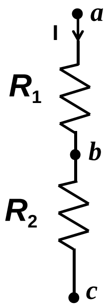
General Physics II

Basic Electric Circuits

Resistors in Series



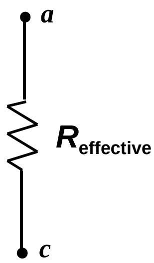
The Voltage "drops":

$$V_a - V_b = IR_1 \qquad V_b - V_c = IR_2$$

$$V_a - V_c = I(R_1 + R_2)$$

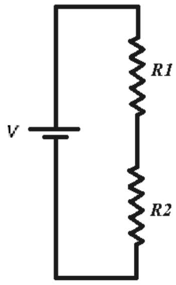
Whenever devices are in SERIES, the current is the same through both !

This reduces the circuit to:



Hence: $R_{effective} = (R_1 + R_2)$

Two resistors are connected in series to a battery with voltage V. The resistances are such that $R_1 = 2R_2$.



Compare the current through R_1 with the current through R_2:

a) $I_1 > I_2$ b) $I_1 = I_2$ c) $I_1 < I_2$

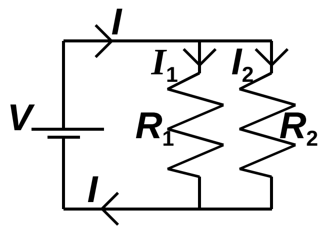
What is the potential difference across R_2?

a) $V_2 = \boldsymbol{E}$ b) $V_2 = 1/2\ \boldsymbol{E}$ c) $V_2 = 1/3\ \boldsymbol{E}$

Resistors in Parallel

- **What to do?** $V = IR$
- **Very generally, devices in parallel have the same voltage drop**
- **But current through R_1 is not I ! Call it I_1. Similarly, $R_2 \leftrightarrow I_2$.**

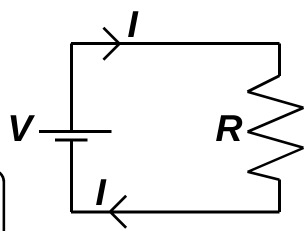
$V = I_1 R_1$ **and** $V = I_2 R_2$



- **How is I related to I_1 & I_2 ?**

Current is conserved!

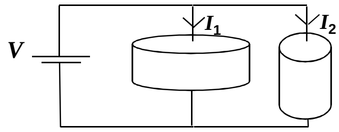
$$I = I_1 + I_2$$



$$\Rightarrow \frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} \Rightarrow \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

Two cylindrical resistors, R_1 and R_2, are made of identical material. R_2 has twice the length of R_1 but half the radius of R_1.

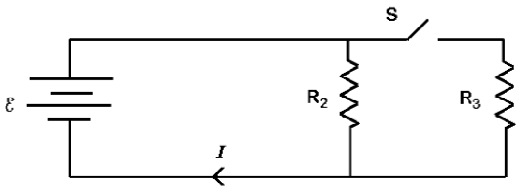
- These resistors are then connected to a battery V as shown:



- What is the relation between I_1, the current flowing in R_1, and I_2, the current flowing in R_2?

(a) $I_1 < I_2$ (b) $I_1 = I_2$ (c) $I_1 > I_2$

Two identical light bulbs are represented by the resistors R_2 and R_3 ($R_2 = R_3$). The switch S is initially open.



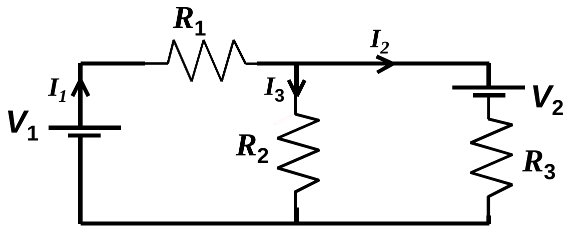
If switch ***S*** is closed, what happens to the brightness of the bulb R_2?

a) It increases b) It decreases c) It doesn't change

What happens to the current I, after the switch is closed ?

a) $I_{after} = 1/2\ I_{before}$ b) $I_{after} = I_{before}$ c) $I_{after} = 2\ I_{before}$

What about circuits with non-series or parallel combinations...or more than one battery?



Kirchhoff's Rules

$$\sum_{loop} V_n = 0$$

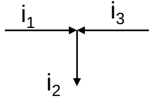
The sum of the voltages (batteries & IR combinations) around a complete loop = 0

$$I_{in} = \sum I_{out}$$

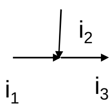
The sum of the currents at a junction = 0

Junction Rule

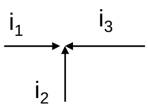
- Sum of all currents entering a junction must equal the sum of all currents leaving the junction.



$i_1+i_3=i_2$



$i_1+i_2=i_3$

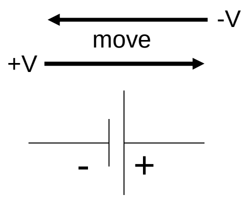


$i_1+i_2+i_3=0$

IN = OUT

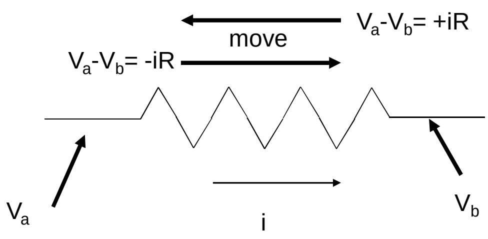
Potential Rule for Batteries

- For a move from the negative terminal to the positive terminal then the change in potential is +V
  - 🡐 For a move from "+" to "-" then the change in potential is -V

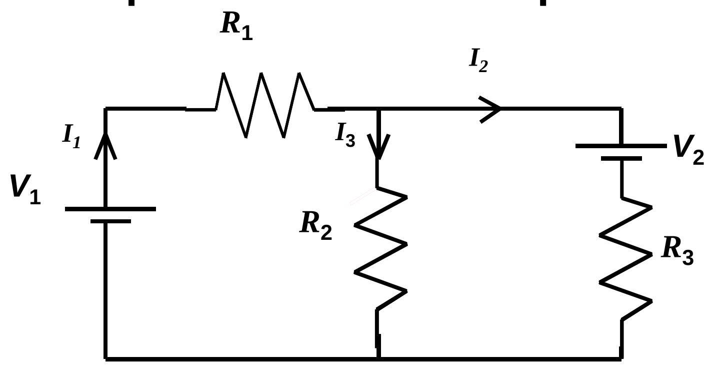


Potential Rule for Resistors with Current

- For a move through a resistor in the direction of current, the change in potential is –iR
  - 🡐 If the move opposes the current then the change in potential is +iR.



Let’s put these ideas into practice....



End of

Basic Electric Circuits

Lecture