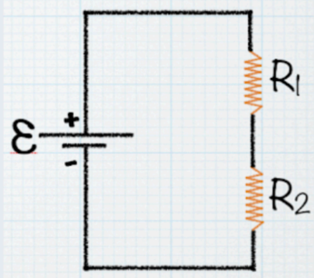
R_1 and R_2 are connected in series. This means the resistors will have the same current flow through them. Since they have different R values, they will not have equal voltage drops across them.

In this example, this circuit has two resistors, with $R_1 > R_2$.



Which of the two resistors dissipates the larger amount of power?

(Remember that the power dissipated in a resistor can be calculated with either $P = \frac{(\Delta V_R)^2}{R}$ or $P = I^2 R$)

To find power dissipated by the resistor, we can use

$$P = \frac{(\Delta V)^2}{R} \quad \text{or} \quad P = I^2 R$$

we don't know enough about this to apply this formula

we know this is the same value for each resistor when connected in series

Power dissipated by R_1 : $P_1 = I^2 R_1$

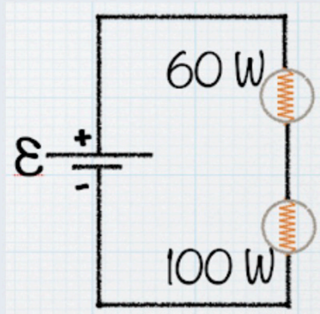
R_2 : $P_2 = I^2 R_2$

$R_1 > R_2$ and $I = I \Rightarrow P_1 > P_2$

Therefore, R_1 dissipates more power than R_2

Replace resistors with lightbulbs (which are also resistors). Instead of being given the resistance values, we're given power rating.

A 60 W light bulb and a 100 W light bulb are placed one after the other in a circuit. The battery's emf is large enough that both bulbs are glowing.



Which one glows more brightly?

The power rating is the amount of power dissipated by the light bulb when it is connected to a 120-V (rms) power supply.

↑ voltage of a standard electric outlet

$$P = \frac{(\Delta V)^2}{R} \Rightarrow R = \frac{(\Delta V)^2}{P}$$

$$R_1 = \frac{(120\,V)^2}{60\,W} = 240\,\Omega \qquad R_2 = \frac{(120\,V)^2}{100\,W} = 144\,\Omega$$

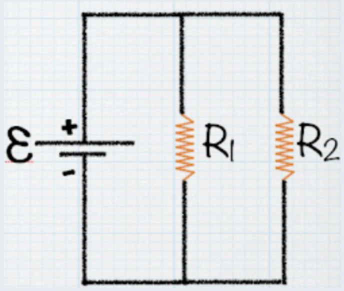
Now we can see that $R_1 > R_2$ and these light bulbs are connected in series so they have equal currents through them. From the previous example, we know:

$$P_1 = I^2 R_1 \text{ and } P_2 = I^2 R_2$$

$$R_1 > R_2 \text{ so } P_1 > P_2$$

This means the 60 W bulb dissipates more power than the 100 W bulb. The 60 W bulb will be brighter than the 100 W bulb, which is counter-intuitive. But that's because we don't normally connect light bulbs in series.

This circuit has two resistors, with $R_1 > R_2$.



Which of the two resistors dissipates the larger amount of power?

Now we have two resistors connected in parallel with the power supply. This means the resistors will have the same voltage drop across them but they will have different currents flowing through them.

Again we can calculate power dissipated in a resistor with $P = \frac{(\Delta V)^2}{R}$ or $P = I^2 R$

will be the same for the two resistors since they are connected in parallel

will be different for the resistors

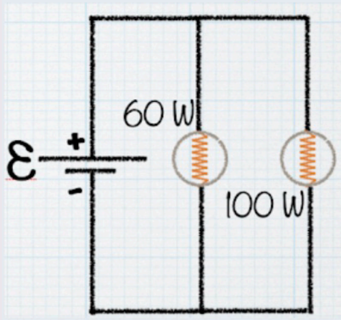
Now we see that when ΔV is the same, then the relationship between P and R is an inverse relationship.

