Part 3

Parallel Circuits

Parallel Circuits

The fundamentals of a parallel circuit

Construction of parallel circuits.

Connected so that each resistor (load) receives the same voltage as the supply.

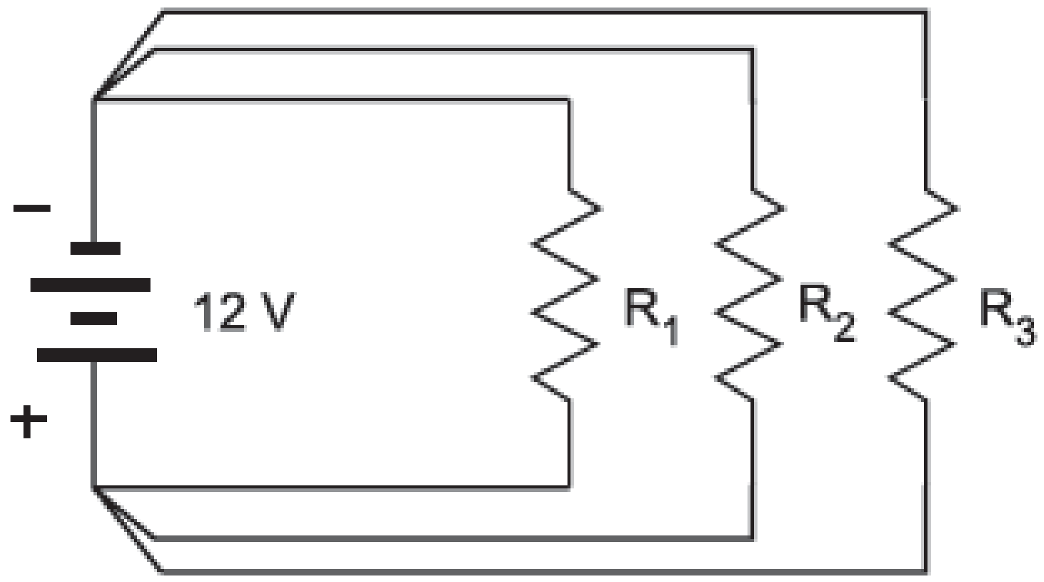


Figure 1—A parallel circuit

Construction of parallel circuits.

These two circuits are essentially the same (both parallel), but the bottom one is how we'll draw our schematics.

Each resistor will get 12V.

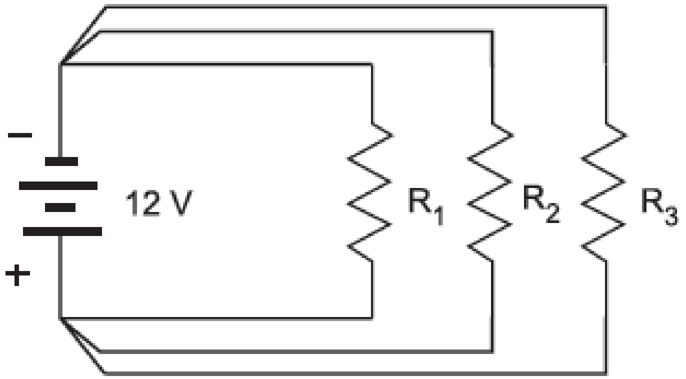


Figure 1—A parallel circuit

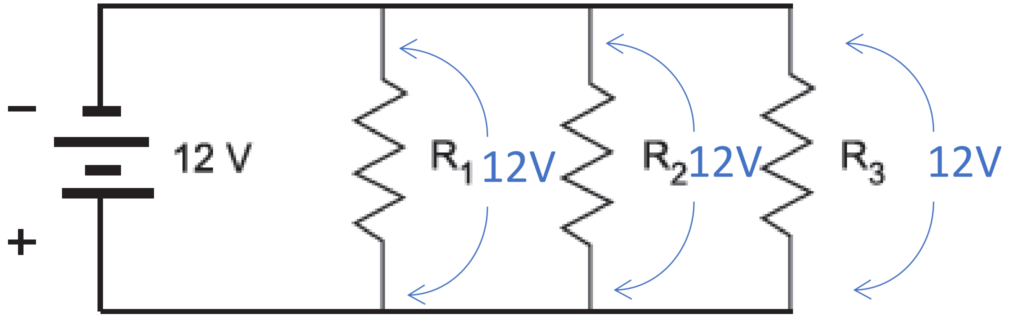
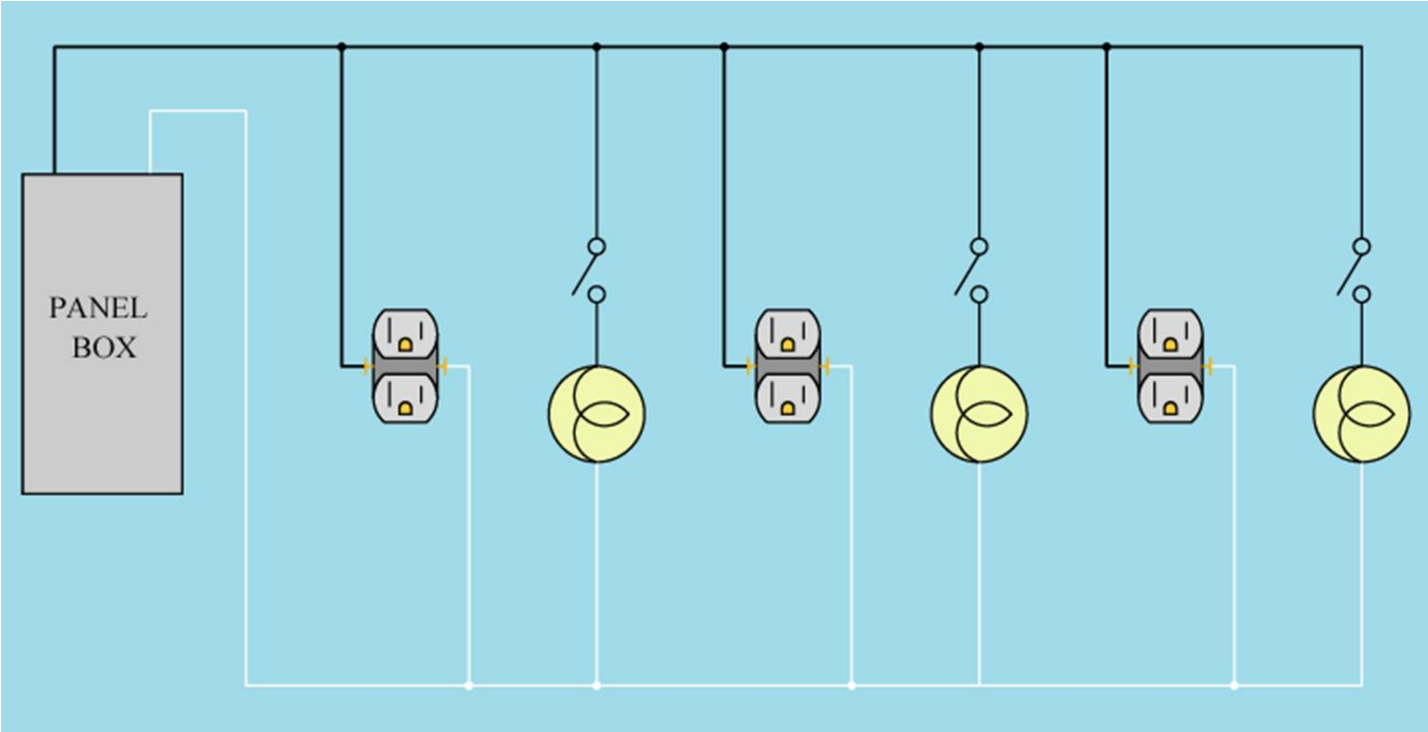


Figure 2—Usual representation of parallel circuit

Construction of parallel circuits.

Plugs, lights, and other loads are connected in parallel so that they all get 120V.



Voltage and current in parallel.

Each resistor gets 12V.

Notice that there is more than one path for current to flow.

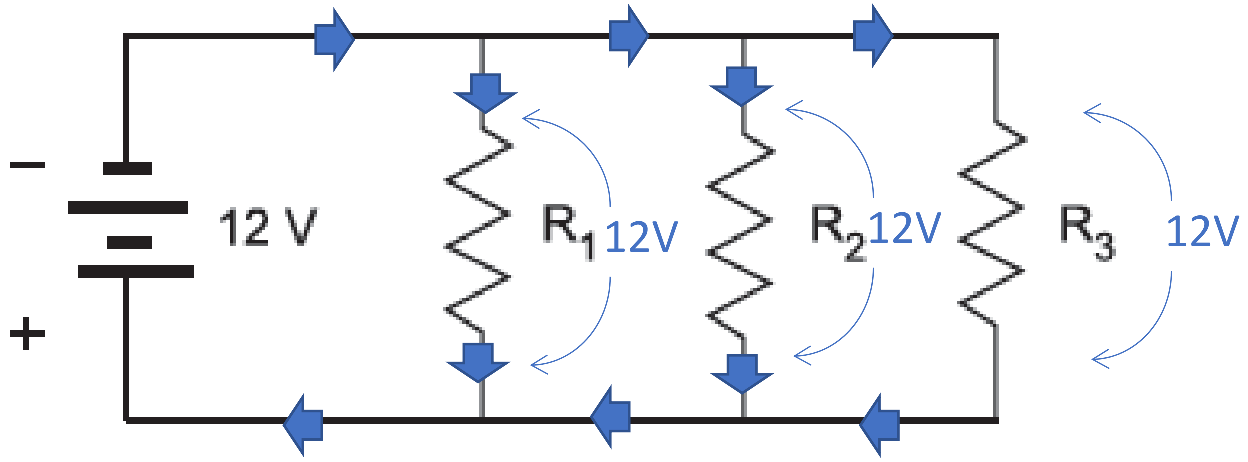


Figure 2—Usual representation of parallel circuit

Voltage in a parallel circuit.

$$E_T = E_1 = E_2 = E_3 \ldots$$ *

The voltage across each branch in a parallel circuit is equal to the supply.

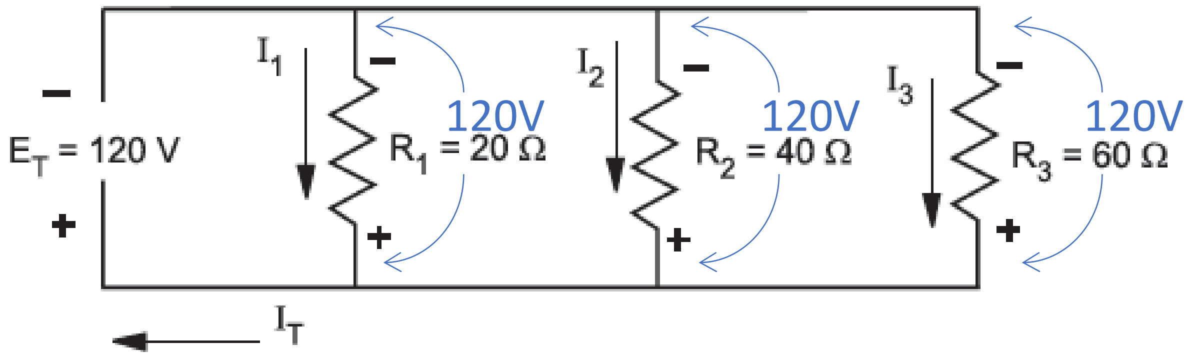


Figure 5—A parallel circuit with three branches

Polarity in a parallel circuit.

Current leaves the negative of the supply and flows through each resistor (- to +) back to the positive of the supply.

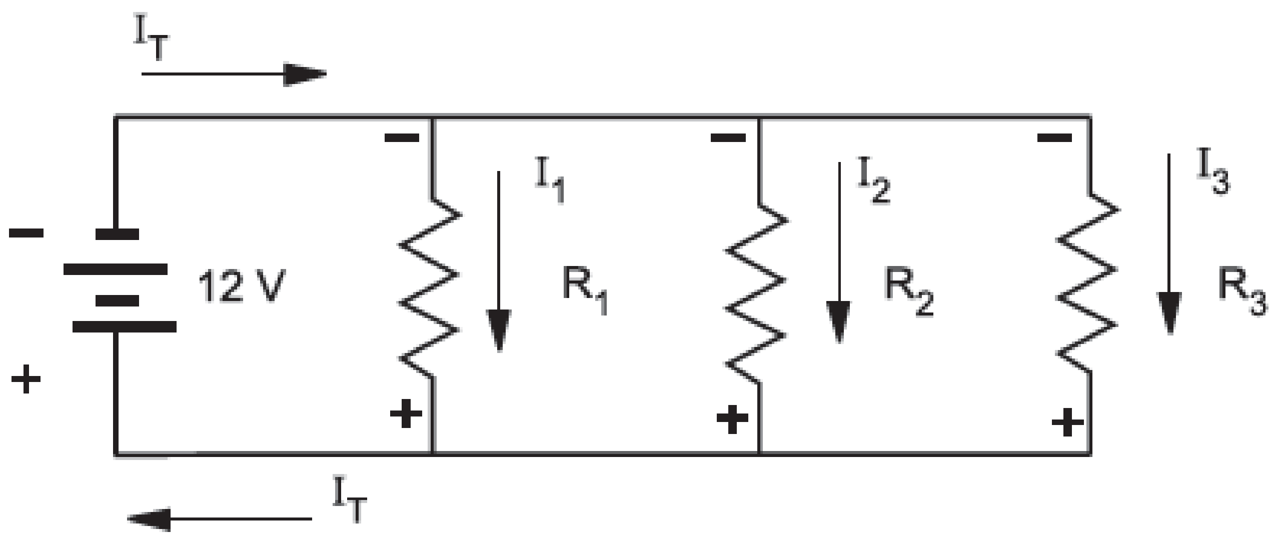


Figure 3—Polarity in a parallel circuit

Current in a parallel circuit.

$$I_T = I_1 + I_2 + I_3 \ldots$$

*

Find the current down each branch using ohm's law.

