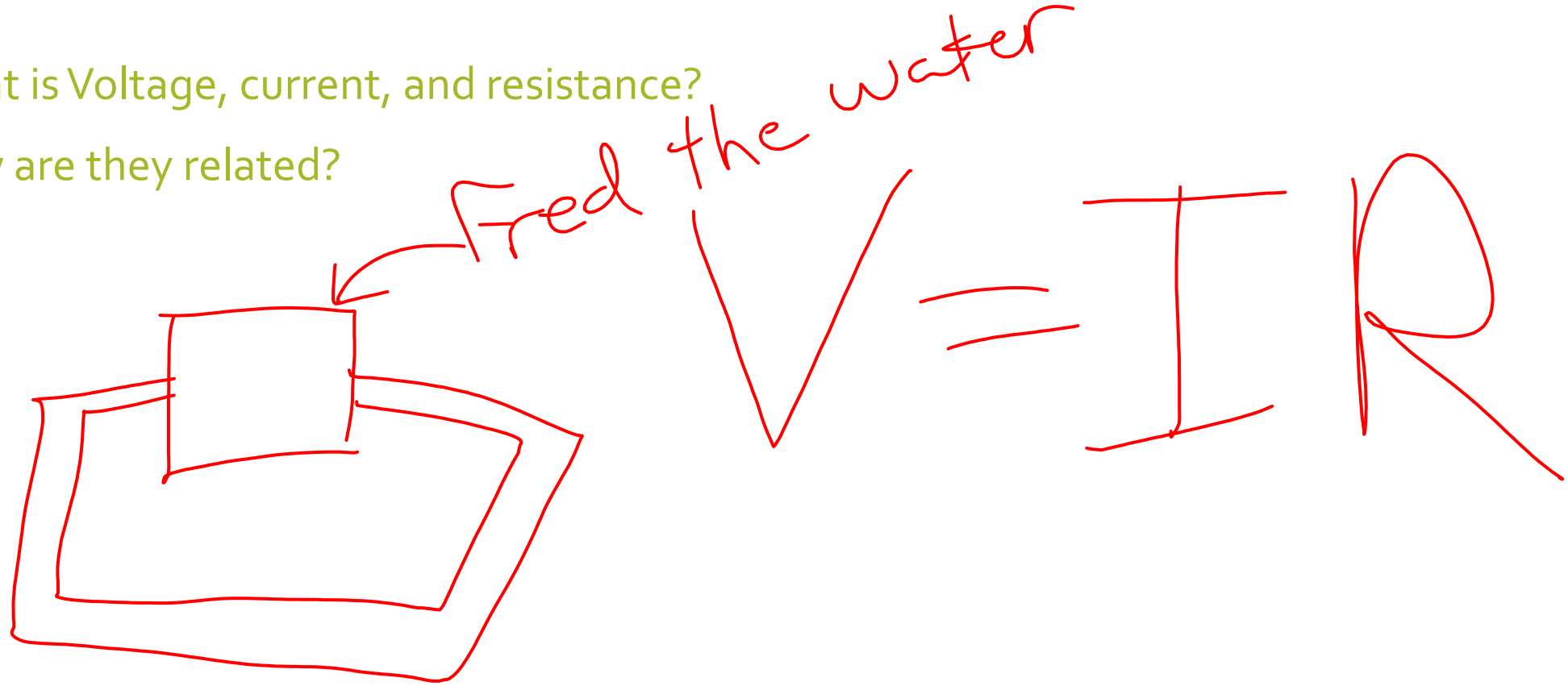
SERIES AND PARALLEL CIRCUITS

Opening

- What is Voltage, current, and resistance?
- How are they related?



