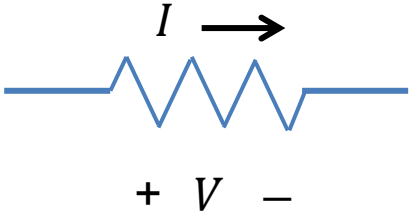
Ohm's Law

Definition: A resistor is a circuit element which impedes the flow of current. All devices do this to varying degrees.



Ohm's Law: The voltage drop across a resistor is proportional to the current flowing through it.

$$V = I \cdot R$$

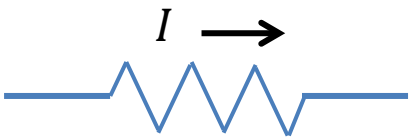
V = voltage measured in Volts (V)

I = current measured in Amps (A)

R = resistance measured in Ohms (Ω)

Ohm's Law

The passive sign convention applies to Ohm's law since it relates current to voltage in a passive device.

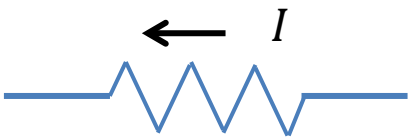


$$V = I \cdot R$$

$$P = I \cdot V$$

$$= (I) \cdot (IR) = I^2R$$

$$= \left(\frac{V}{R}\right) \cdot V = \frac{V^2}{R}$$



$$V = -I \cdot R$$

$$P = -I \cdot V$$

$$= -(I) \cdot (-IR) = I^2R$$

$$= -\left(-\frac{V}{R}\right) \cdot V = \frac{V^2}{R}$$

Note that the power in a resistor is always positive regardless of which polarity/direction we choose for voltage/current. Positive power means that the resistor is consuming power. Where does it go?

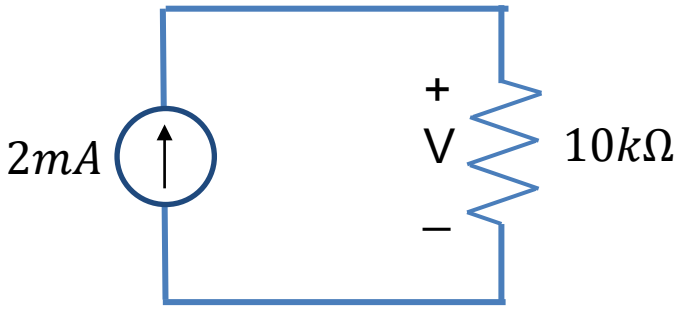
Example

For the circuit shown:

(a) Calculate the voltage drop across the resistor. Is it positive or negative?

(b) Determine the power dissipated (absorbed) in the resistor?

(c) From our answer to part (b), what could you infer about the power generated by the source?



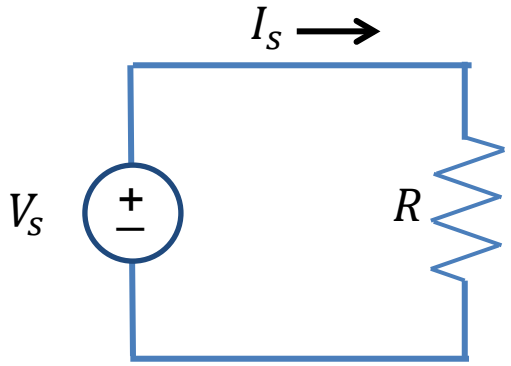
Example

For the circuit shown:

(a) If $V_s = 1kV$ and $I_s = 5mA$, find the value of R and the power absorbed by the resistor.

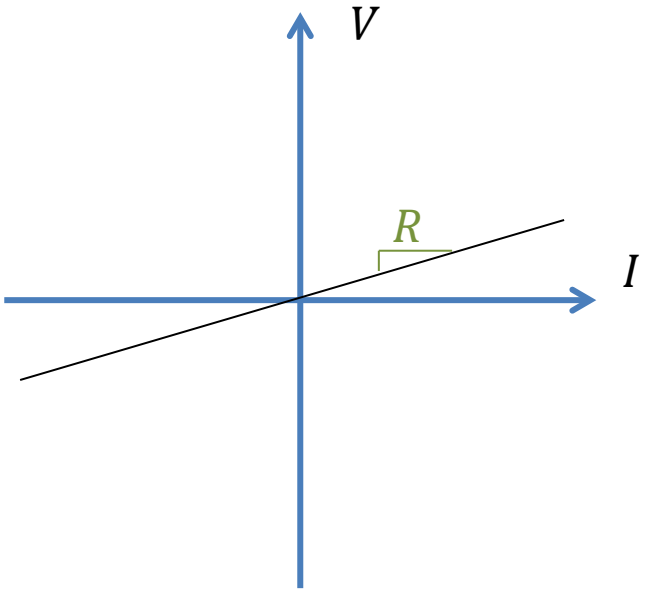
(b) If $I_s = 75mA$ and the power delivered by the voltage source is $3W$, find V_s, R, and the power absorbed by the resistor.