Add them up to solve for the total current.

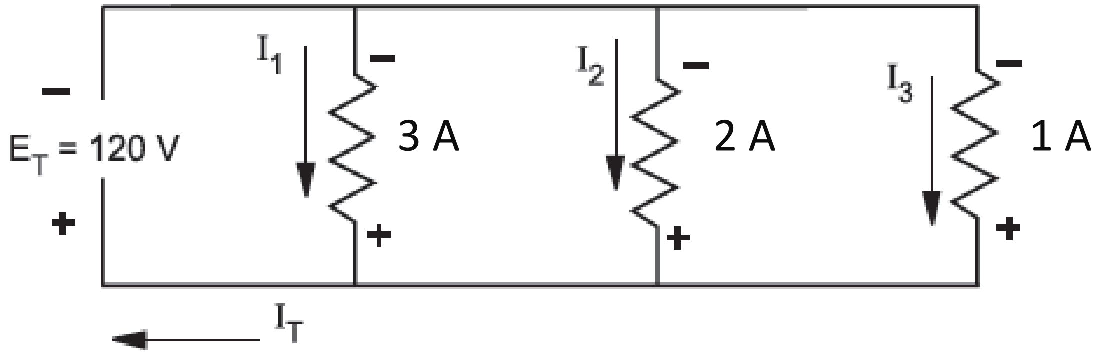


Figure 5—A parallel circuit with three branches

Kirchhoff's current law.

The sum of currents entering a junction/ node must equal the sum of the currents leaving that node.

6A entering. (3A+3A) 6A leaving.

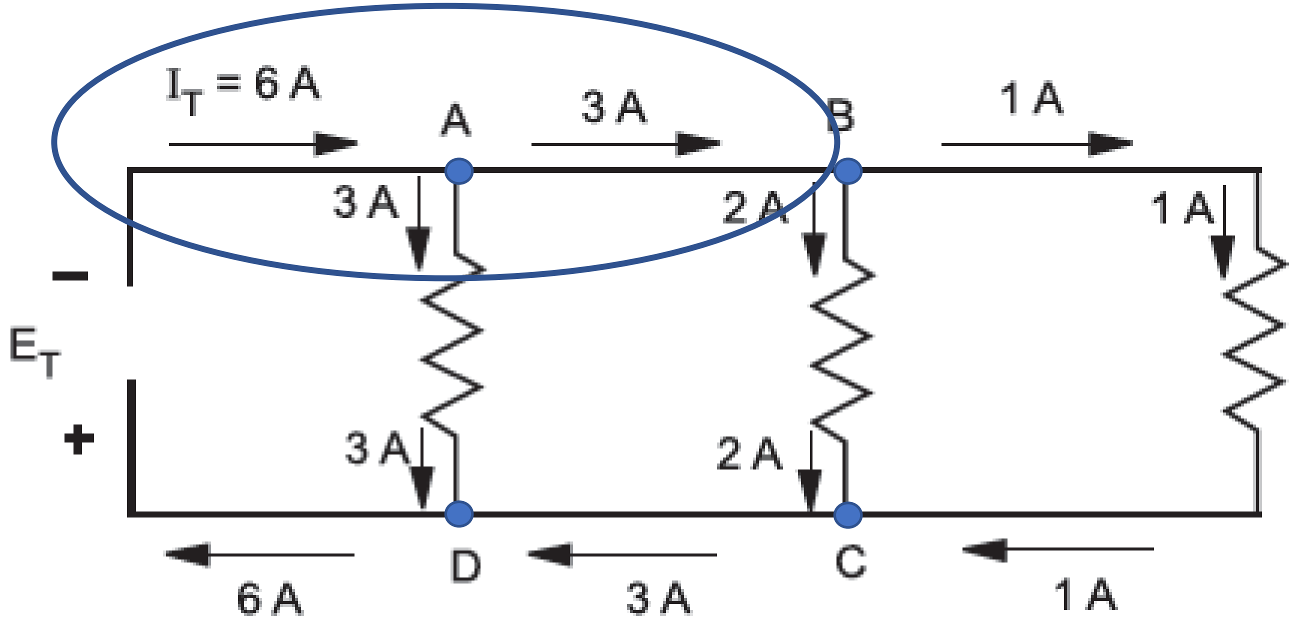


Figure 6—Circuit illustrating Kirchhoff's current law

Resistance in parallel.

What if you don't have enough info to use ohm's law? Well, there's a formula for that.

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

That formula hasn't quite solved for Rt yet.

$$R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} \cdots$$ *

But that one did.

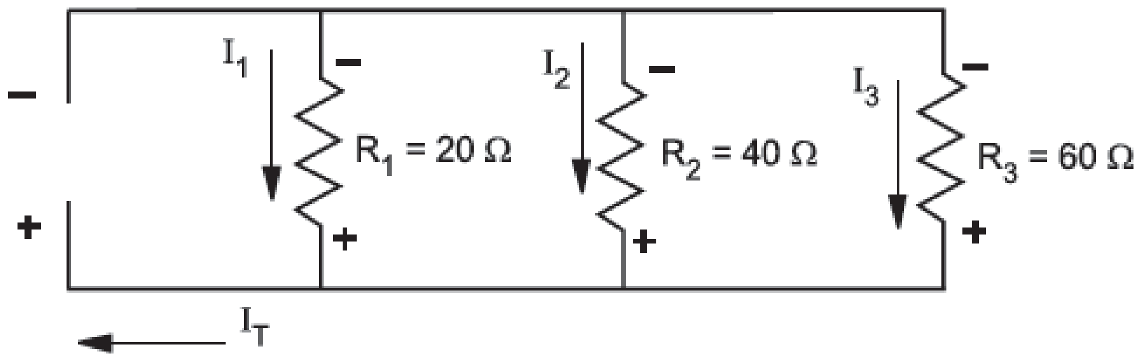


Figure 5—A parallel circuit with three branches

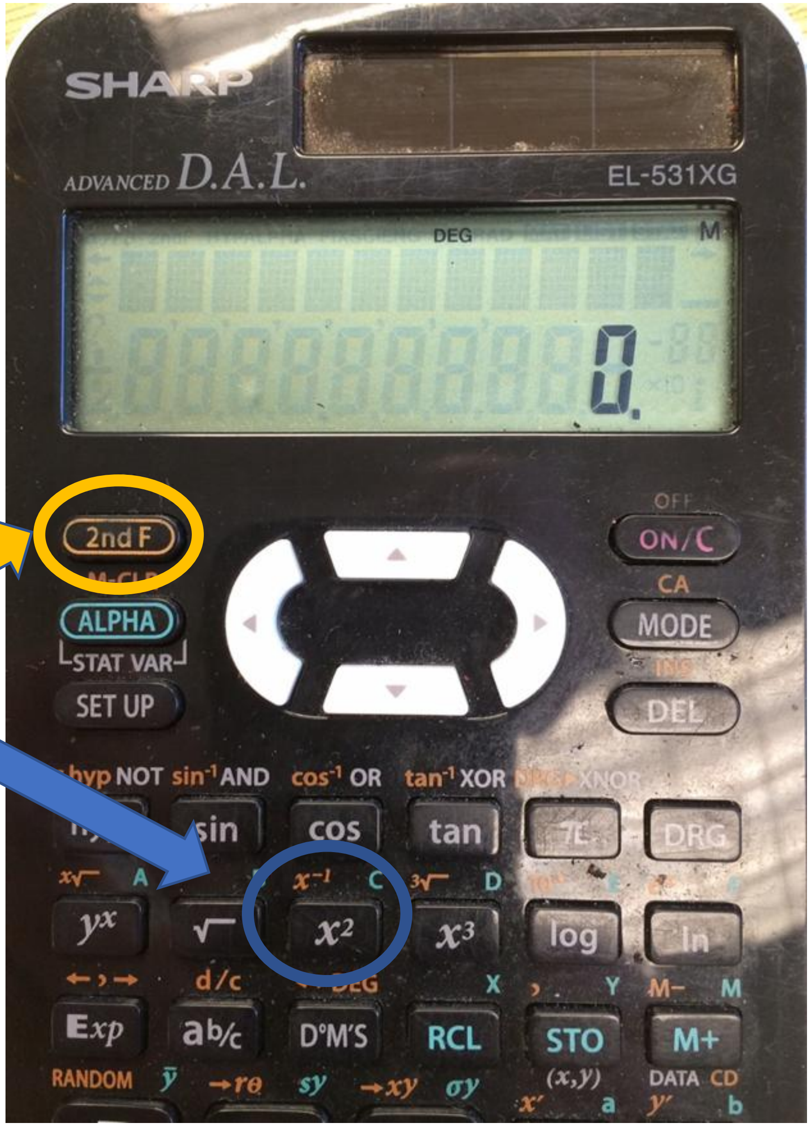
Using the Sharp calculator to solve for Rt.

$$R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\cdots}$$

Find the reciprocal key.

It will either be $x^{-1} or\ {}^{1}/_{x}$

You might need to use the 2ndF key to access it.



Using the Sharp calculator to solve for Rt.

Let's try it for the circuit we've been working on.

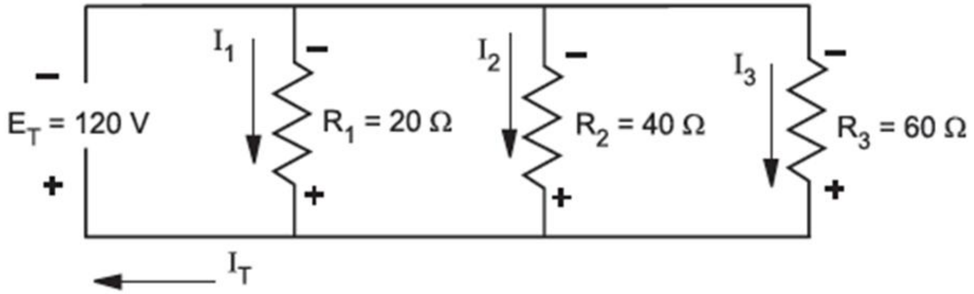
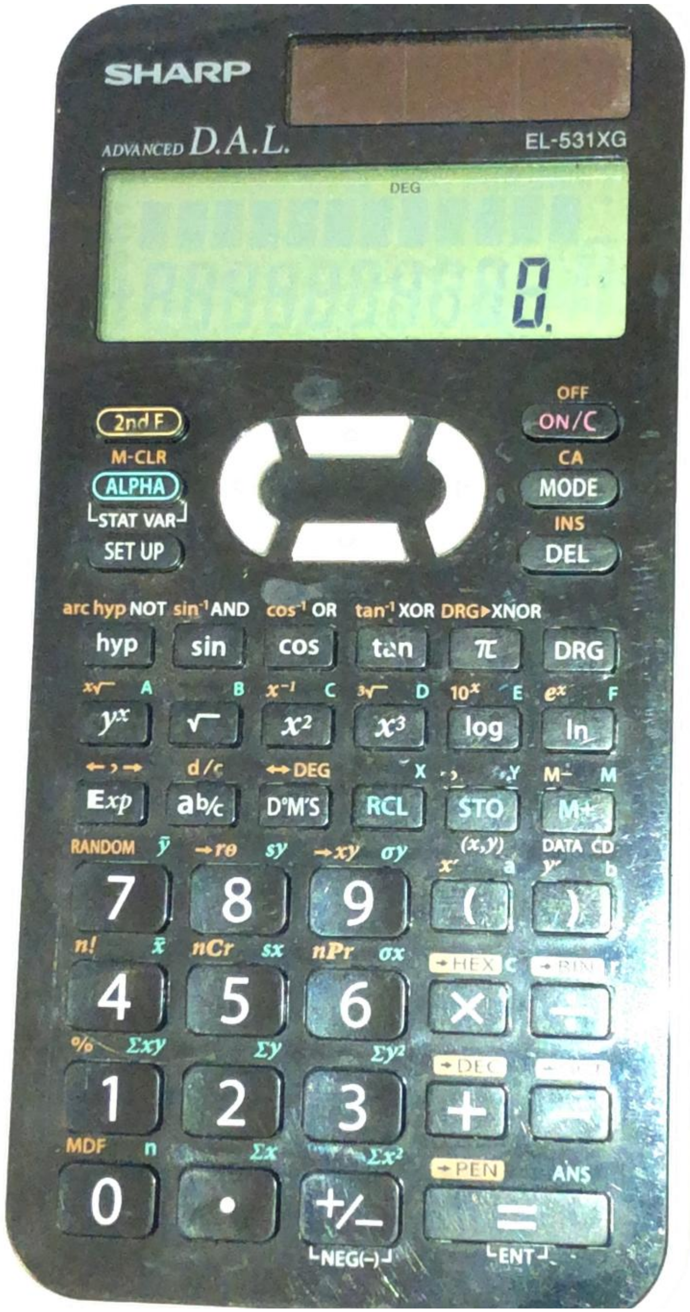


Figure 5—A parallel circuit with three branches

$$R_T = \frac{1}{\frac{1}{20} + \frac{1}{40} + \frac{1}{60}} =$$



Using the Sharp calculator to solve for Rt.

Let’s try it for the circuit we’ve been working on.