Series Circuits

Voltage: adds together

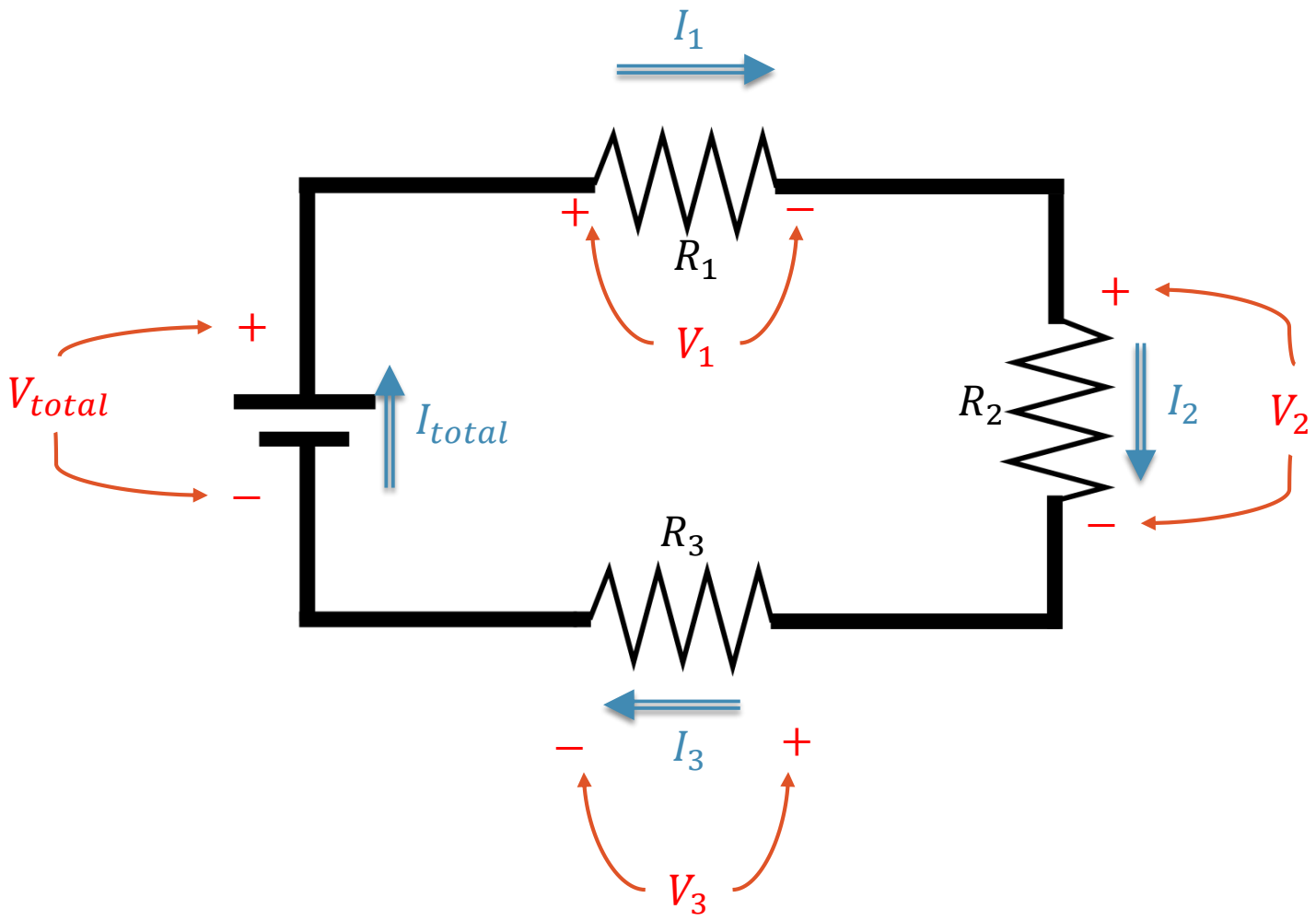
$$V_{total} = V_1 + V_2 + V_3$$

Current: All the same

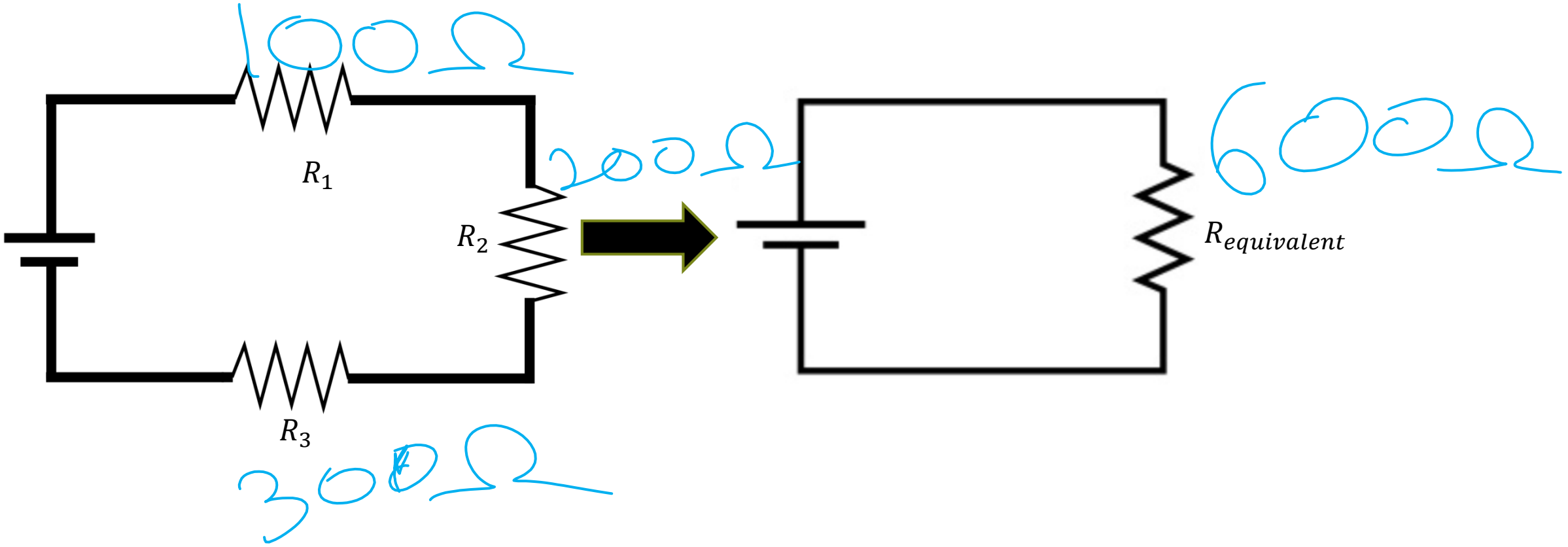
$$I_{total} = I_1 = I_2 = I_3$$

Resistance: adds together