$P \propto \frac{1}{R}$ so P is larger when R is smaller.

Since $R_1 > R_2$, the smaller resistor (R_2) will dissipate more power than the larger resistor.

We do what we did previously and we replace R_1 and R_2 with light bulbs.

A 60 W light bulb and a 100 W light bulb are placed one after the other in a circuit. The battery's emf is large enough that both bulbs are glowing.

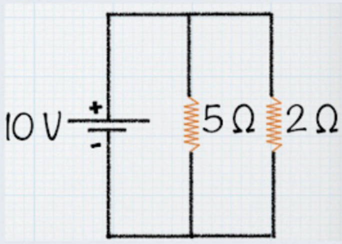


Which one glows more brightly?

From the power rating calculations we did on the previous example, we know the 60 W bulb has $R_1 = 240\,\Omega$ and $R_2 = 144\,\Omega$.

Since the bulbs are connected in parallel (they have the same ΔV) and $R_1 > R_2$, we can conclude that R_2 (the 100 W bulb) dissipates more power. This means the 100 W bulb will be brighter than the 60 W bulb. This outcome is what you'd expect. That's because light bulbs are normally connected in parallel when used in household circuits.

What is the current through the 5 Ω resistor?



These two resistors are connected in parallel with the 10 V power supply.

Because of this parallel connection, we know ΔV will be the same across each resistor and will be 10 V.

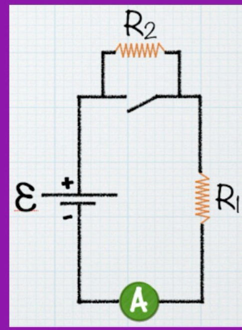
Applying Ohm's law: $I = \dfrac{\Delta V}{R}$

For $R = 5\Omega$: $I = \dfrac{10\,V}{5\Omega} = 2A$

$R = 2\Omega$: $I = \dfrac{10\,V}{2\Omega} = 5A$

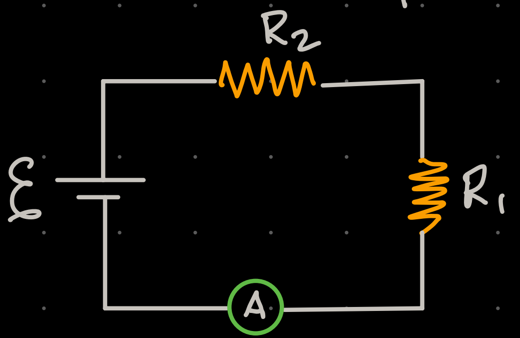
We can add these currents together: $2A + 5A = 7A$, which is the total current being pumped through the power supply.

We need to look at what happens in this circuit when the switch is open and closed. To see this, I'll draw a circuit diagram for each scenario.

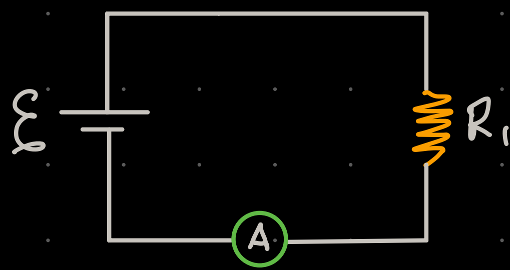


With the switch closed, there is no current in R_2 because the current has an alternate zero-resistance path through the switch. There is current in R_1 and this current is measured with the ammeter (a device for measuring current) at the bottom of the circuit. If the switch is opened, there is current in R_2. What happens to the reading on the ammeter when the switch is opened?