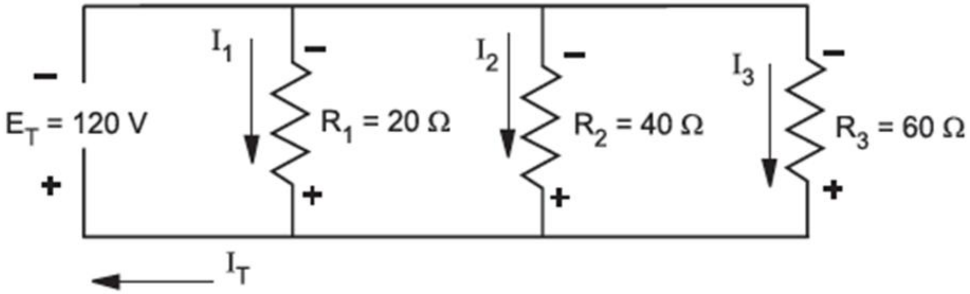
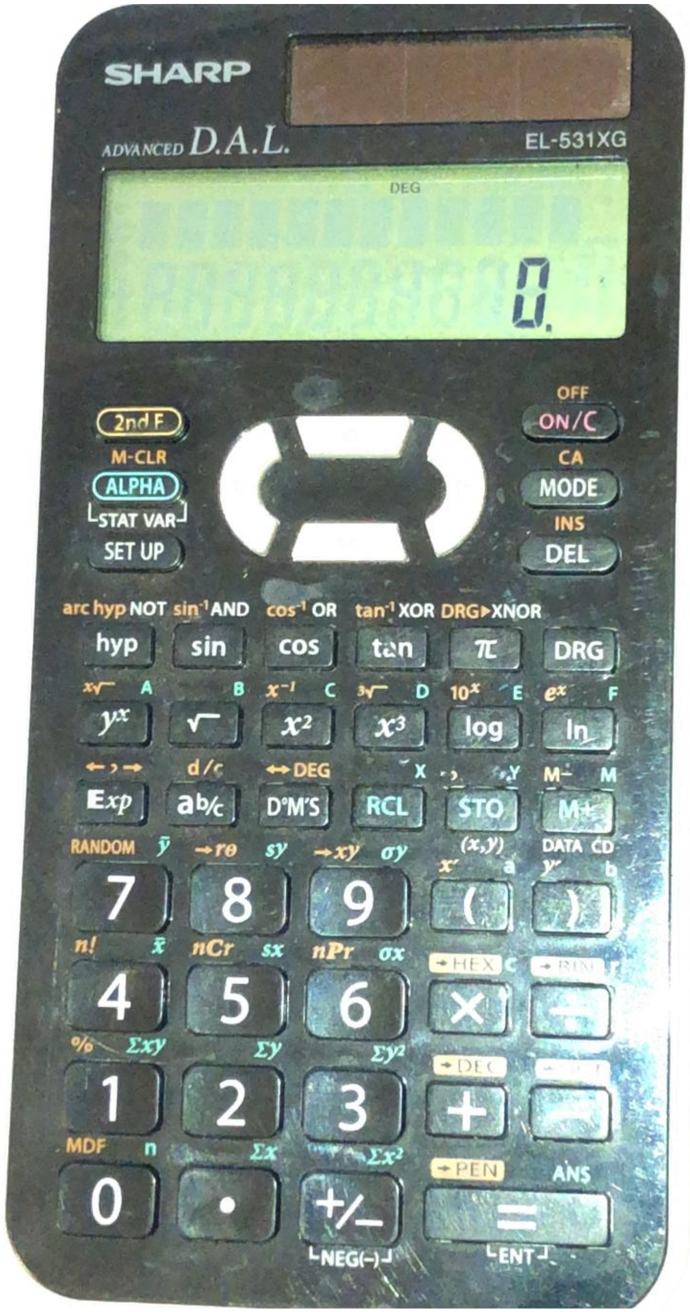


Figure 5—A parallel circuit with three branches

$$R_T = \frac{1}{\frac{1}{20} + \frac{1}{40} + \frac{1}{60}} = 10.91\ \Omega$$

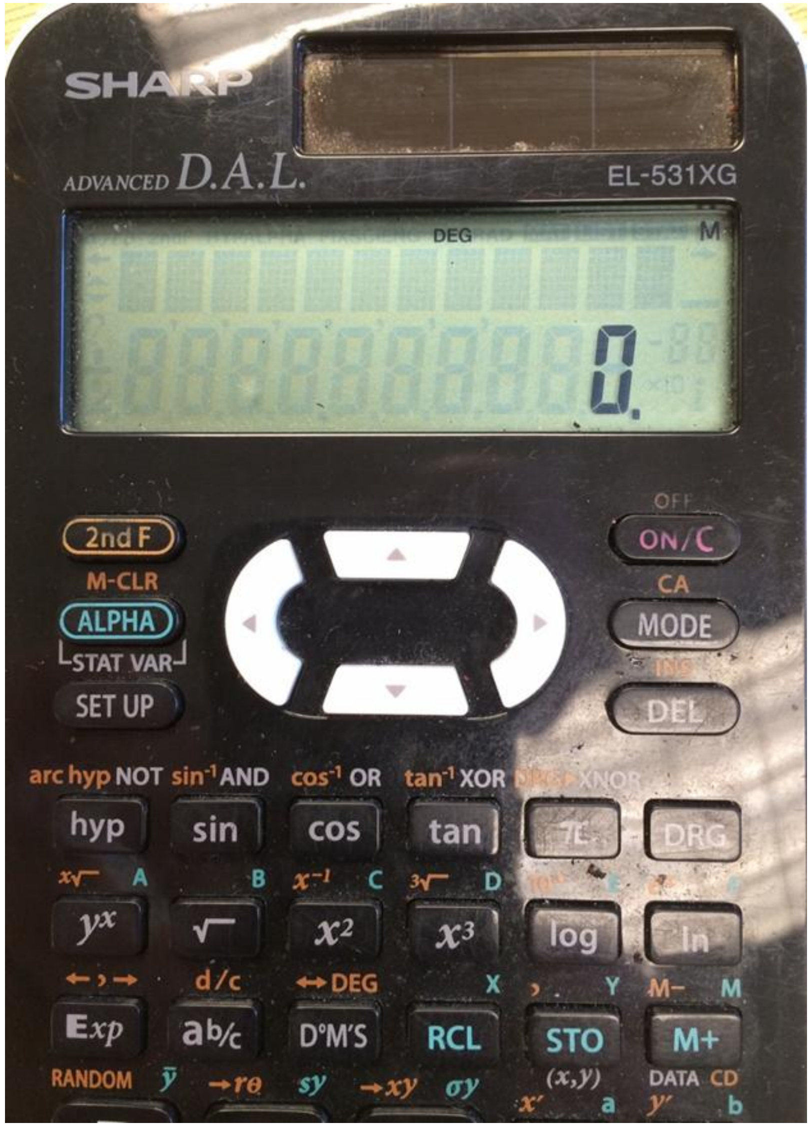


Using the Sharp calculator to store numbers.

Sometimes we get a calculated value that is very long.

We may want to use that number for further calculations.

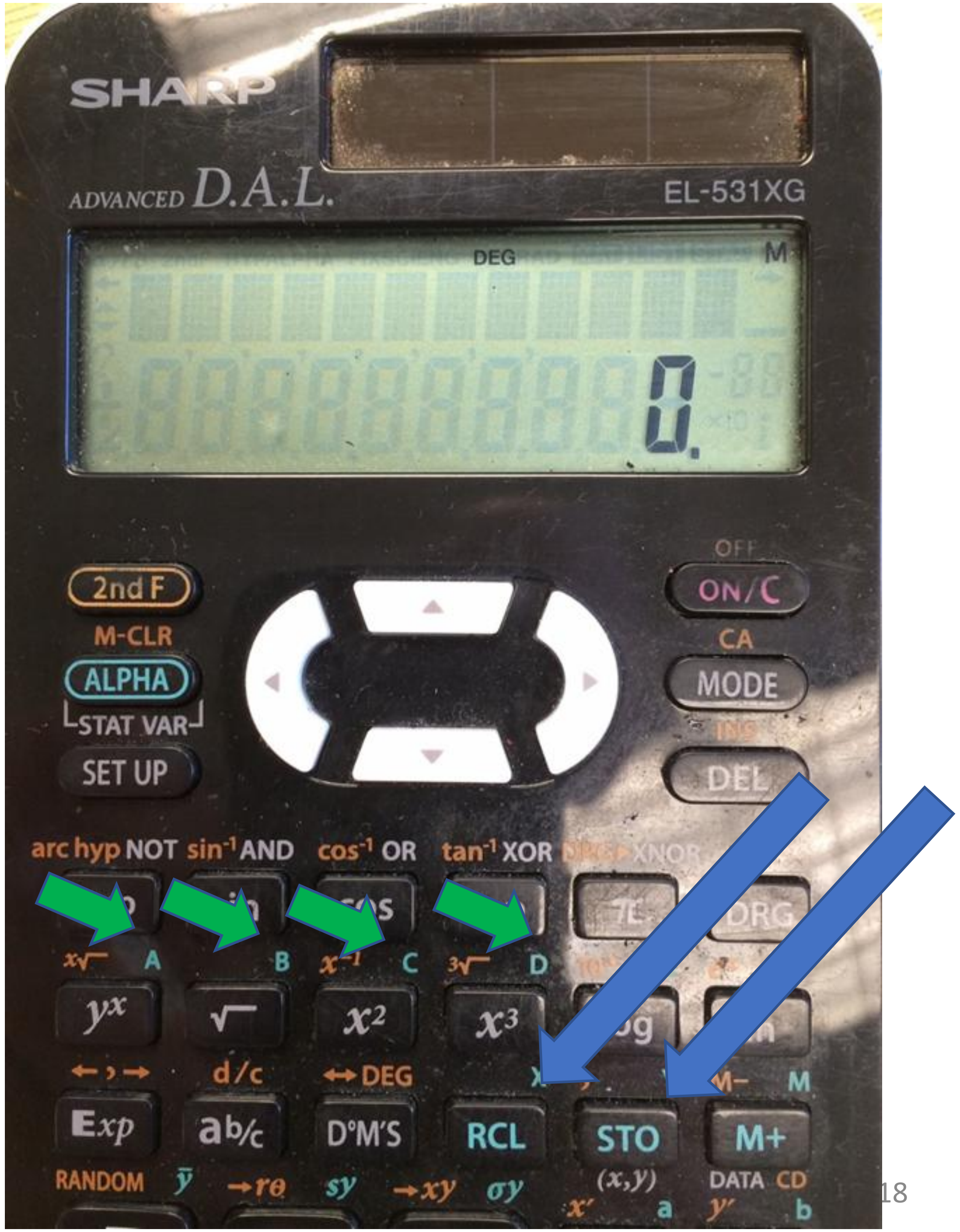
Storing that number in your calculator ensures the best accuracy.



Using the Sharp calculator to store numbers.

Find the STO and RCL buttons on your calculator.

The Sharp calculator has (at least) six places to store numbers. (A,B,C,D,E,F)



Power in parallel.

$$P_T = P_1 + P_2 + P_3 \ldots$$ *

Solve for power at each resistor using Watt's law.

The just add them up to solve for the total power in the circuit.

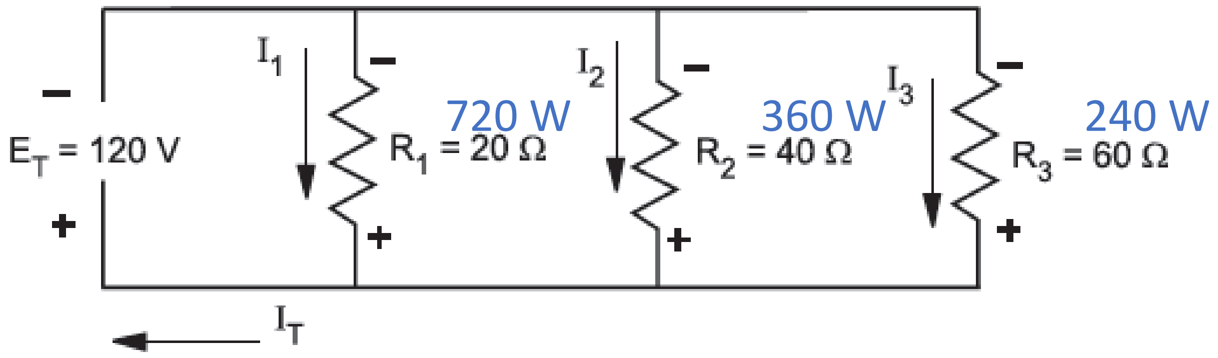


Figure 5—A parallel circuit with three branches

Power in parallel.

$P_T = 1320\ W = 720\ W + 360\ W + 240\ W$

$$P_T = P_1 + P_2 + P_3 \ldots$$

*

Solve for power at each resistor using Watt's law.

The just add them up to solve for the total power in the circuit.

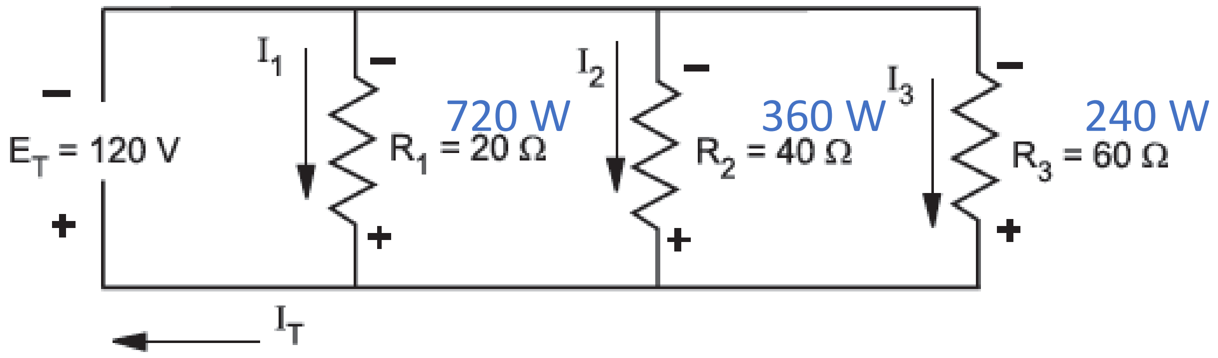


Figure 5—A parallel circuit with three branches

Laws of parallel circuits.