$$R_{total} = R_1 + R_2 + R_3$$



Simplifying a series circuit



Parallel Circuits

Voltage: All the same

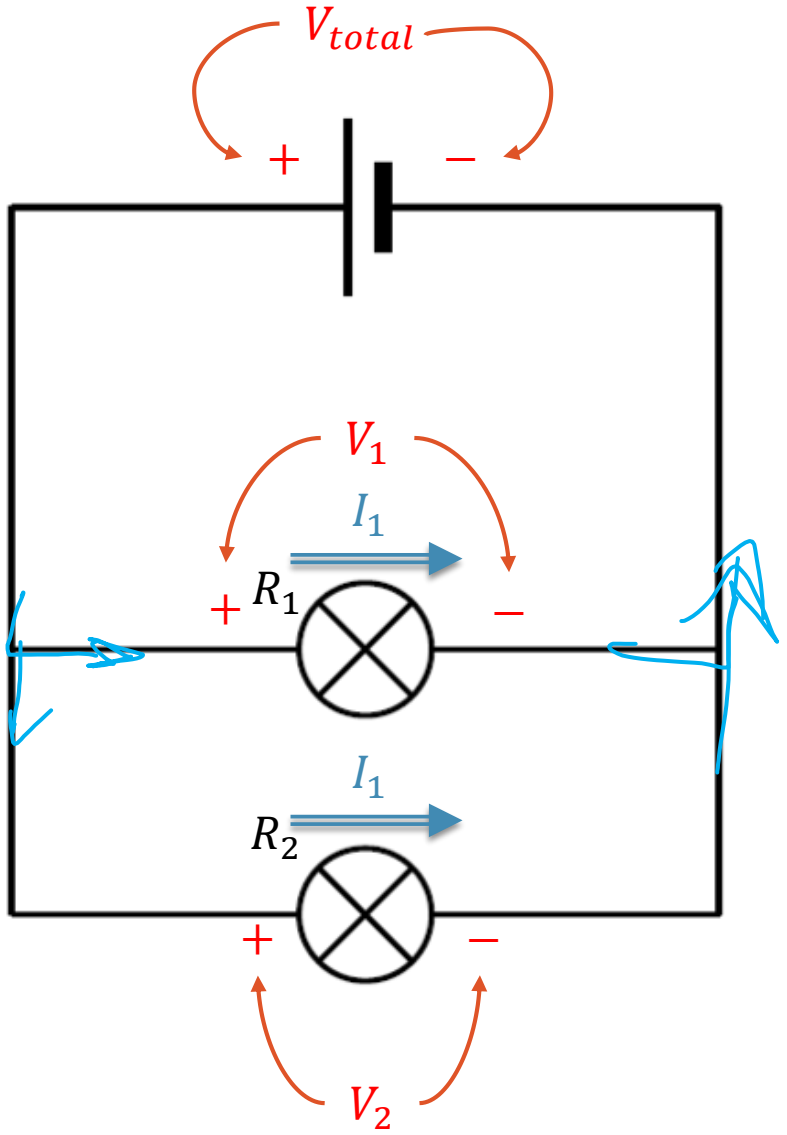
$$V_{total} = V_1 = V_2$$

Current: Divided between each "branch"