Switch open



Switch closed

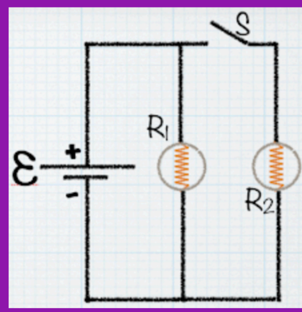


Here, R_1 and R_2 are connected in series. The total resistance is $R_1 + R_2$. The current will be $I = \dfrac{\mathcal{E}}{R_1 + R_2}$

Here, there is only R_1. So the current will be $I = \dfrac{\mathcal{E}}{R_1}$

I is smaller when the switch is open because there is more resistance than when the switch is closed. So when you open the switch, the ammeter reading decreases.

When this switch is closed, R_1 and R_2 are connected in parallel with the power supply.



Two identical light bulbs are represented by the resistors R_1 and R_2 ($R_1 = R_2$). The switch S is initially open. $I_{(before)}$ is the current before the switch is closed and $I_{(after)}$ is the current after the switch is closed.

(a) What happens to the total current after the switch is closed? In other words, what is $I_{(after)}$ in terms of $I_{(before)}$?

(b) If switch S is closed, what happens to the brightness of the bulb R_1?

This means the ΔV across each resistor (bulb) is the same and is equal to $\mathcal{E}$. So the current through each is:

$$I_1 = \frac{\mathcal{E}}{R_1} \quad \text{and} \quad I_2 = \frac{\mathcal{E}}{R_2}$$

The total current is $I = I_1 + I_2 = \frac{\mathcal{E}}{R_1} + \frac{\mathcal{E}}{R_2}$

When the switch is open, R_2 is disconnected from the circuit. This makes the total current $I = \mathcal{E}/R_1$

Before closing the switch: $I_{before} = \frac{\mathcal{E}}{R_1}$

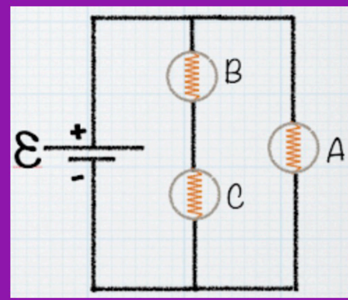
After closing the switch: $I_{after} = \frac{\mathcal{E}}{R_1} + \frac{\mathcal{E}}{R_2}$

$\Rightarrow$ Total current increases after closing the switch

The brightness of bulb 1 doesn't change and we can check that by calculating power:

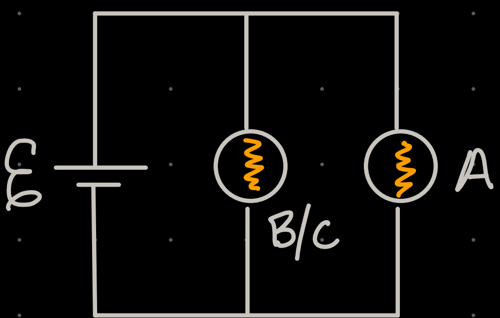
Before: $P = \frac{\mathcal{E}^2}{R_1}$ and After: $P = \frac{\mathcal{E}^2}{R_1}$

Now we have resistors connected in both series and parallel.



The three light bulbs in the circuit all have the same resistance of 1 Ω. Compare the brightness of bulb B to the brightness of bulb A. (brightness is proportional to power)

Bulbs B and C are connected in series so the total resistance of B + C is $R_{BC} = R_B + R_C$. If we replace B and C with one equivalent bulb, the circuit will look like this:



Now with this simplified circuit we have two resistors in parallel with the power supply. But they don't have the same resistance.

Bulb B/C has more resistance than bulb A. They have the same ΔV across them (connected in parallel)

Power : $P_{B/C} = \dfrac{\varepsilon^2}{R_{B/C}}$ $\quad P_A = \dfrac{\varepsilon^2}{R_A}$

Since $R_{B/C} > R_A \Rightarrow P_A > P_{B/C}$

This means bulb A is brighter than bulb B (and also brighter than bulb C)