Quiz #3 : figure in Q#3 is not showing correctly
→ don't start if you have not yet
→ I will add the figure in the quiz pre-amble
→ I will add extra attempt (4)

Chapter 19:

REVIEW

Ohm's Law: $\Delta V = IR$

Resistance: $R = \frac{\rho L}{A}$

Capacitor: $C = \frac{Q}{\Delta V}$

Joule's Law: $P = \left|\frac{\Delta U_q}{\Delta t}\right| = I\Delta V$

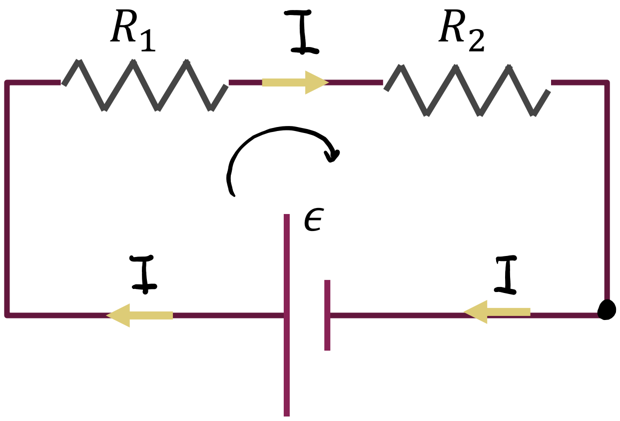
Kirchhoff's Loop Law:

$$\sum_{loop} \Delta V_i = 0$$

Kirchhoff's Junction (Node) Law:

$$\sum_{node} I_i = 0$$

19.8 DC Circuits – Resistors in Series



Current has only one way to go, so the current through each resistor is the same.

$$\epsilon - IR_1 - IR_2 = 0$$

$$\epsilon = \underbrace{\Delta V_1}_{IR_1} + \Delta V_2$$

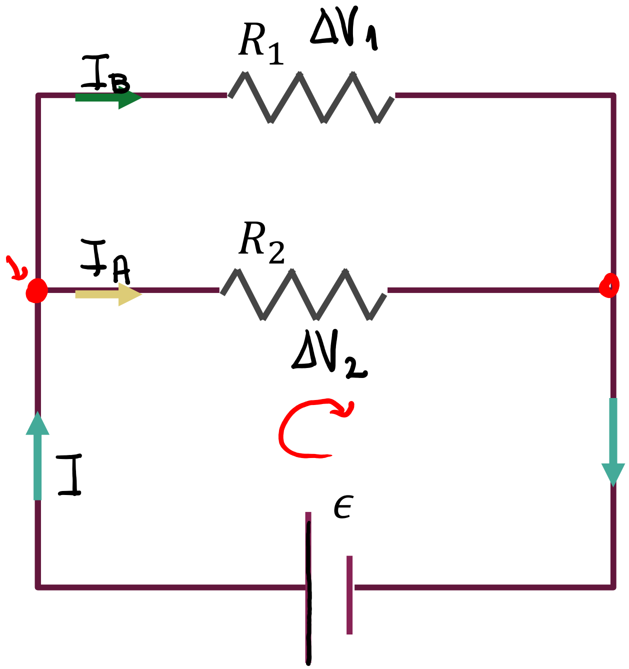
$$IR_{eq} = IR_1 + IR_2$$

$$R_{eq} = R_1 + R_2$$

IN SERIES

$$R_{eq} = \sum_{i=1}^{N} R_i$$

19.8 DC Circuits – Resistors in Parallel



Current splits at the node, but potential difference across each resistor is the same:

$$-I_A R_2 + \epsilon = 0 \quad 1$$
$$-I_B R_1 + \epsilon = 0$$
$$I_A + I_B = I$$