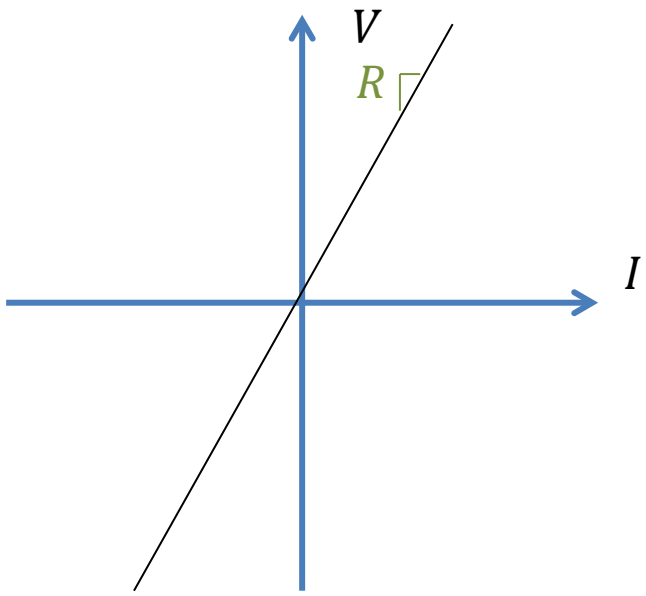
(c) If $R = 300\Omega$ and the power absorbed by the resistor is $480mW$, find I_s and V_s.



Ohm's Law

Ohm's law describes a linear relationship between the current and voltage in a resistor.



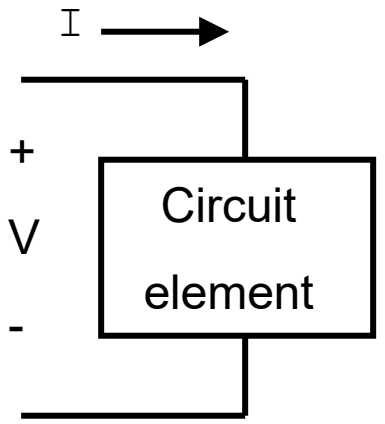


Small resistance → larger currents, smaller voltages.

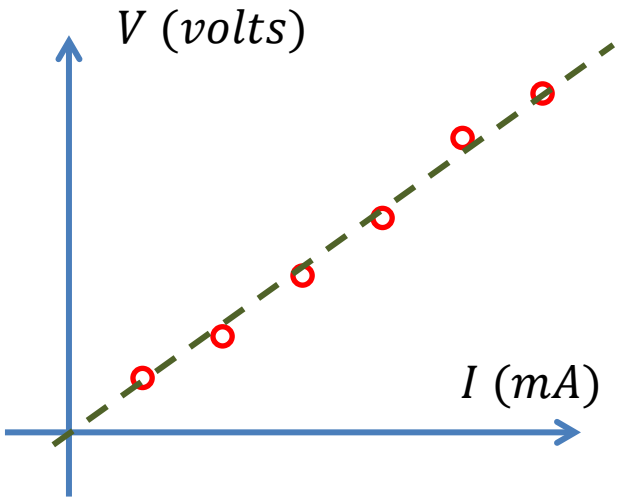
Large resistance → smaller currents, larger voltages.

Ohm's Law

Example: Suppose we apply several different voltages to an unknown two-terminal element and measure the resulting current that flows through the element. The results of this experiment are given in the table below. If we wanted to model this element as a resistor, what resistance should we choose?



Applied Voltage (Volts)	Measured Current (mA)
1.5	30.1
3	59.7
4.5	89.4
6	119.9
7.5	149.9
9	180.3



Best fit line to data has a slope of 0.05003 volts/mA. Therefore, we can model the circuit element as a resistor with $R = 50\Omega$

Discussion point: How does one find the "best fit" line to a set of data points as was done in this example?