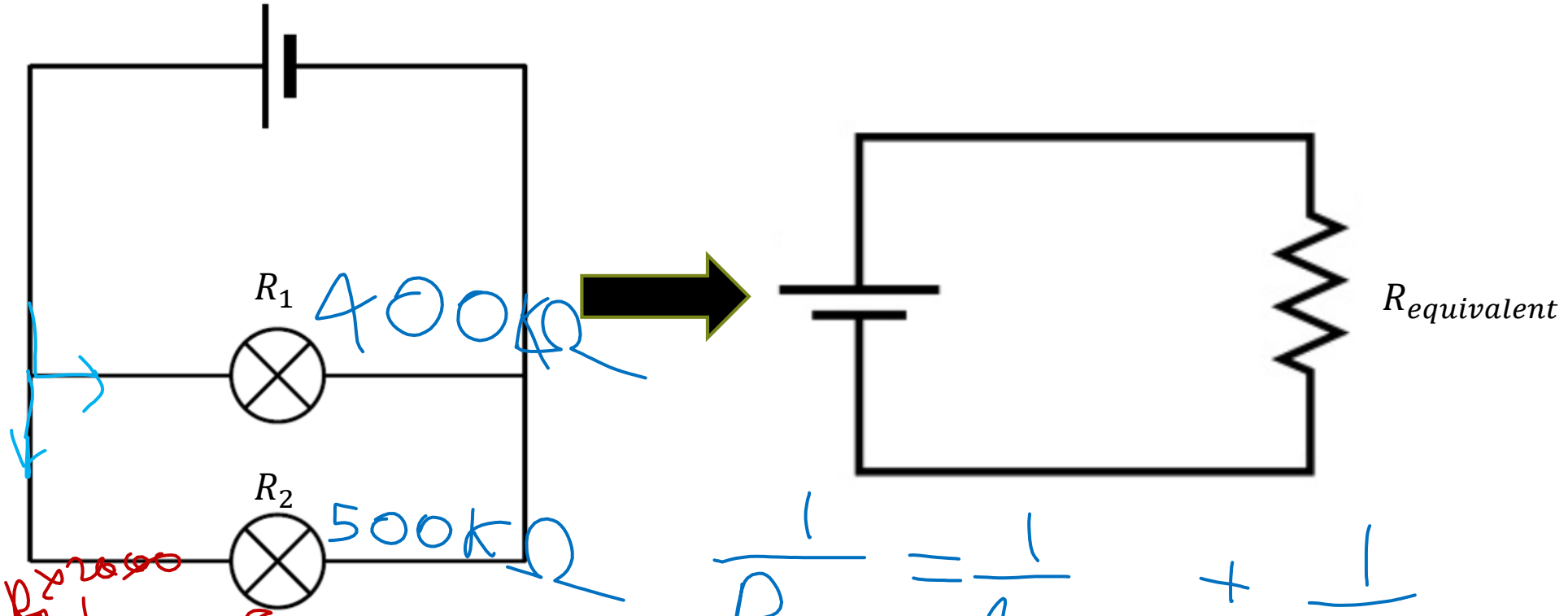
$$I_{total} = I_1 + I_2$$

Resistance: reduces total resistance

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2}$$



Simplifying a Parallel Circuit



$$\frac{1}{R_T} = \frac{1}{400} + \frac{1}{500}$$

$$\frac{1}{R_T} = \frac{5}{2000} + \frac{4}{2000} = \frac{9}{2000}$$

$$\frac{1}{R_T} = \frac{9}{2000} \times R_T \times 2000$$

$$2000 = 9R_T$$

$$R_T = 2000/9 = 222\,k\Omega$$

Understanding the difference between Series and Parallel

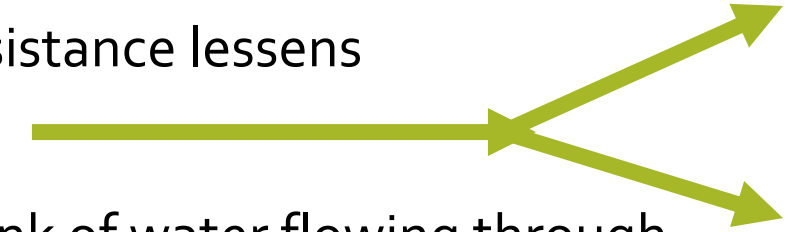
Series

- Voltage adds
- Constant current
- Resistance adds

- Think of water flowing through a hose
  - Water passing through one point needs to pass all points (constant current)
  - The longer the hose the more resistance (resistance adds)

Parallel

- Voltage constant
- Current splits
- Resistance lessens



- Think of water flowing through a hose that splits into two hoses
  - At the split, less water flows into each hose (current splits)
  - Adding more hoses in parallel decreases the resistance (resistance lessens)