$\Delta V_1 = \epsilon$, $\Delta V_2 = \epsilon$

$$I_A = \frac{\Delta V_2}{R_2} = \frac{\epsilon}{R_2} \qquad I_B = \frac{\Delta V_1}{R_1} = \frac{\epsilon}{R_1}$$

$R_{TOTAL} = R_{equivalent}$

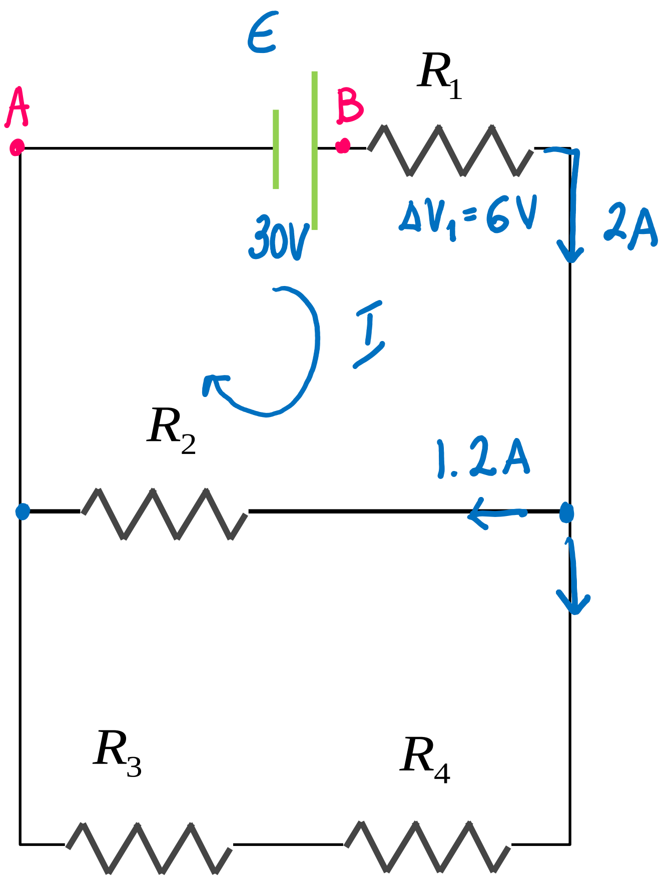
$$I = \frac{\epsilon}{R_{TOT}}$$

$$\frac{\epsilon}{R_{eq}} = \frac{\epsilon}{R_1} + \frac{\epsilon}{R_2} \rightarrow \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_{eq}} = \sum_{i=1}^{N} \frac{1}{R_i}$$

Example 19e – TRY

If the voltage of 30 V is applied between points A and B, what is the current through each resistor, voltage across each resistor and power dissipated by each one.