* $E_T = E_1 = E_2 = E_3 \ldots$ E_T is the key for a parallel circuit! *

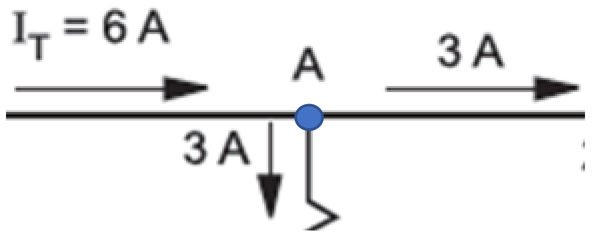
$I_T = I_1 + I_2 + I_3 \ldots$ *

$R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \cdots}$ *

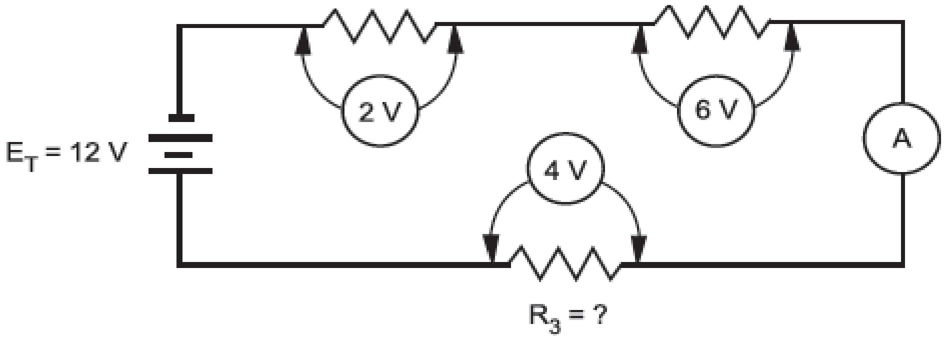
$P_T = P_1 + P_2 + P_3 \ldots$ *

Kirchhoff's Laws. *

<u>Kirchhoff's current law (parallel):</u> the currents going into a node must be equal to the currents coming out of that node.



<u>Kirchhoff's voltage law (series):</u> the voltage drops around a closed loop must add up to the voltage supply (rise) for that loop.



3.1 Parallel Circuit Fundamentals

VIDEO

Engineering Mindset. (January 13, 2020)

DC parallel circuits explained. YouTube.

https://www.youtube.com/watch?v=5uyJezQNSHw&t=644s

Parallel Circuits

Parallel circuit board problems

Solve it #1.

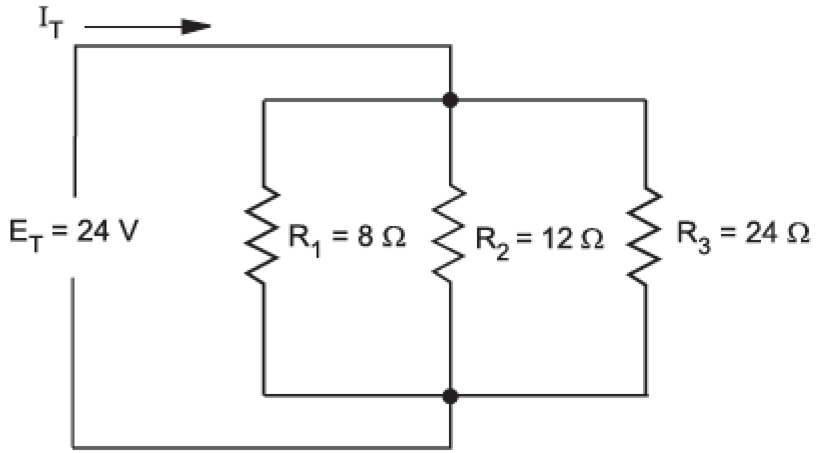


Figure 1—Parallel circuit for Example 1

	E	I	R	P
Branch 1	_____	_____	8 Ω	_____
Branch 2	_____	_____	12 Ω	_____
Branch 3	_____	_____	24 Ω	_____
Total	24 V	_____	_____	_____

Solve it #2.

What is R_T?

A little trick if all the resistors are equal.

$$R_T = \frac{\Omega}{\#\ of\ resistors\ in\ parallel}$$

$$R_T = \frac{36\Omega}{4} = 9\ \Omega$$

Only if they're equal

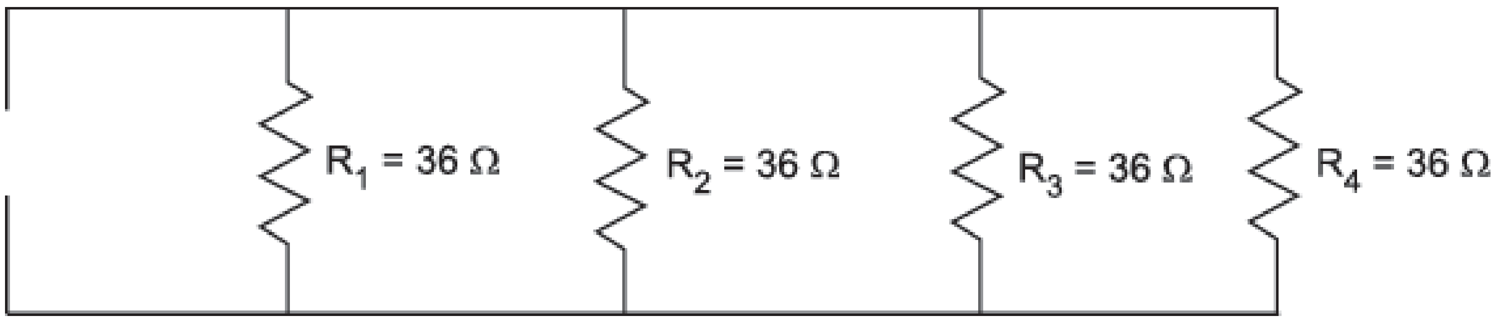


Figure 2—Equal parallel resistors

Solve it #3.

1. Use Kirchhoff's current law.
2. Find voltage at R1.
3. Find voltage at R2 (it's parallel with R1).
4. Find R2 ohms
5. Find Rt

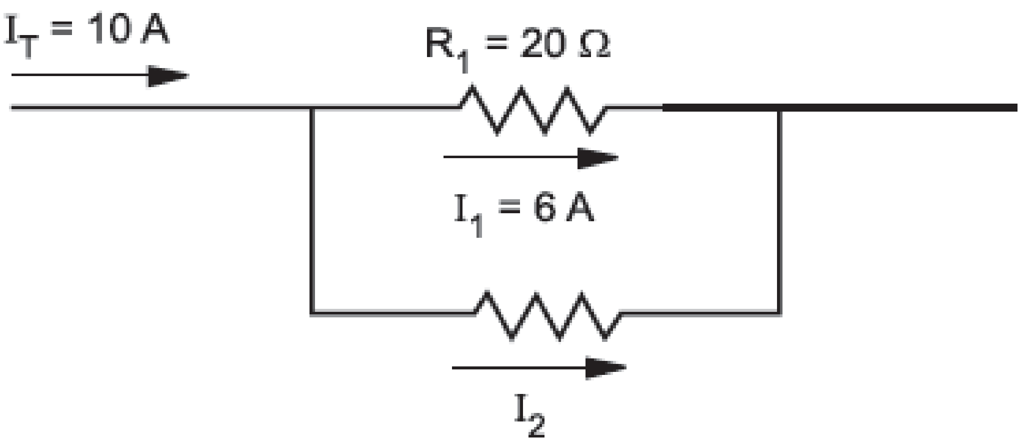


Figure 4—Schematic for Example 3

Solve it #4.

Find the power of lightbulb #2

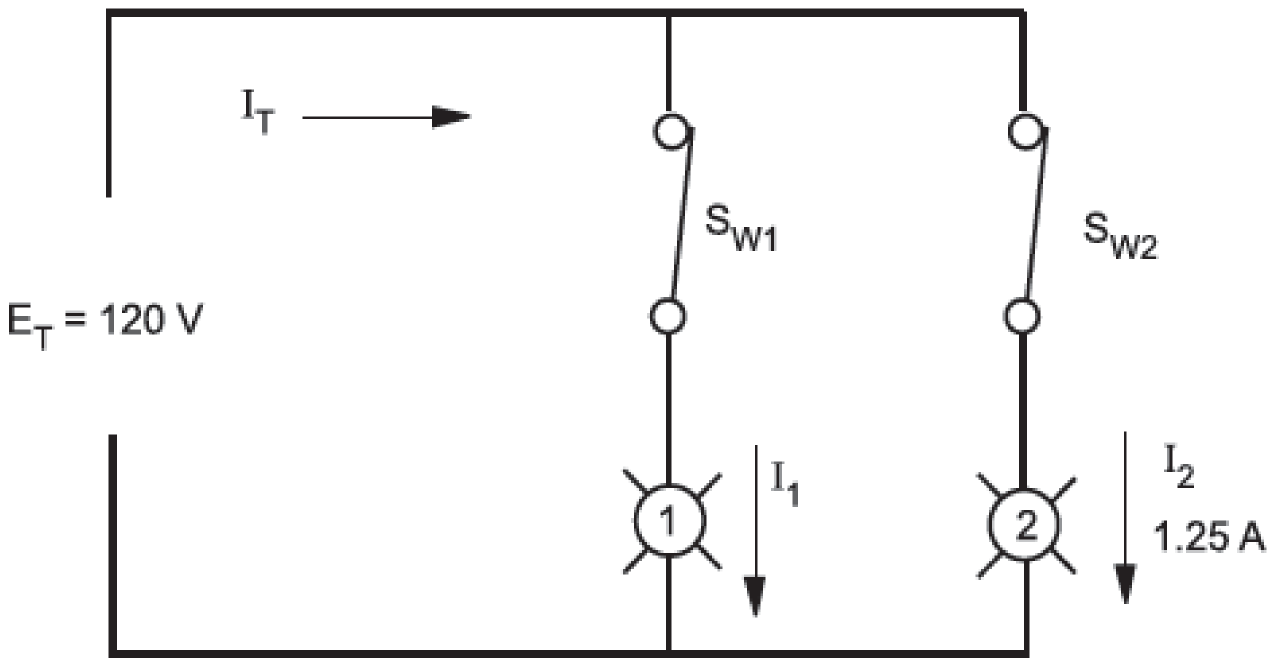


Figure 5—Schematic for Example 4

Solve it #5.

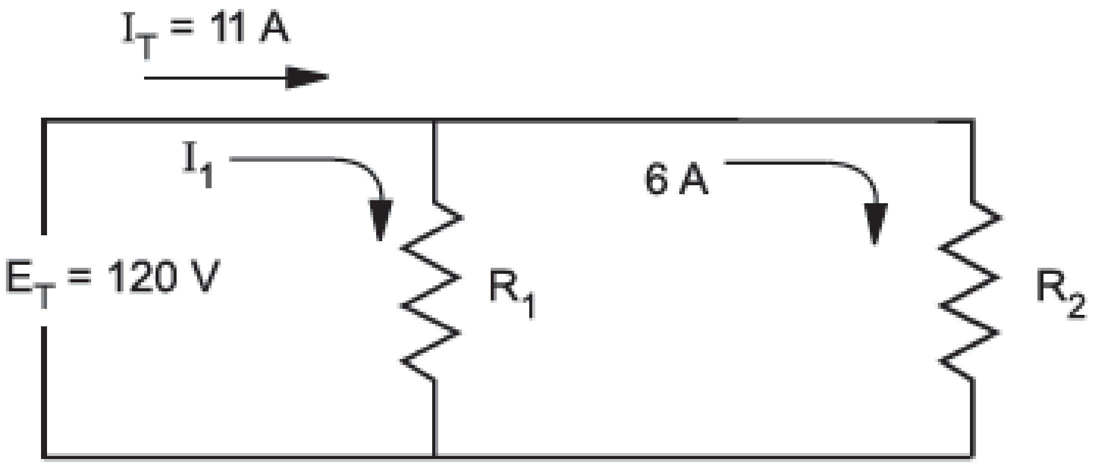


Figure 6—Circuit for Example 5

	E	I	R	P
Branch 1	120 V	_____	_____	_____
Branch 2	120 V	6 A	_____	_____
Total	120 V	11 A	_____	_____

Solve it #6.

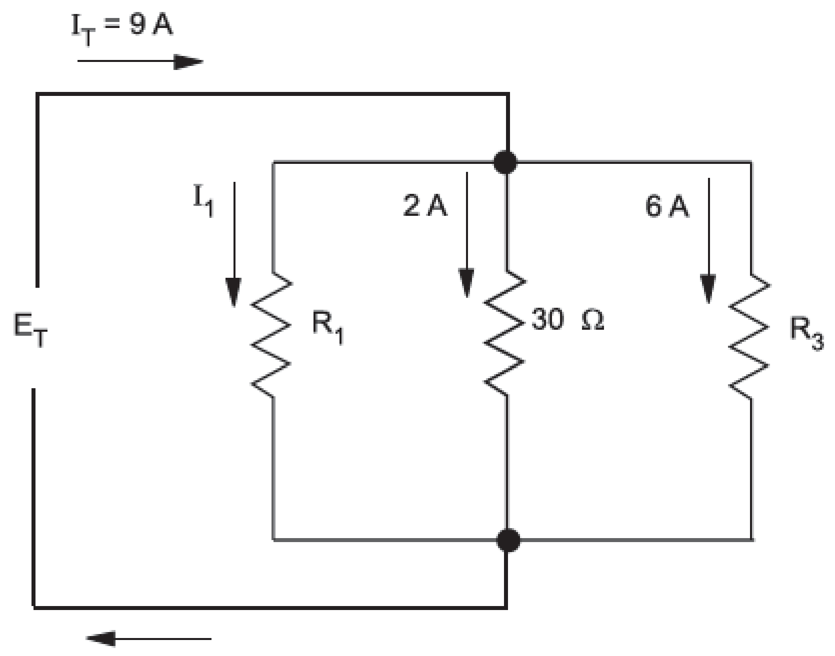


Figure 7—Circuit for Example 6

	E	I	R	P
Branch 1				
Branch 2		2 A	30 Ω	
Branch 3		6 A		
Total		9 A		

Solve it #7.

