hook up a voltmeter as shown. What changes (if anything)?



(Could change!!)

We've forced

$I_5 = 0$

So $u_a = u_b$

$I_1 = I_2$

$I_3 = I_4$

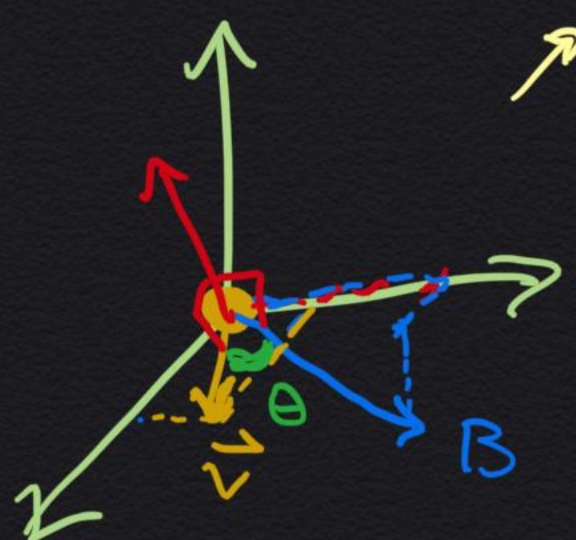
Bonus! (not required)

Why are ammeters like closed circuits??

$$m\vec{a} = \vec{F} = q\vec{E} + q\underbrace{\vec{v} \times \vec{B}}$$

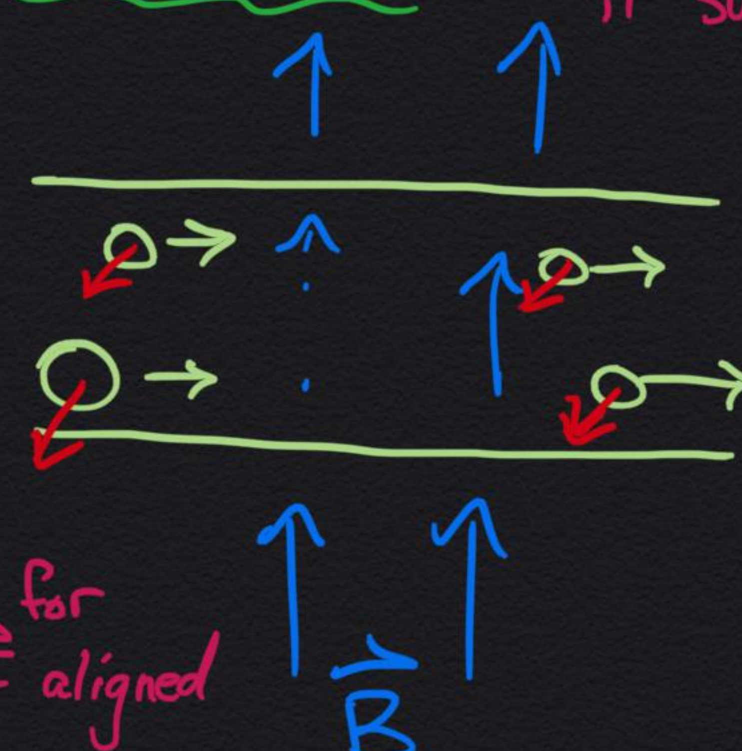
Note: $\vec{I} \propto q\vec{v}$

(not equal though!) but same direction



Lorentz force

We might not know the cross product, but it says the magnetic force points 90° from $\vec{v}$ and $\vec{B}$!