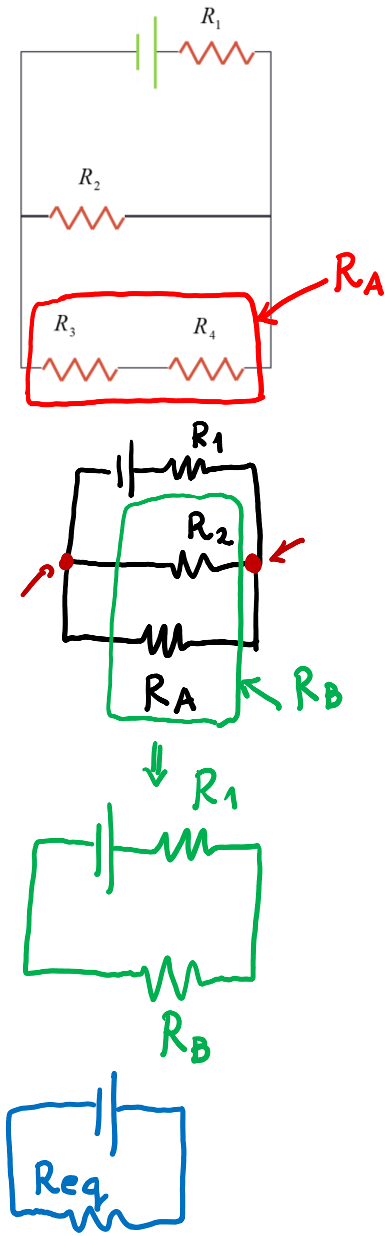


Loop1: $\varepsilon - \Delta V_1 - \Delta V_2 = 0$

$30V - 6V = \Delta V_2$

$R\ [\Omega]$	$V\ [V]$	$I\ [A]$	$P\ [W]$ $V \cdot I$
$R_1 = 3\Omega$	$\Delta V_1 = R_1 \cdot I_1$ 6V	2	12
$R_2 = 20\Omega$	$\Delta V_2 = 24V$	1.2	28.8
$R_3 = 18\Omega$	$0.8 \cdot 18$ 14.4	$2 - 1.2 = 0.8$	11.52
$R_4 = 12\Omega$	9.6	0.8	7.68
$R_{eq} =$ 15Ω	30V	$\frac{\varepsilon}{R_{eq}} = 2$	60W

$$R_A = R_3 + R_4 = 18\,\Omega + 12\,\Omega = 30\,\Omega$$



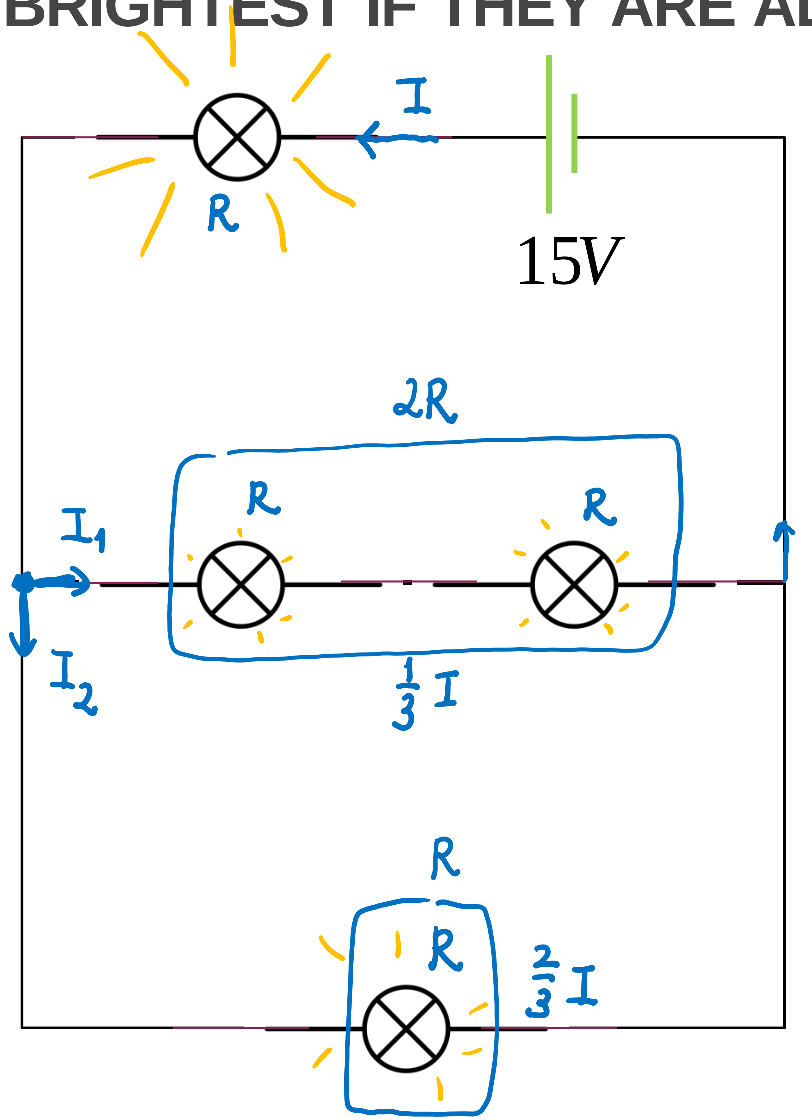
R_2 & R_A in parallel

$$\frac{1}{R_B} = \frac{1}{R_2} + \frac{1}{R_A} = \frac{1}{20} + \frac{1}{30} = \frac{3}{60} + \frac{2}{60} = \frac{5}{60}$$