1. Use Kirchoff's current law.
2. Find voltage at R1.
3. Find voltage at R2 (it’s parallel with R1).
4. Find R2 ohms
5. Find Rt

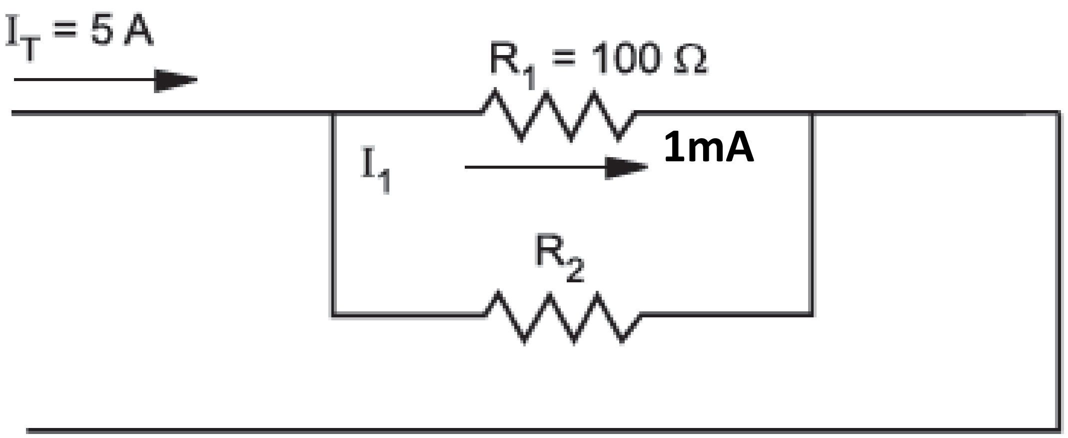


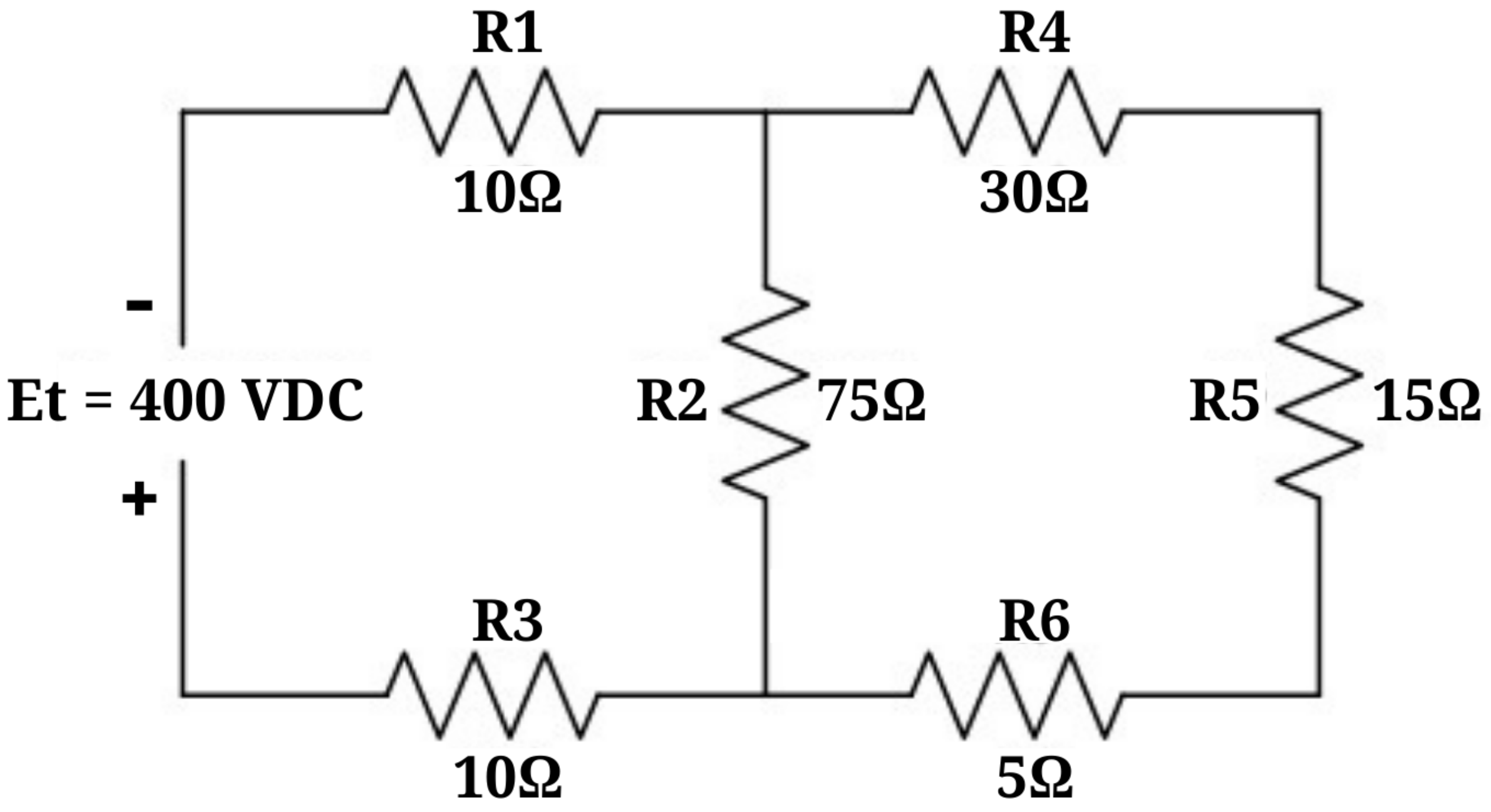
Figure 8—Circuit for Example 7

3.2 Parallel Circuits

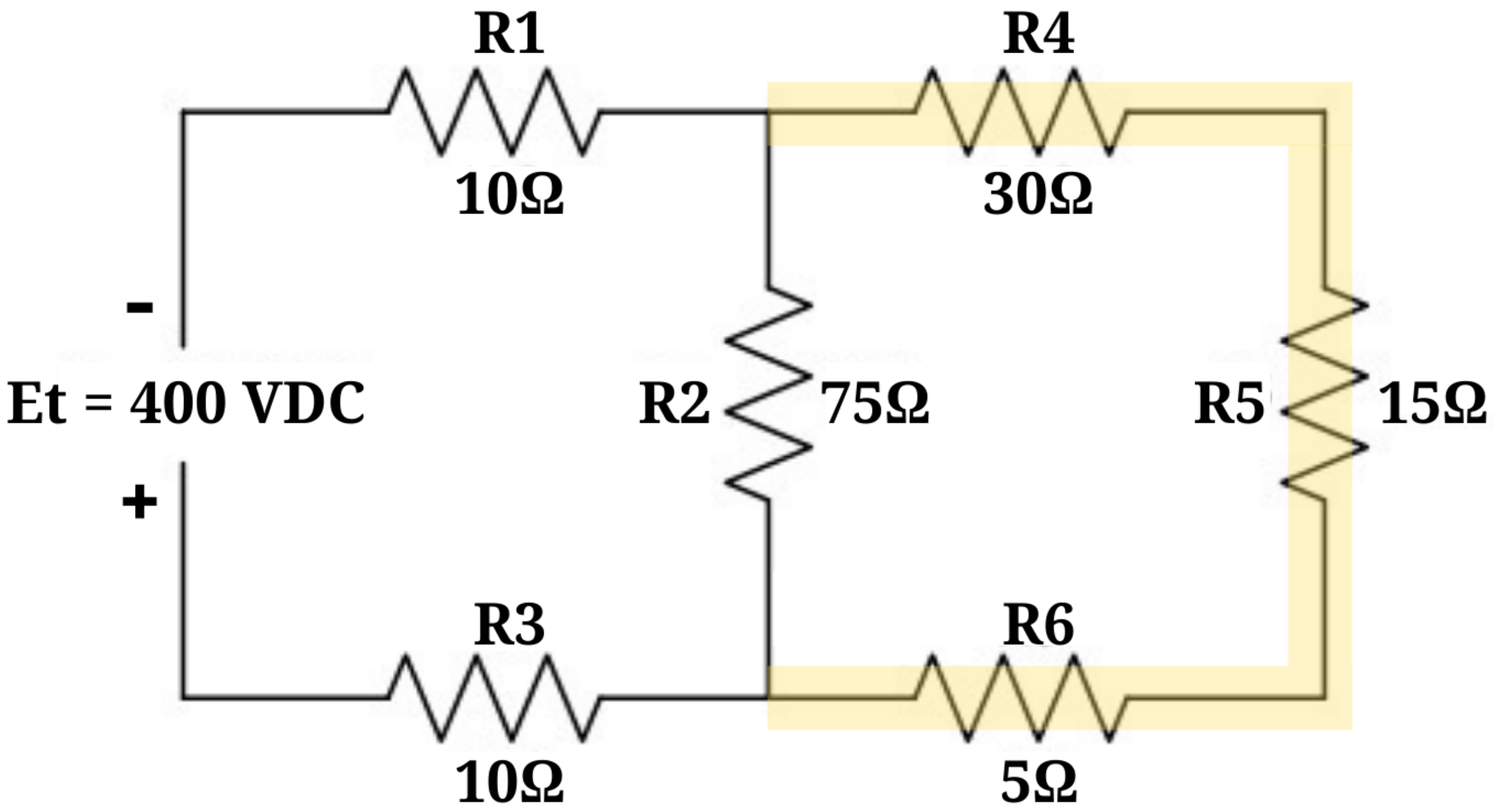
Parallel Circuits

Intro to combination circuit board problems

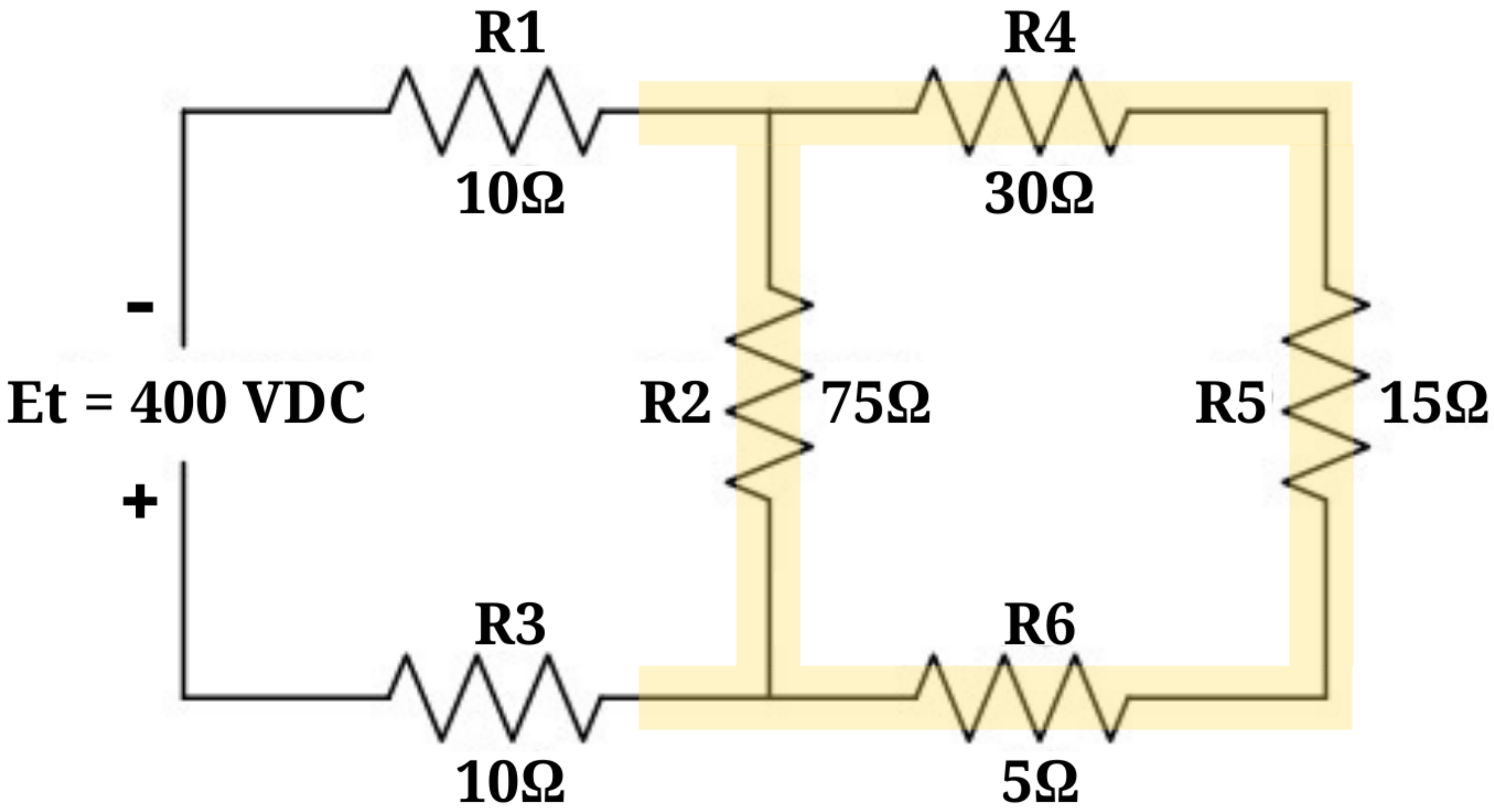