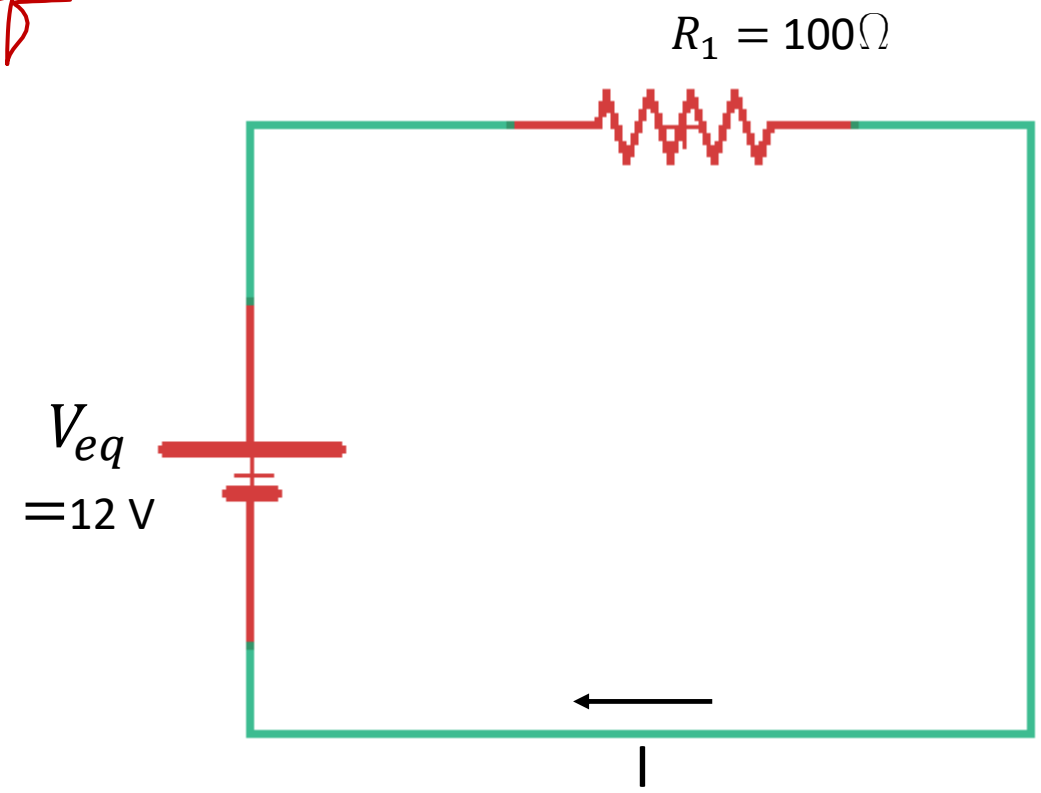
MORE SERIES AND PARALLEL CIRCUITS

Wheeler HS Fall 2019

Basic Circuit

$$I_{eq} = \frac{V_{eq}}{R_{eq}} = \frac{12\,V}{100\,\Omega} = .012\,A$$

V = IR

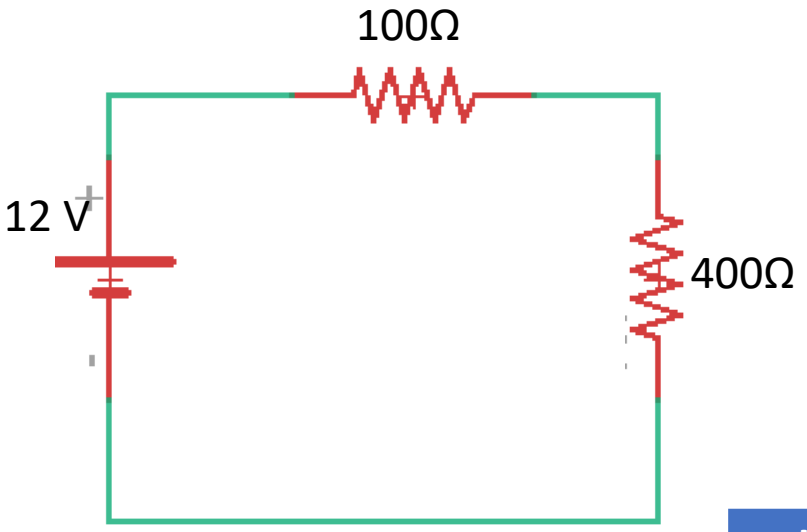


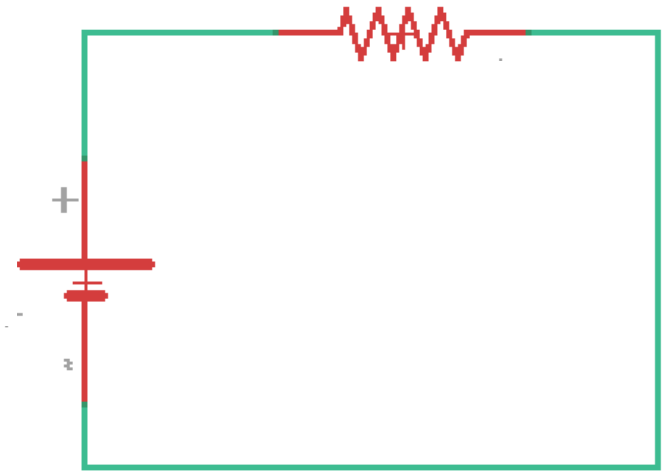
Voltage	Current	Resistance
$V_1 =$ 12 V	$I_1 =$ 0.12A	$R_1 =$ 100 Ω
$V_{eq} =$ 12 V	$I_{eq} =$ 0.12A	$R_{eq} =$ 100 Ω

Simplifying Series

Equivalent resistance for series circuits adds together

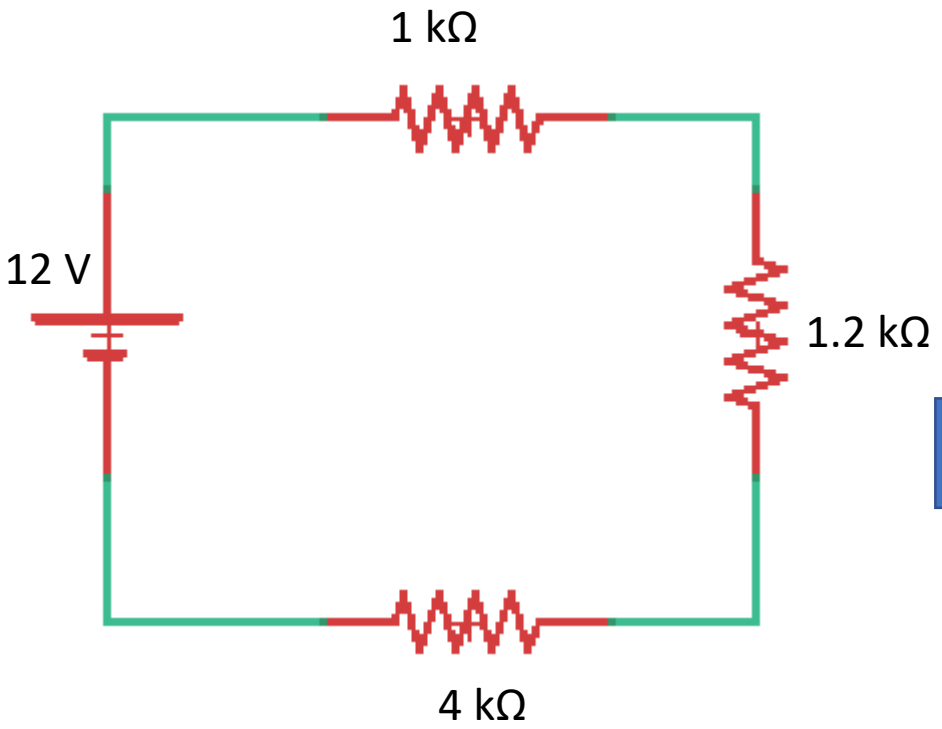
$$R_{total} = R_1 + R_2 + \cdots$$





Voltage	Current	Resistance
$V_1 =$	$I_1 =$	$R_1 =$
$V_2 =$	$I_2 =$	$R_2 =$
$V_{eq} =$	$I_{eq} =$	$R_{eq} =$