$$R_B = 12\,\Omega$$

$$R_{eq} = R_B + R_1 = 12\,\Omega + 3\,\Omega = 15\,\Omega$$

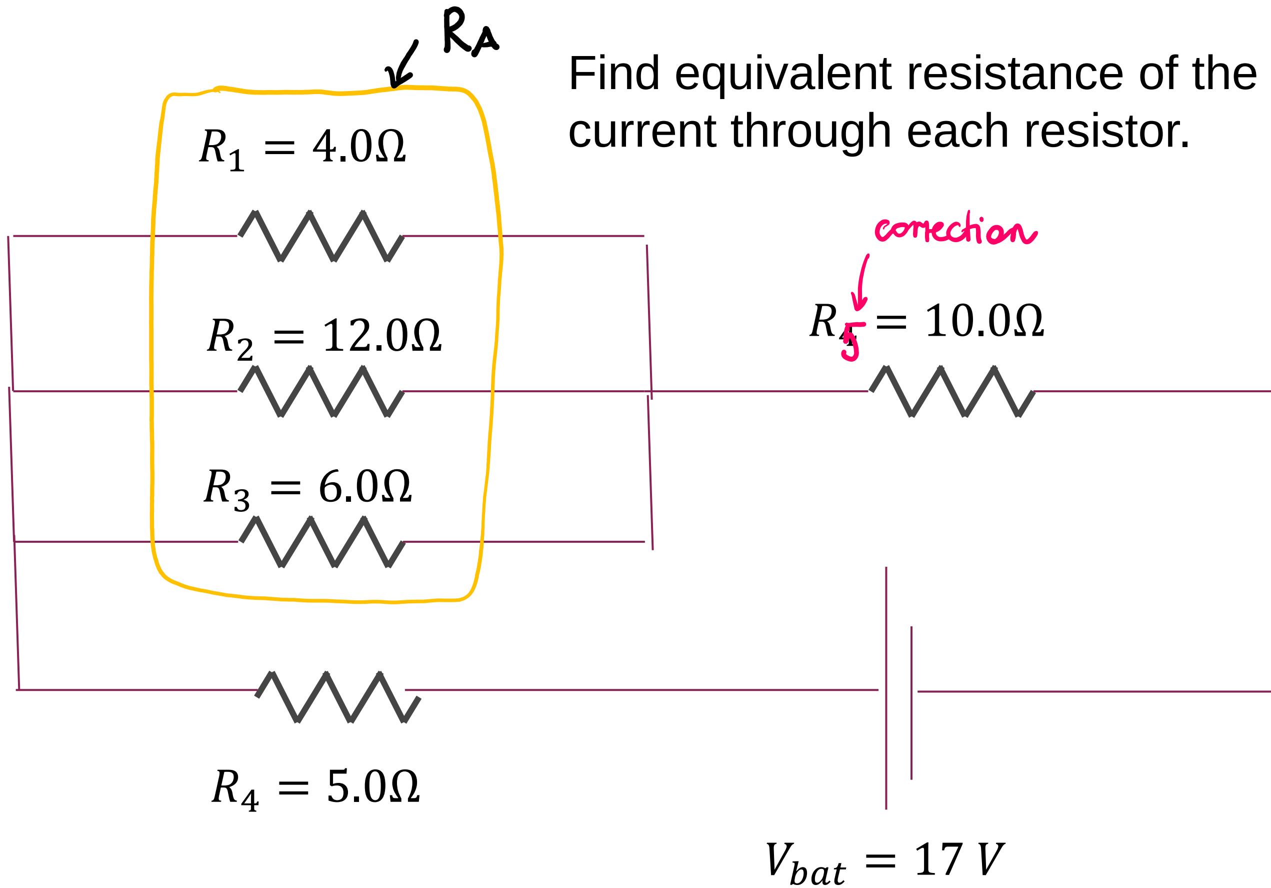
EXAMPLE 19F – WHICH LIGHTBULB WOULD BE THE BRIGHTEST IF THEY ARE ALL IDENTICAL?