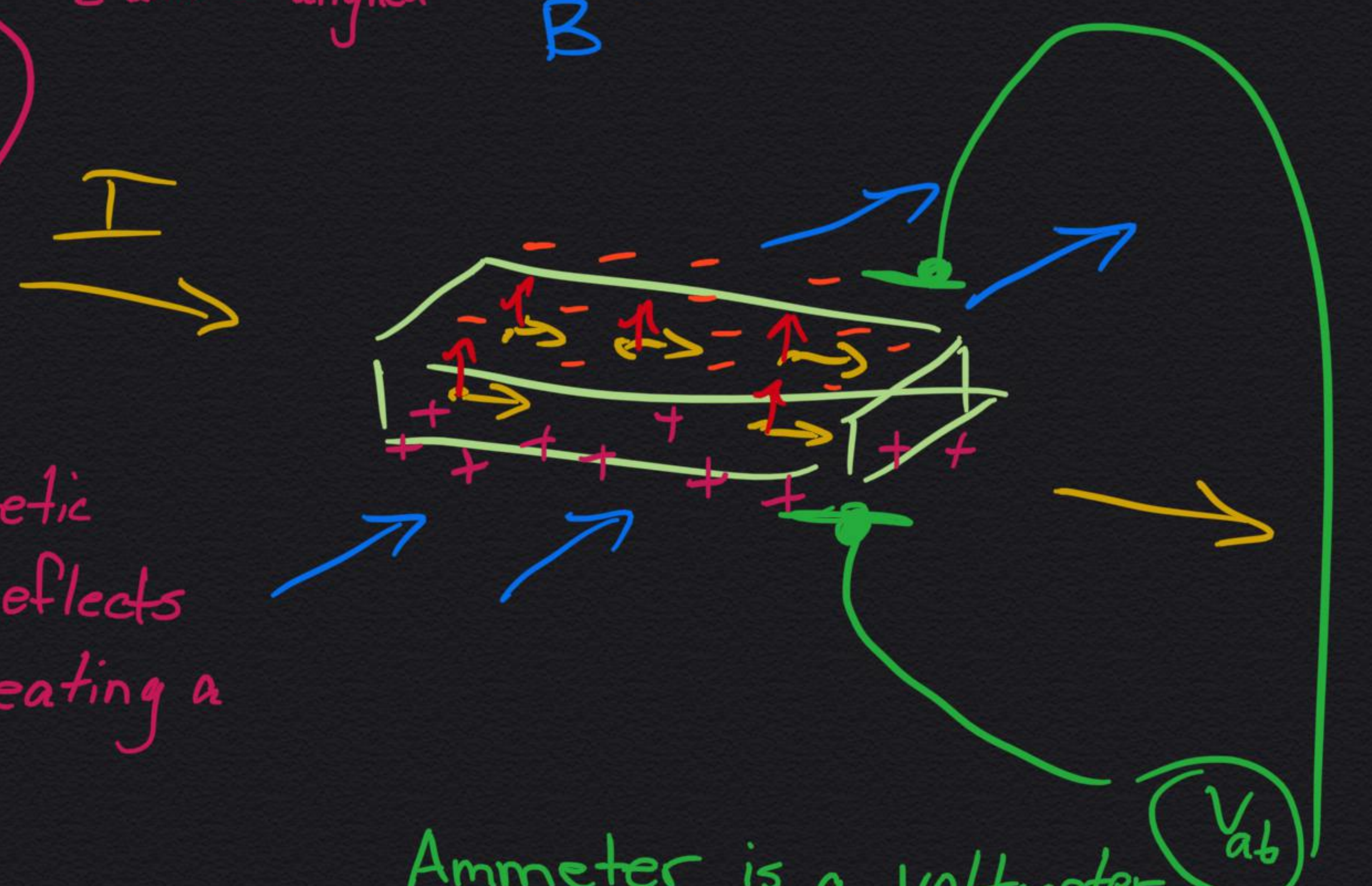


$$\|\vec{v} \times \vec{B}\| = \|v\| \|B\| \sin(\theta)$$

magnitude: $\|\cdot\|$

is zero for $\vec{B}$ and $\vec{I}$ aligned

Hall Effect:



In Hall effect, a magnetic field $\vec{B}$ on a current deflects charge to the sides, creating a voltage

Ammeter is a voltmeter, for the Hall Effect!!!