Another Series Example

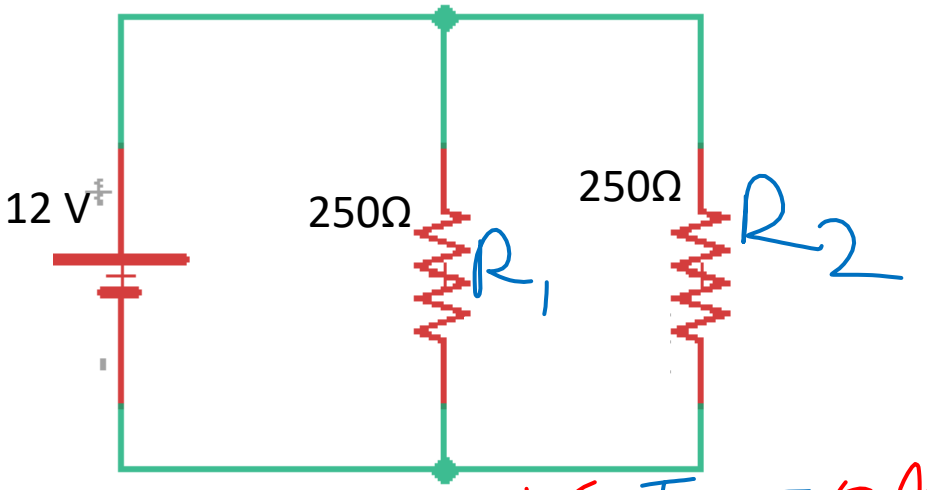


Find the equivalent resistance of this circuit

Simplifying Parallel

Equivalent resistance for parallel circuits:

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$$



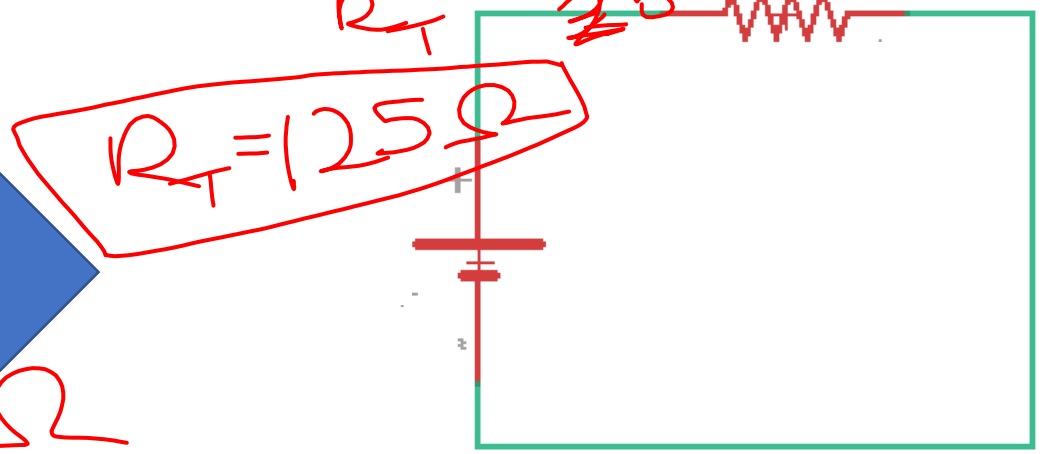
R_1 R_2

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

$\frac{1}{R_T} = \frac{1}{250} + \frac{1}{250}$

$\frac{1}{R_T} = \frac{2}{250}$

$R_T = 125\,\Omega$

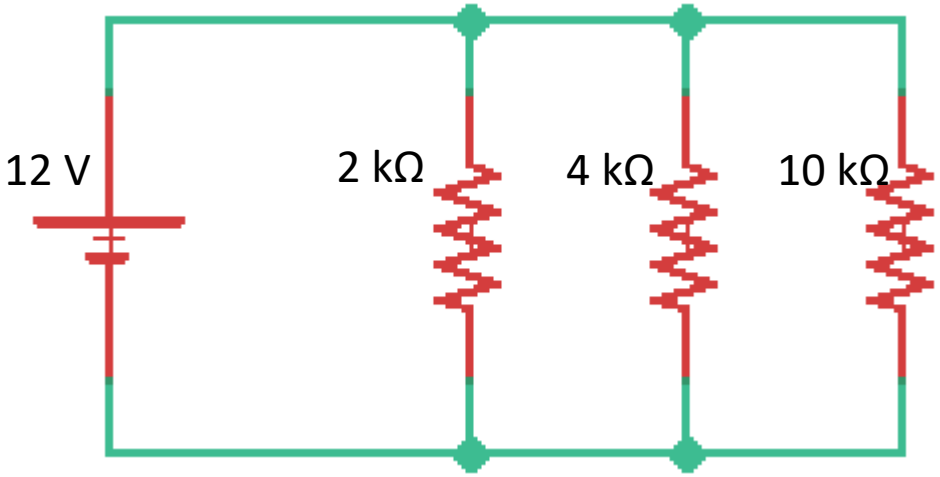


$V_1 = 12\,V \quad I_1 = 0.48\,A \quad R_1 = 250\,\Omega$

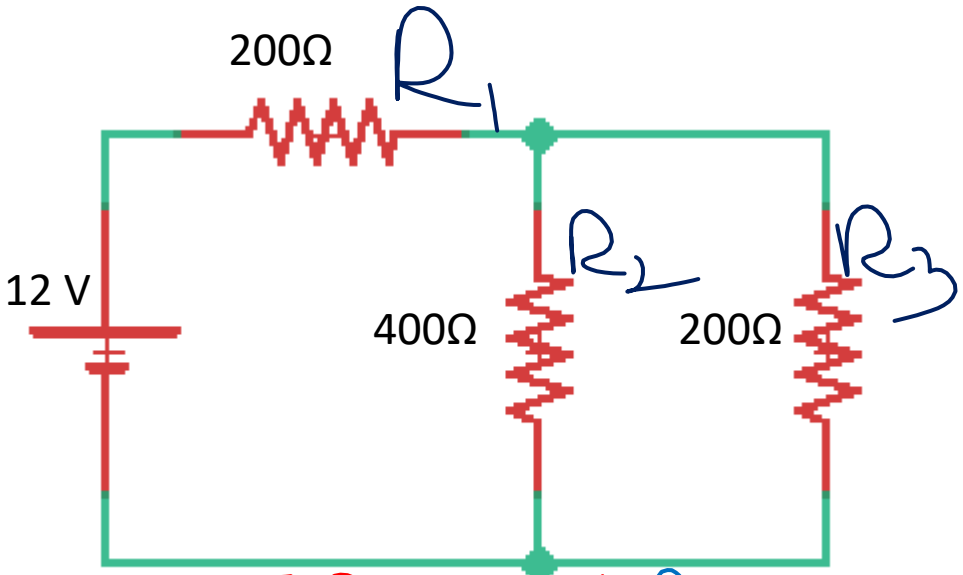
$V_2 = 12\,V \quad I_2 = 0.48\,A \quad R_2 = 250\,\Omega$

$V_T = 12\,V \quad I_T = 0.96\,A \quad R_T = 125\,\Omega$

Another Parallel



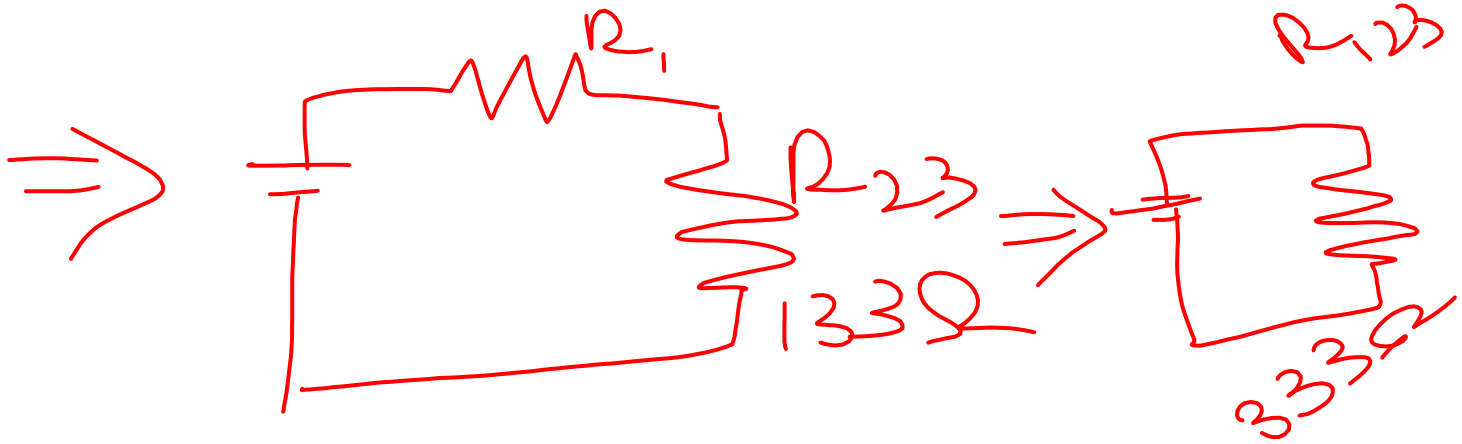
Putting it together



$$\frac{1}{R_{23}} = \frac{1}{R_2} + \frac{1}{R_3} \qquad R_{23} \sim 133$$

$$\frac{1}{R_{23}} = \frac{1}{400} + \frac{1}{200} = \frac{3}{400}$$

Find the equivalent resistance of this circuit



V_1 7.2V I_1 .036A R_1 200Ω

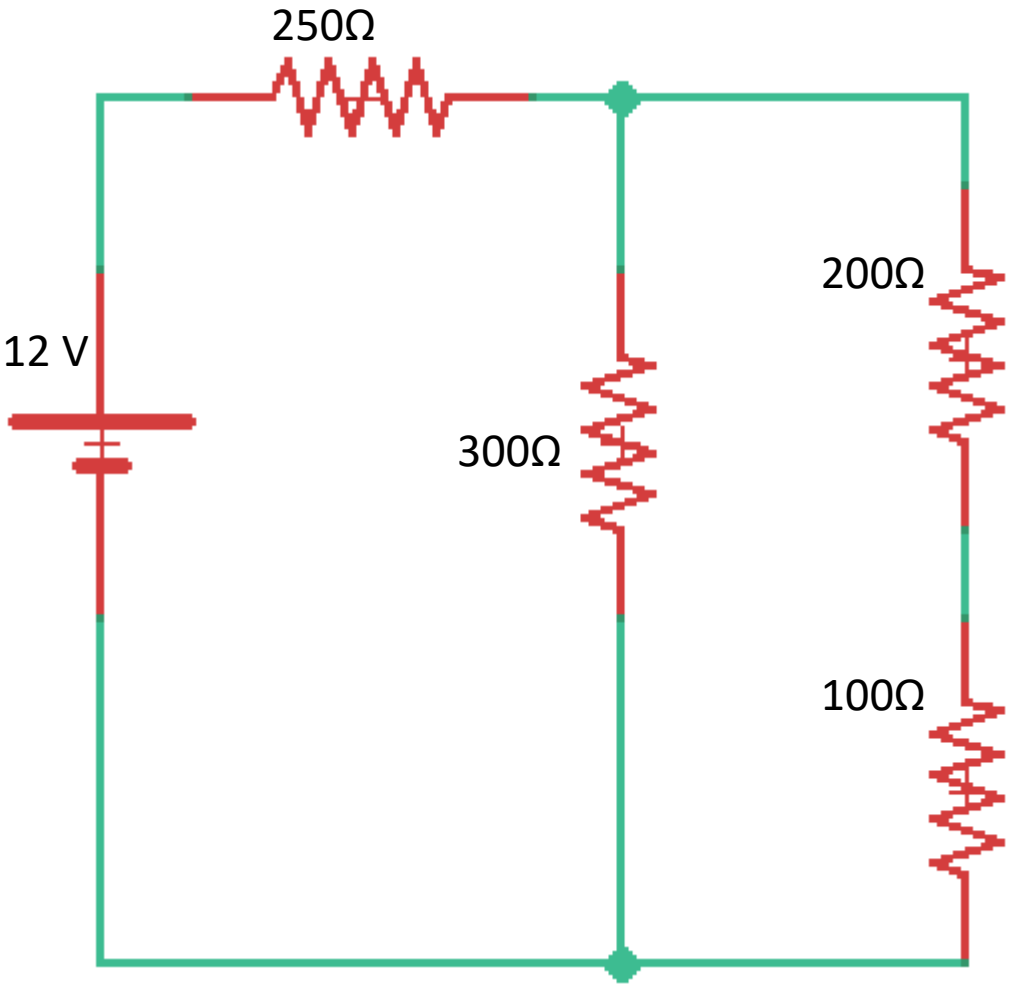
V_2 4.8V I_2 .012A R_2 400Ω

V_3 4.8V I_3 .024A R_3 200Ω

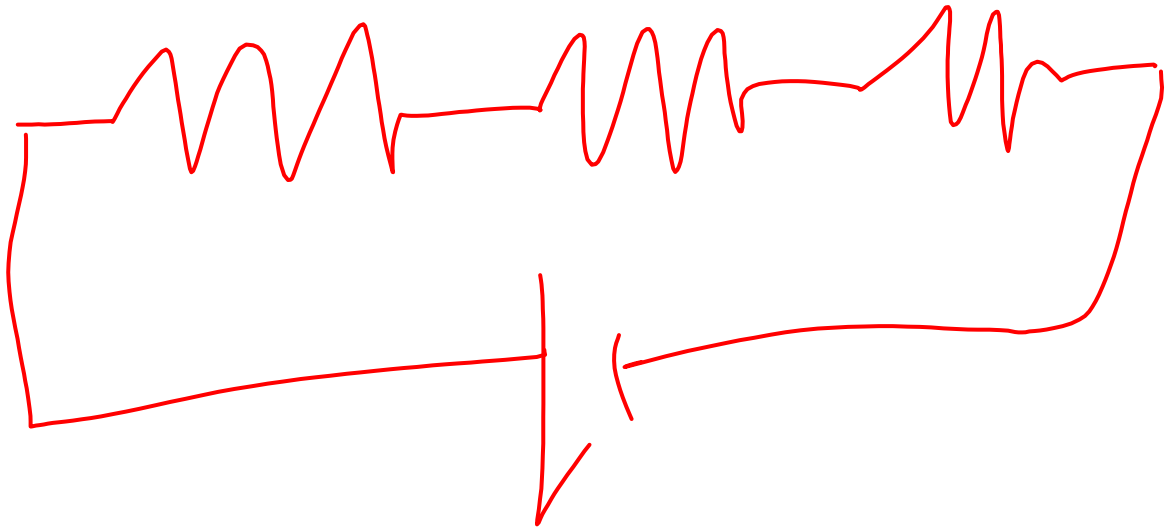
V_{23} 4.8V I_{23} .036A R_{23} 133Ω

V_T 12V I_T .036A R_T 333Ω

More!



Find the equivalent resistance of this circuit



Closing

- You did it! You graduated High School and are now entering the corporate workforce doing what you do best: being a resistor. You (a resistor) wish to join a circuit with a good culture/benefits/dental-plan/etc., but are undecided on whether to join a circuit in parallel or in series. From a safety standpoint, do you think you should join a circuit in series or in parallel and why?