$$P = I\Delta V = \underbrace{I^2R} = \frac{\Delta V^2}{R}$$

EXAMPLE 19G – A MORE COMPLICATED APPROACH

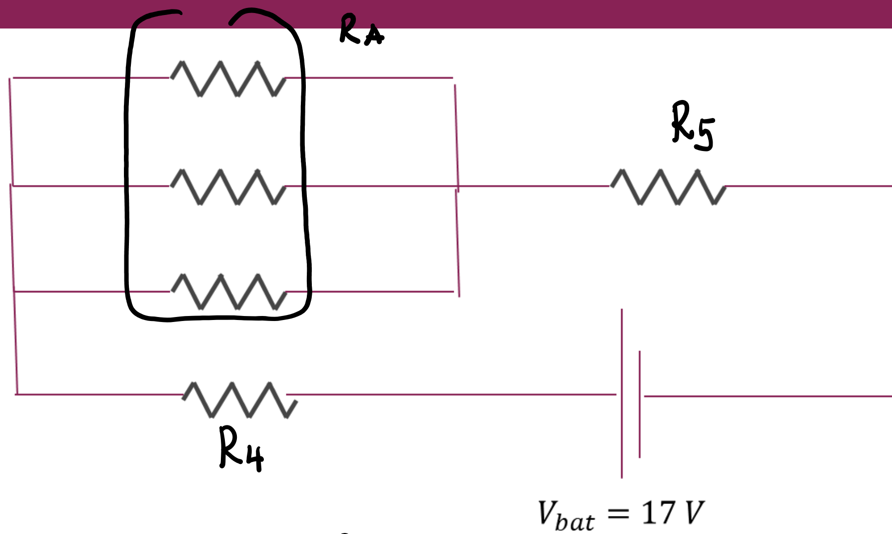
Find equivalent resistance of the circuit and current through each resistor.



R_A : R_1, R_2, R_3 in parallel

$$\frac{1}{R_A} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{4} + \frac{1}{12} + \frac{1}{6} = \frac{3}{12} + \frac{1}{12} + \frac{2}{12} = \frac{6}{12}$$

$$R_A = 2\Omega$$



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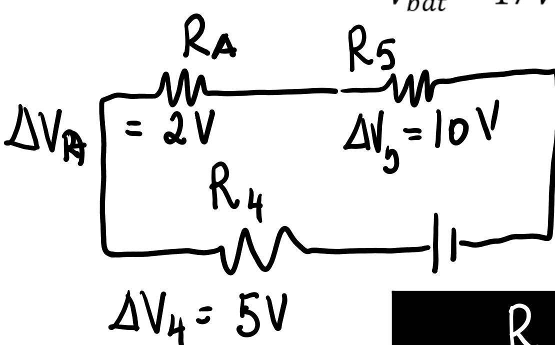