Solving for Combination Circuits



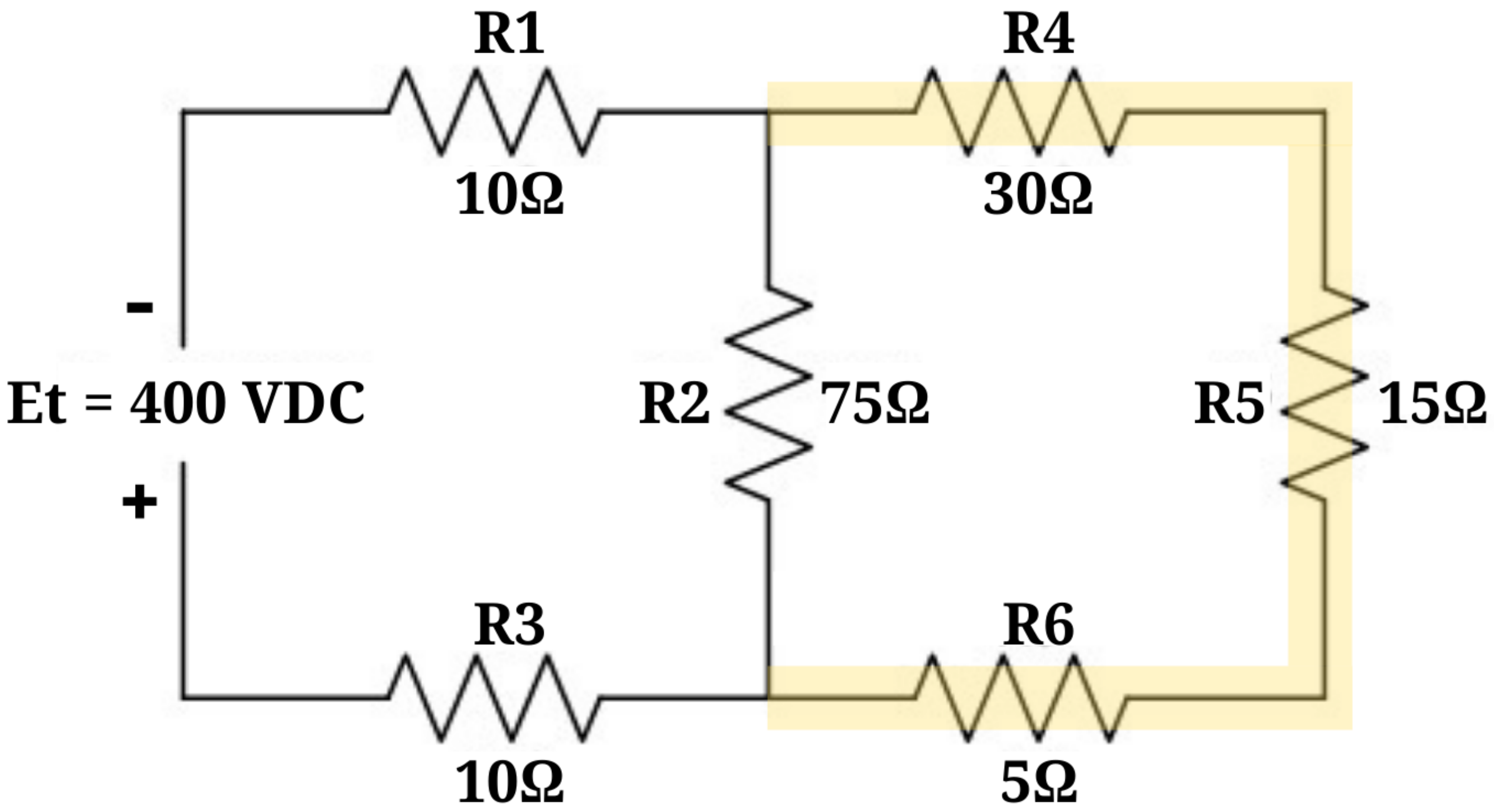
Solving for Combination Circuits



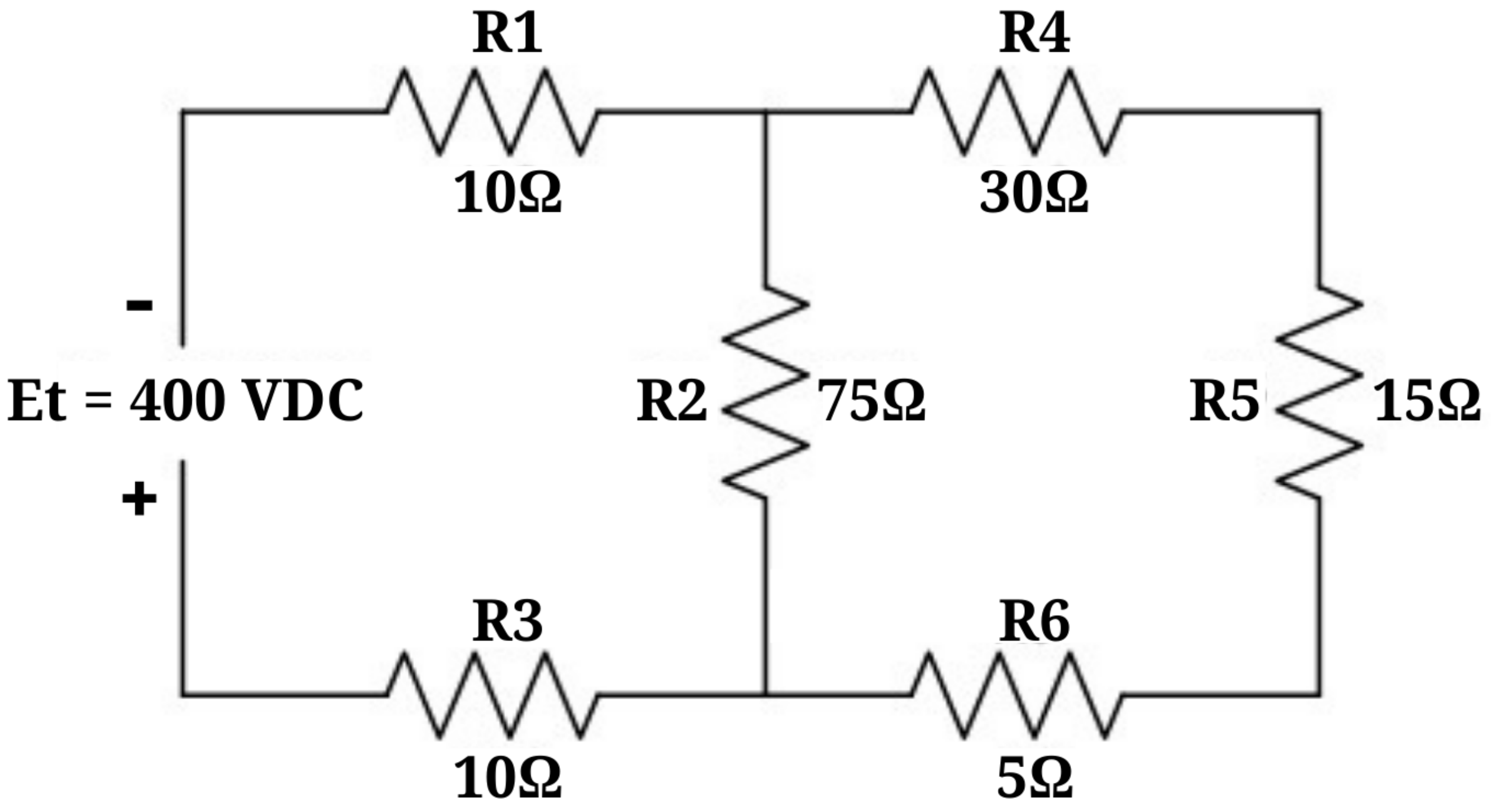
Solving for Combination Circuits



Solving for Combination Circuits



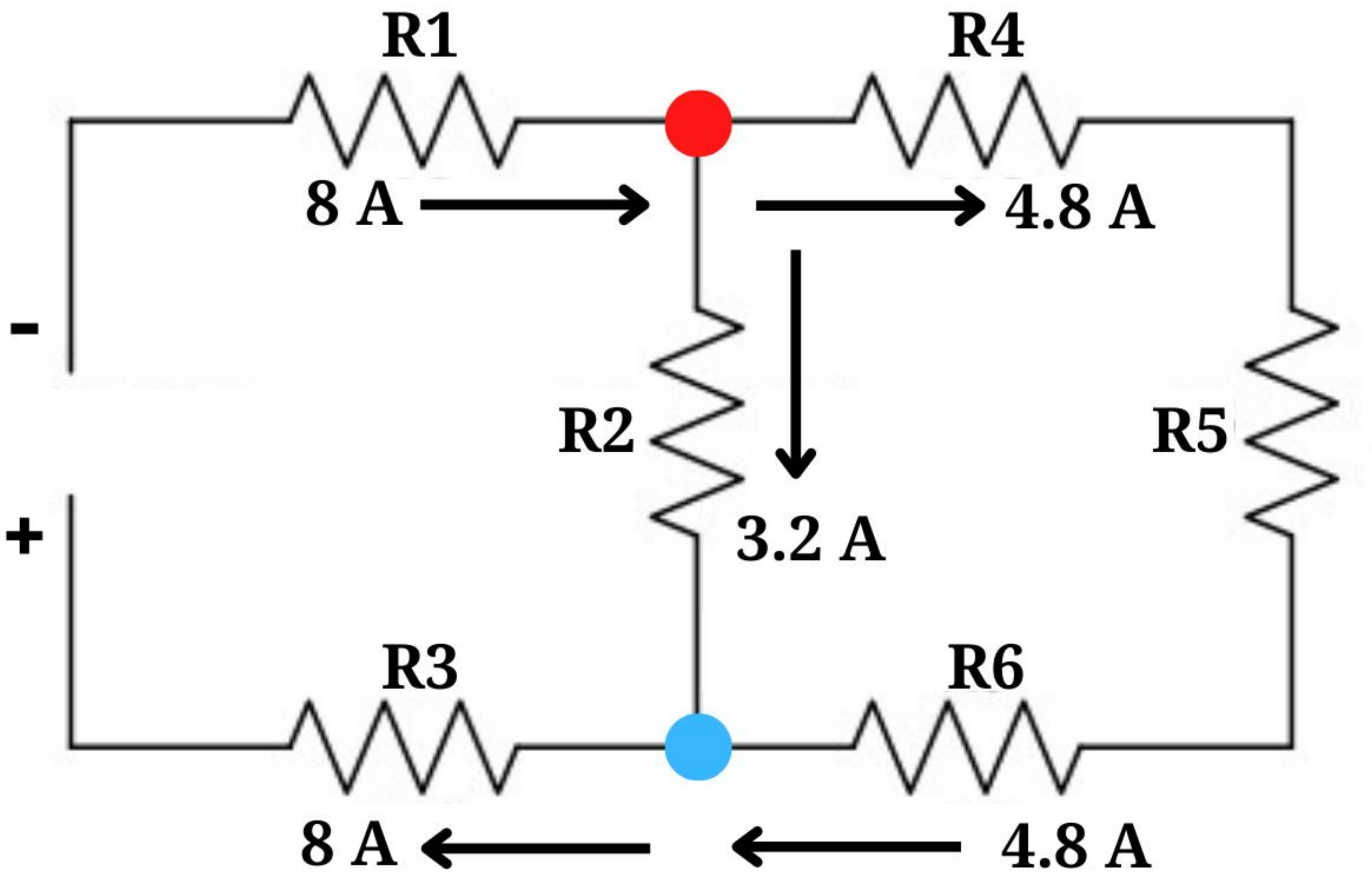
Solving for Combination Circuits



Kirchoff's Current Law

The sum of the currents entering a junction (node) is equal to the sum of the currents leaving that junction.

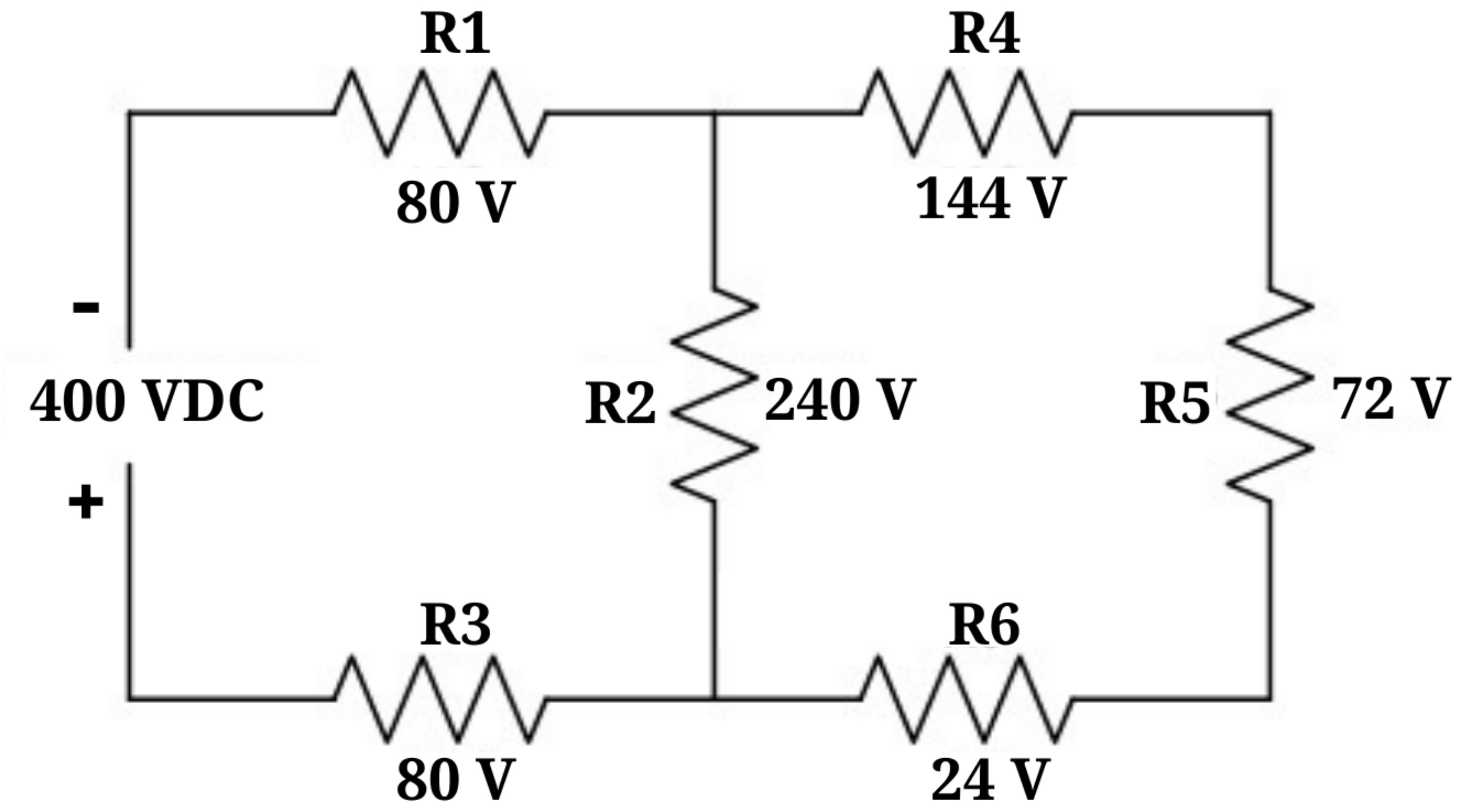
Kirchoff's Current Law



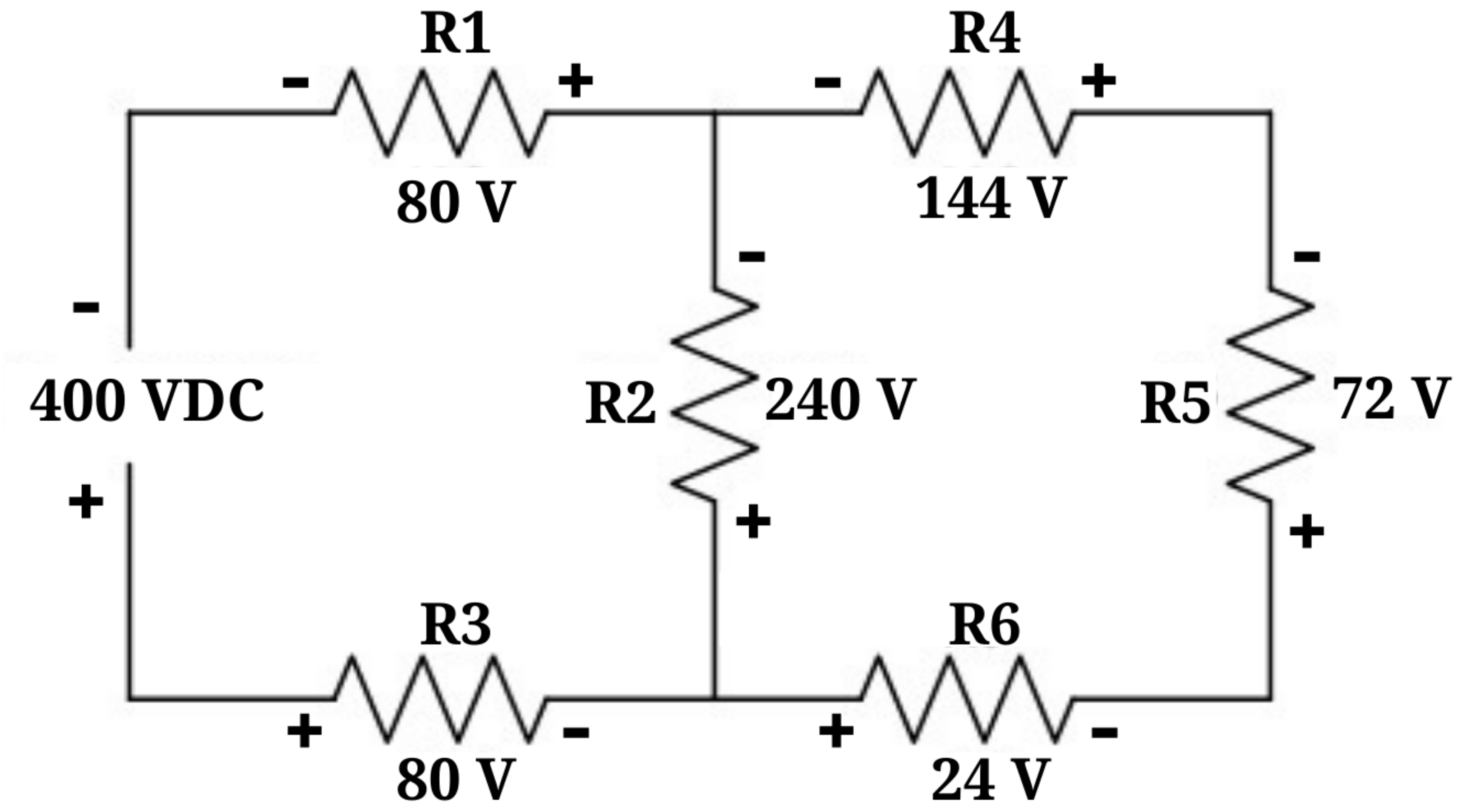
Kirchoff's Voltage Law

Around any closed loop, the algebraic sum of all the voltages is zero.

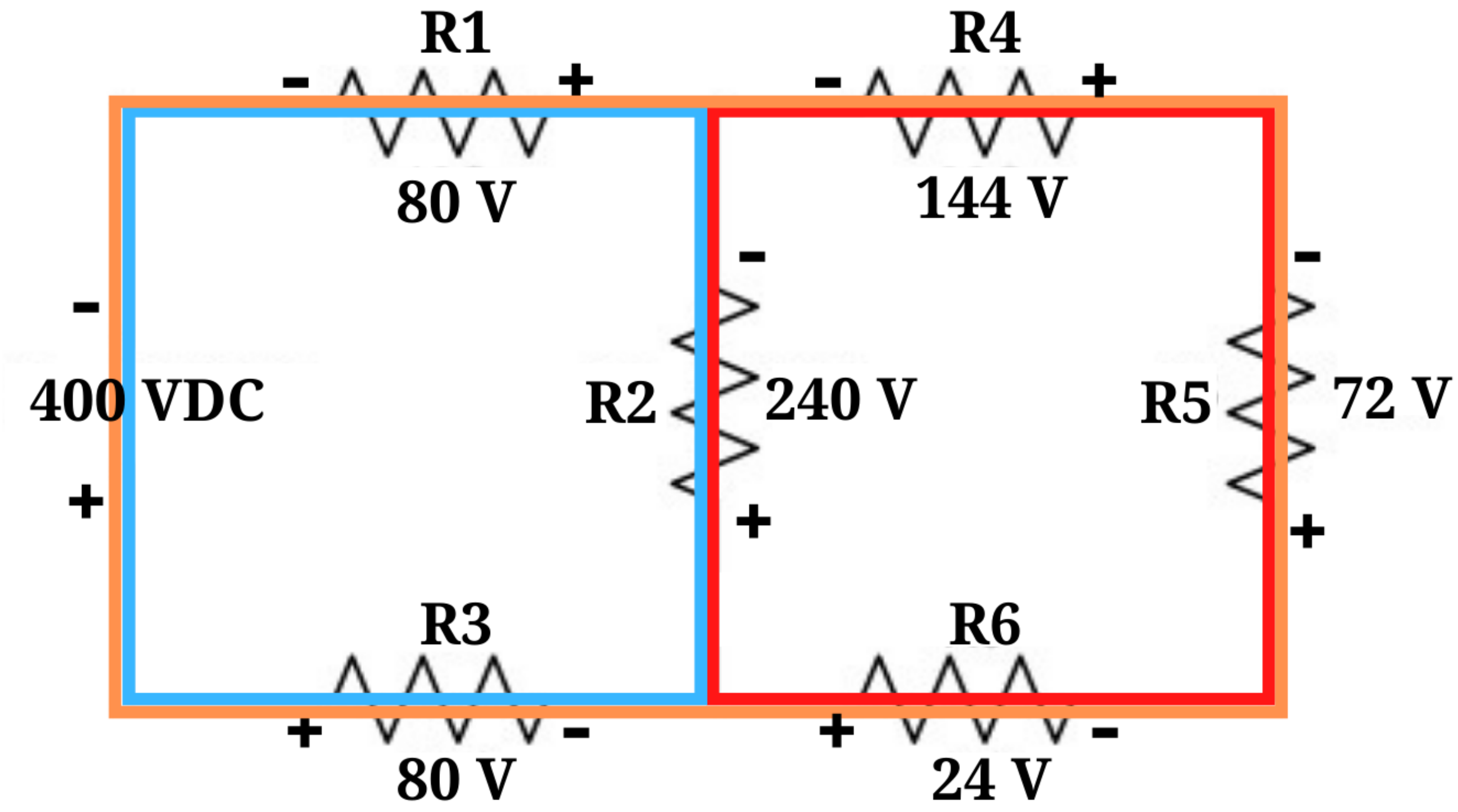
Kirchoff's Voltage Law



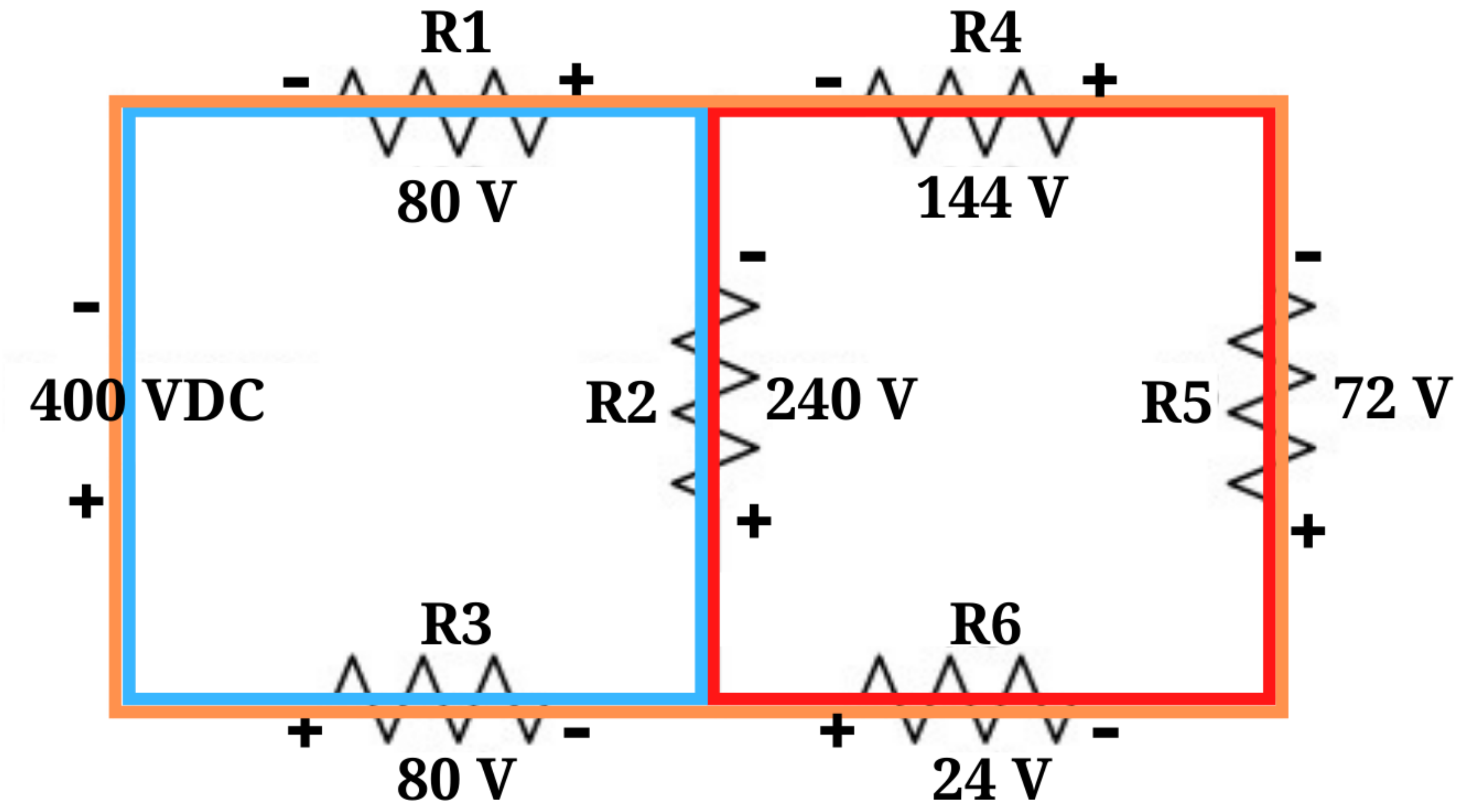
Kirchoff's Voltage Law



Kirchoff's Voltage Law

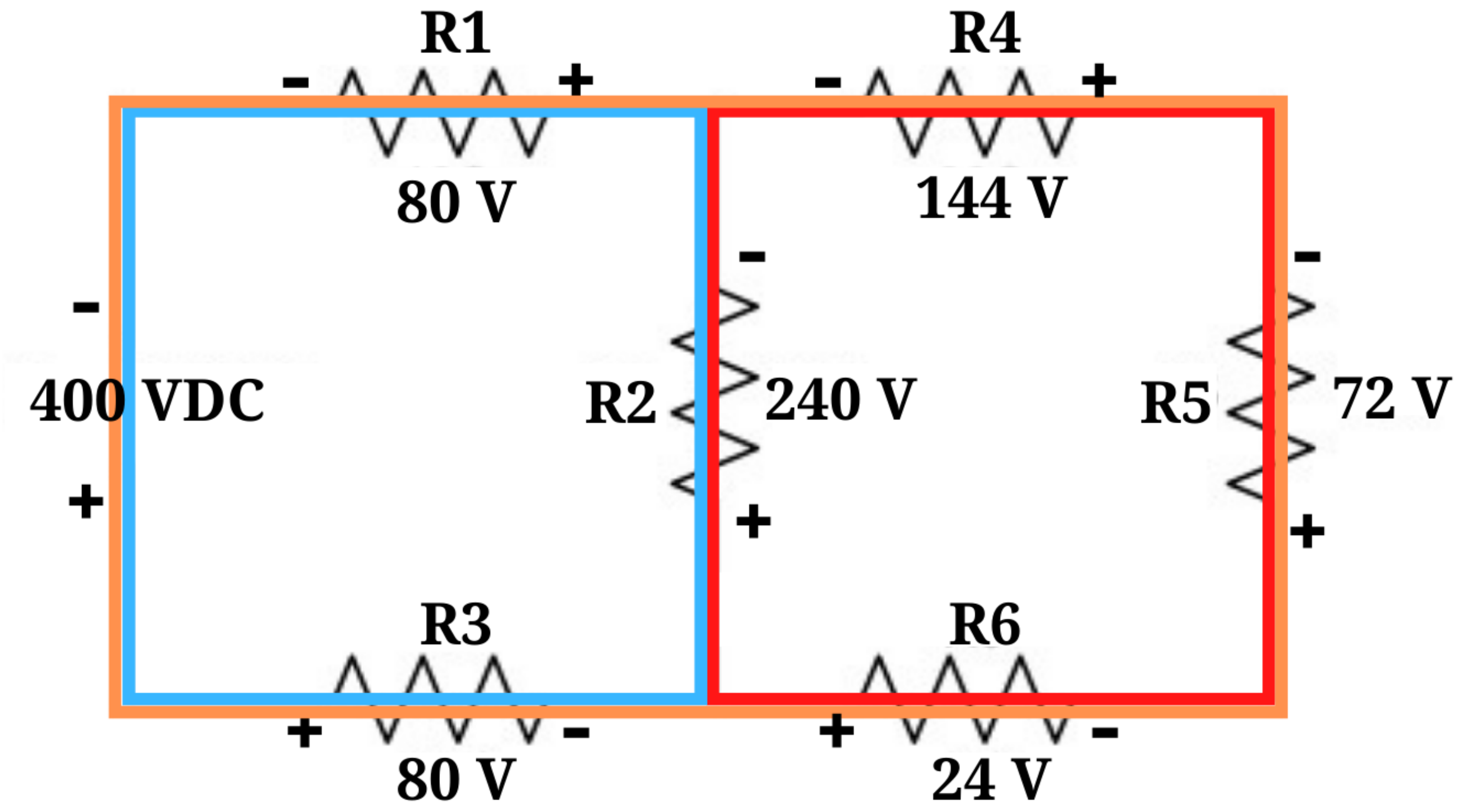


Kirchoff's Voltage Law



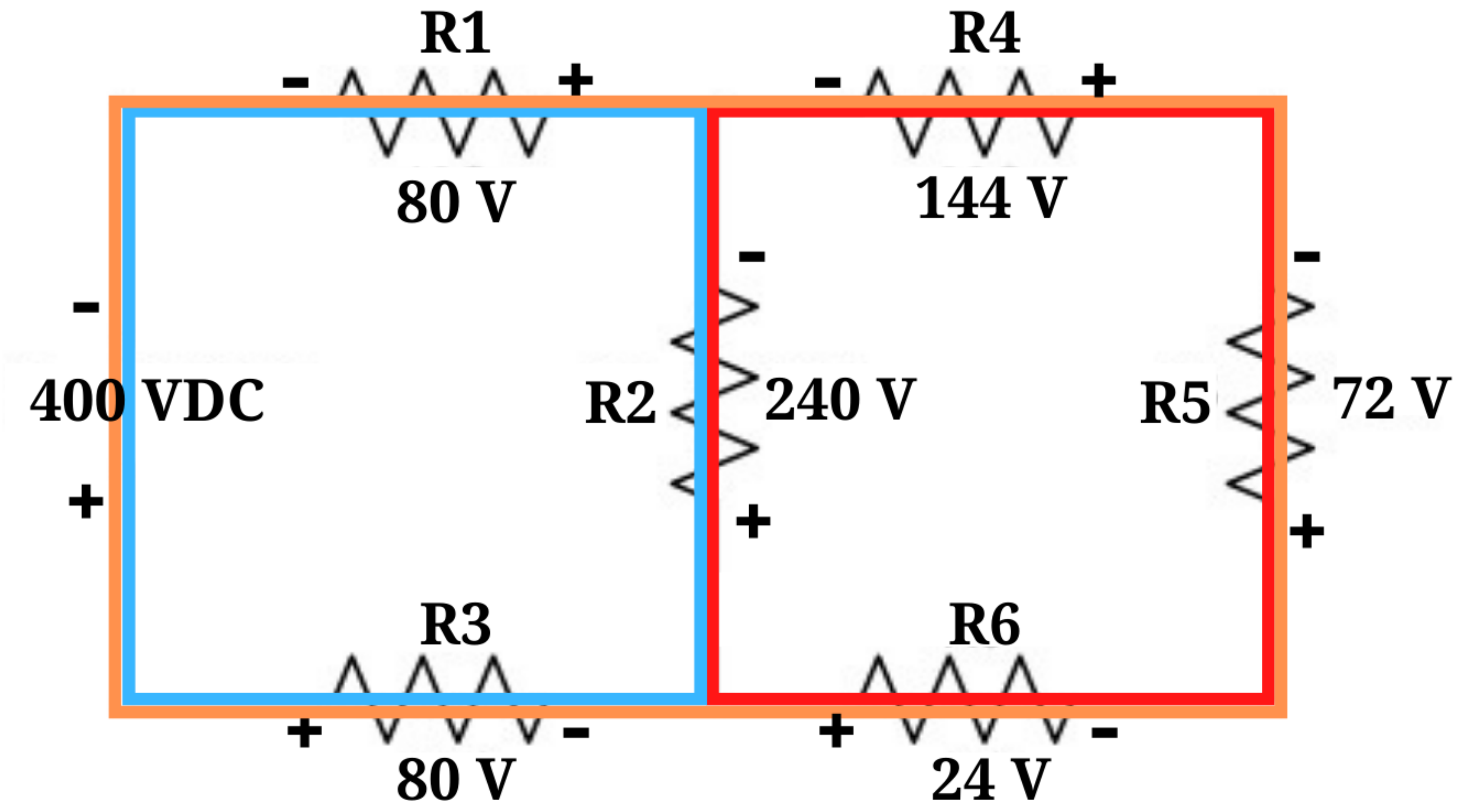
-144 V - 72 V - 24 V + 240 V = 0

Kirchoff's Voltage Law



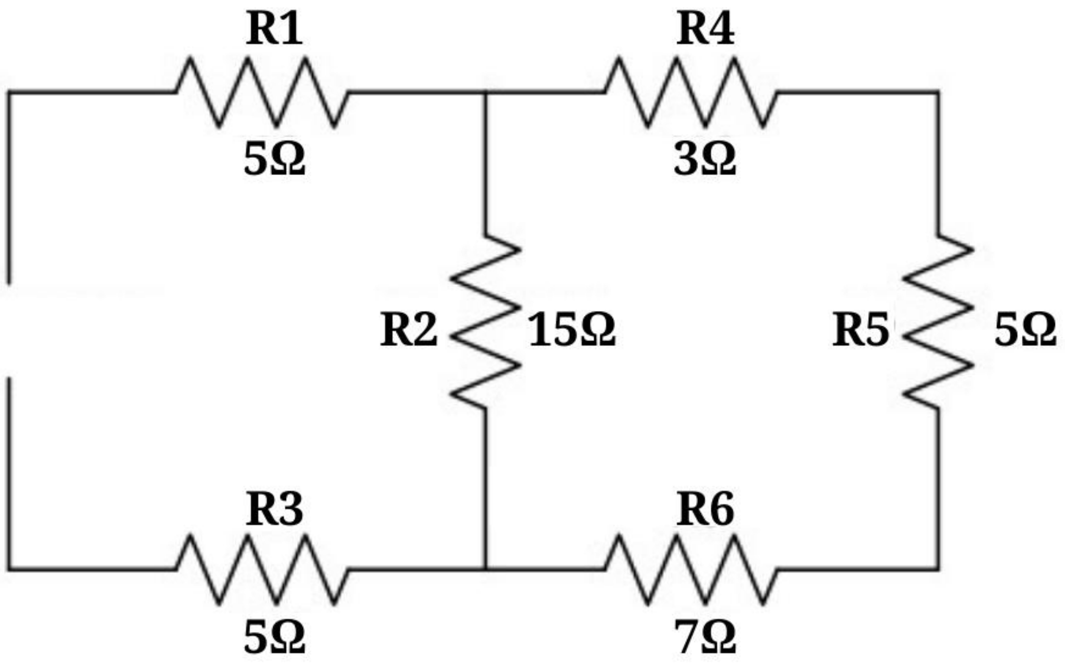
-80 V - 240 V - 80 V + 400 V = 0

Kirchoff's Voltage Law

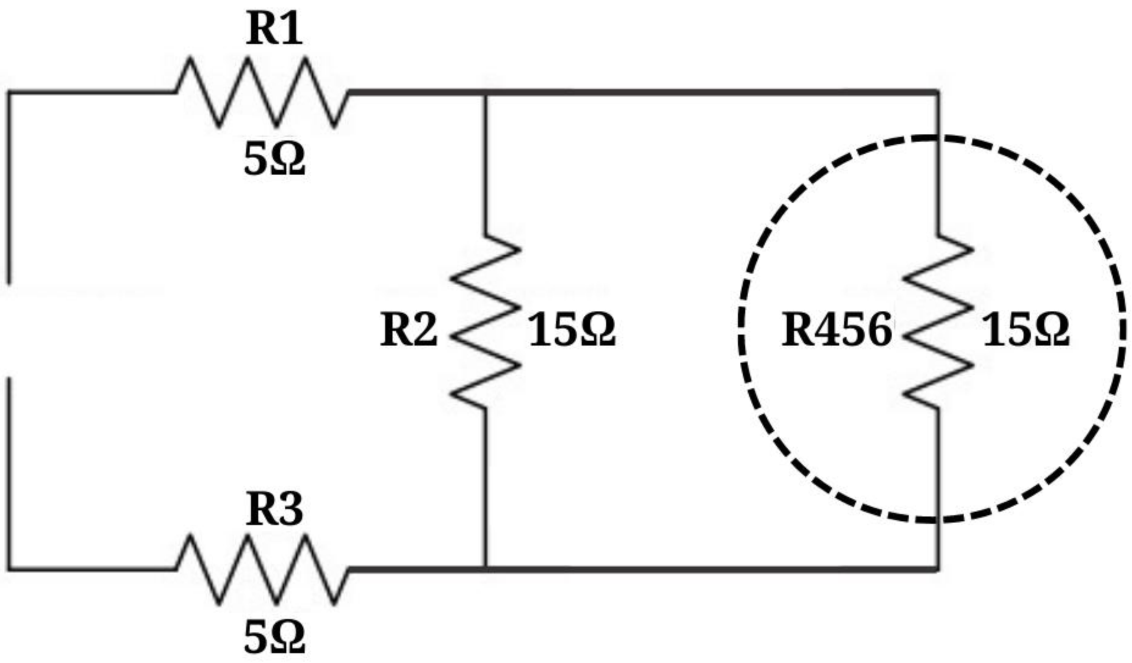


-80 V - 144 V - 72 V - 24 V - 80 V + 400 V = 0

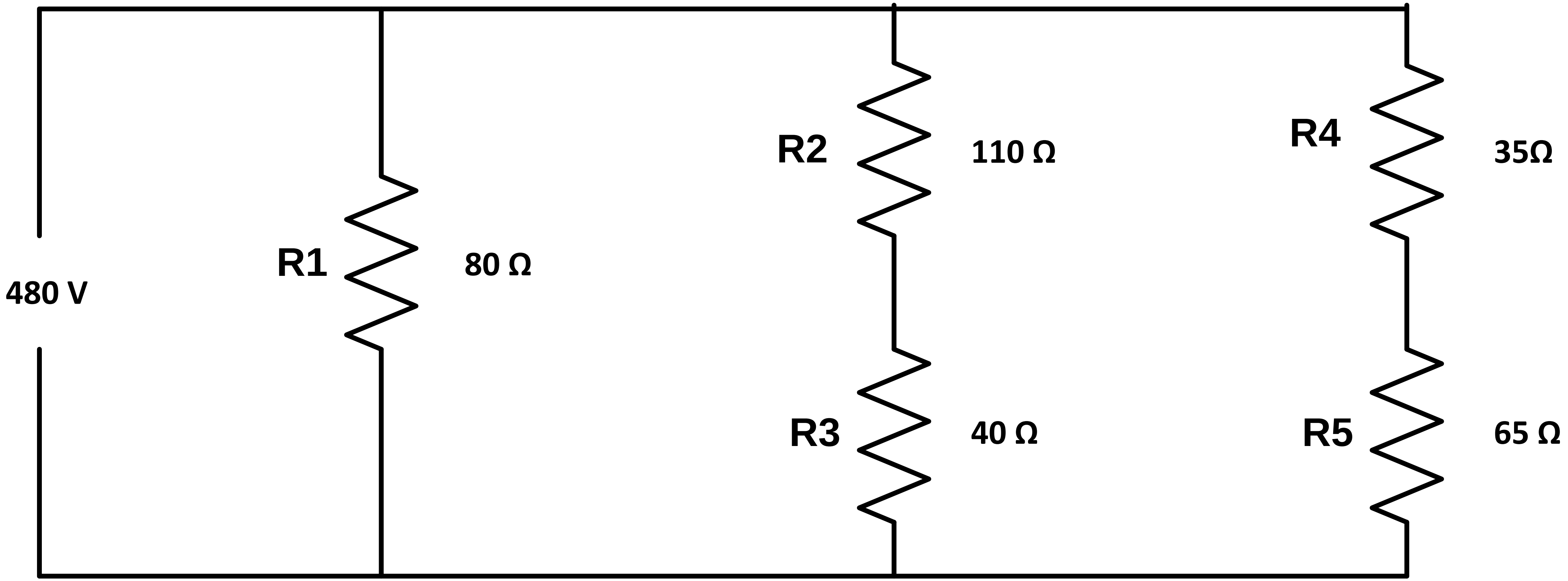
What is the equivalent resistance value for R4, R5, and R6?



What is the equivalent resistance value for R456 and R2?



Intro to combination circuits



3.3 Combination Circuits

KAHOOT!

QUIZ 3