add in series

$$R_A + R_4 + R_5 = 2\Omega + 5\Omega + 10\Omega = 17\Omega$$

Table

- given

$$R_A \to V_A = I_{TOT} \cdot R_A$$
$$= 2.0\Omega \cdot 1A = 2V$$

$R\,[\Omega]$	$I\,[A]$	$V\,[V]$	$P\,[W]$
$R_1 = 4.0$	$I = \frac{\Delta V_A}{R_1} = 0.5$	$\Delta V_A = \Delta V_1 = 2V$	1
$R_2 = 12.0$	$= 1/6\ V$	$\Delta V_A = \Delta V_2 = 2V$	1/3
$R_3 = 6.0$	$= 1/3\ V$	$\Delta V_A = \Delta V_3 = 2V$	2/3
$R_4 = 5.0$	all 1A	$I \cdot R_4 = 5V$	5
$R_5 = 10.0$	all 1A	$I \cdot R_5 = 10V$	10
$R_{eq} = 17\Omega$	$\varepsilon / R_{eq} = 1$	17V	17 yay!

When analyzing circuits some people find if helpful to keep all the info in the table like this one:

Bolded values are given.

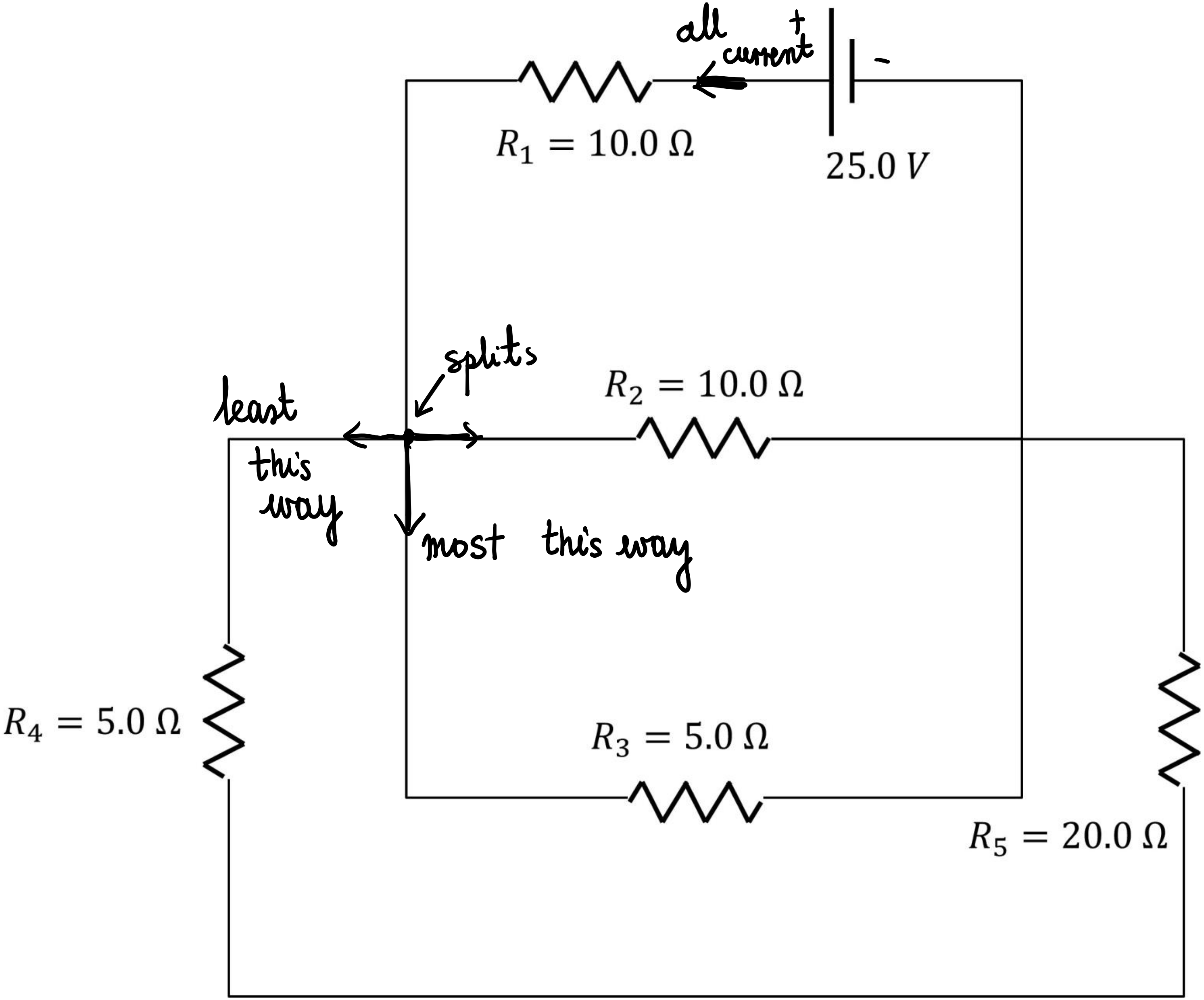
Red values are those than can be calculated once two things for a given resistor are known.

	$\boldsymbol{Total}$	$\boldsymbol{R_1}$	$\boldsymbol{R_2}$	$\boldsymbol{R_3}$	$\boldsymbol{R_4}$	$\boldsymbol{R_5}$
R	R_{eq}	$\boldsymbol{R_1}$	$\boldsymbol{R_2}$	$\boldsymbol{R_3}$	$\boldsymbol{R_4}$	$\boldsymbol{R_5}$
I	$I_{total} = \frac{V_{bat}}{R_{eq}}$	I_1	I_2	I_3	I_4	I_5
V	$\boldsymbol{V_{bat}}$	V_1	V_2	V_3	V_4	V_5
P	$P_{total} = V_{bat} I_{tot}$	P_1	P_2	P_3	P_4	P_5

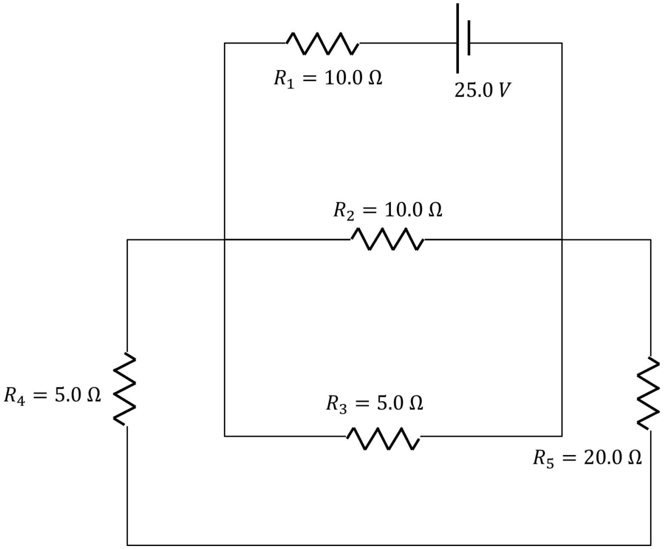
As you figure out information, you just fill the table, keeping track of the information.

I don’t use the tables (my brain doesn’t really work that way, I prefer putting my info in the figure), but I figured I would share the technique just in case someone finds it useful.

Learning Calatytics Problem:



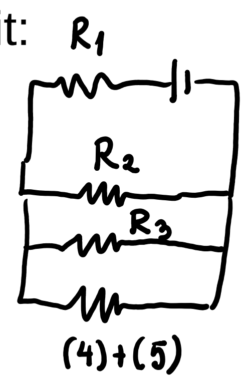
Learning Calatytics Problem:



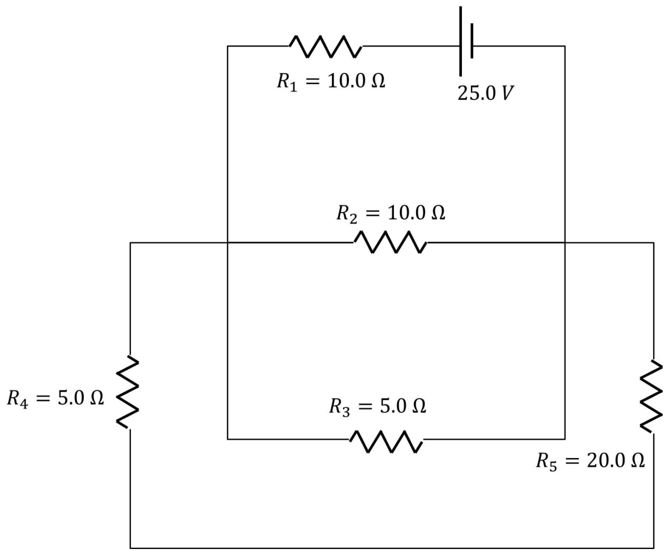
What is the equivalent resistance of R_4 and R_5?

in series!

Simplified circuit:



Learning Calatytics Problem:

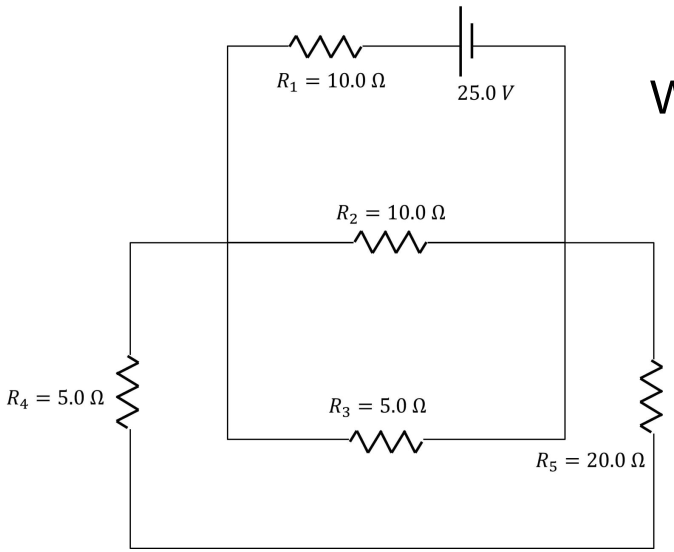


What is the equivalent resistance of R_2 and R_3?

in parallel!

Simplified circuit:

Learning Calatytics Problem:

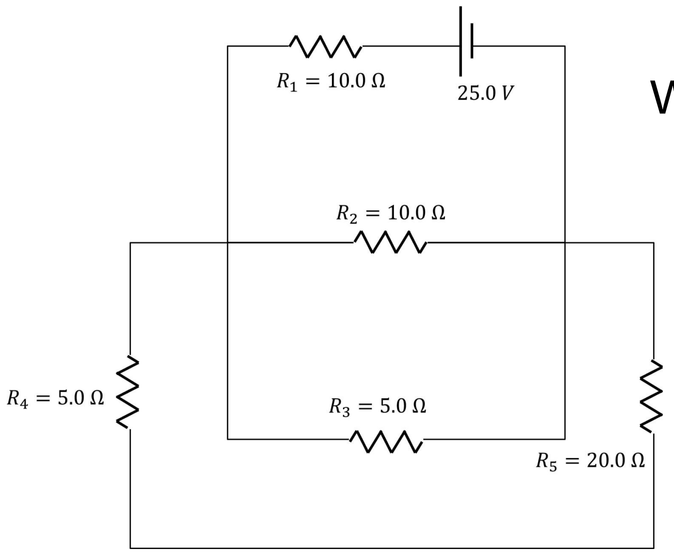


What is the equivalent resistance of R_2, R_3, R_4 and R_5?

R_4 & R_5 are in parallel w/ R_2 & R_3

Simplified circuit:

Learning Calatytics Problem:



What is the equivalent resistance for this circuit?
"one resistor to replace them all"

R_1 is in series with the rest of the resistors

Simplified circuit: