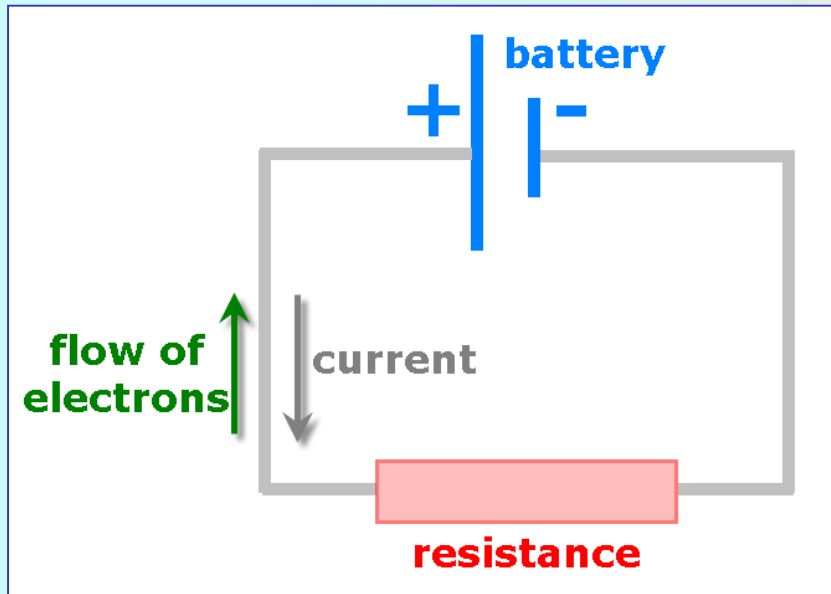


Ohm's Law



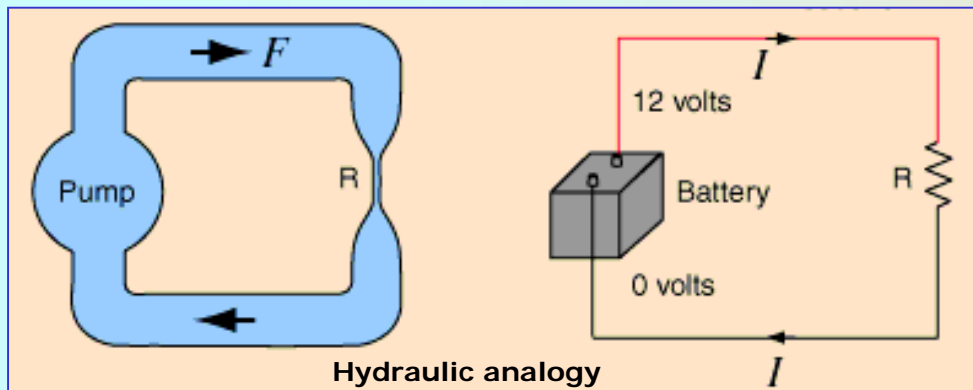
Ohm's Law

Ohm discovered that the current in a circuit is directly proportional to the voltage impressed across the circuit, and is inversely proportional to the resistance of the circuit

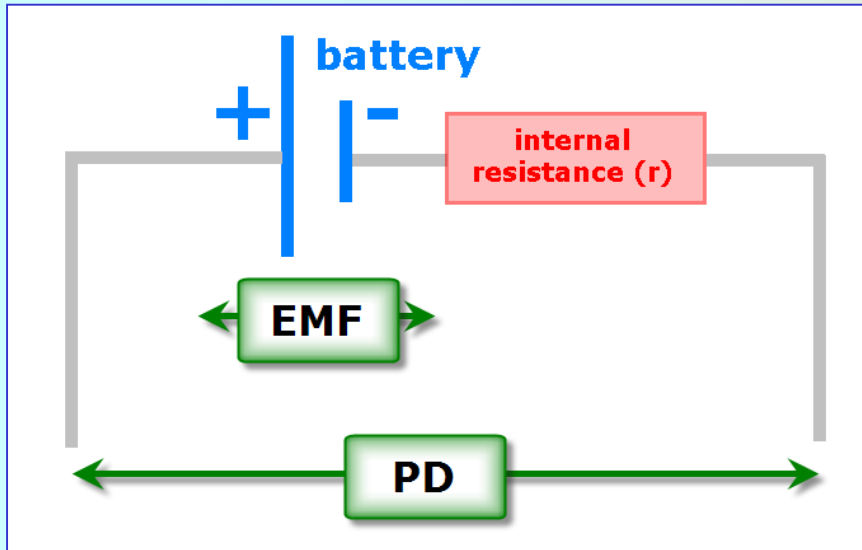
$$\text{current} = \frac{\text{voltage}}{\text{resistance}}$$

The relationships between the units of measurements for these three quantities is

$$1 \text{ ampere (A)} = \frac{1 \text{ volt (V)}}{1 \text{ ohm } (\Omega)}$$



Ohm's Law



Voltage (PD and EMF)

The potential difference (PD) is the difference across the battery terminals.

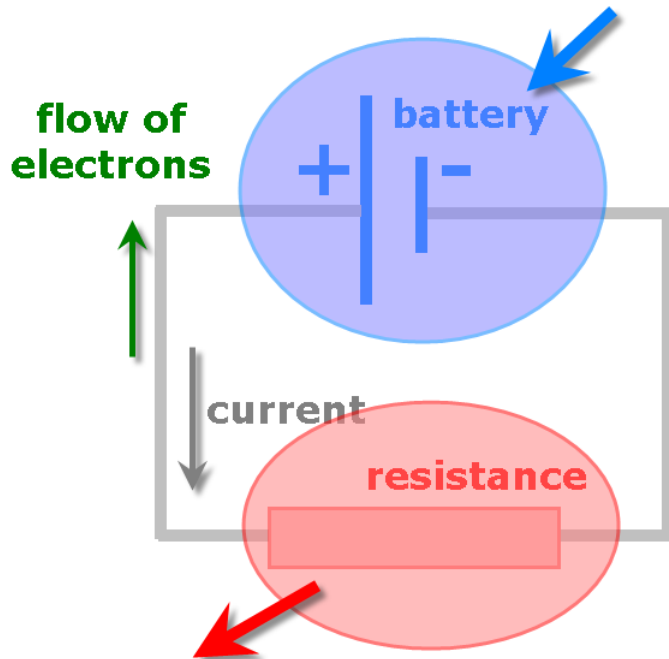
The voltage produced by the chemical reactions inside a battery is called the electromotive force (EMF).

When a battery is supplying current, some energy is wasted inside it, which reduces the PD across the terminals.

$$\text{PD} = \text{EMF} - \begin{array}{l} \text{potential lost in} \\ \text{internal resistance} \end{array} \xrightarrow{V_{\text{lost}} = I * r}$$
$$\text{PD} = \text{EMF} - I * r$$

Ohm's Law

Electric Energy input ... $E = V * I * t$ (J)
Electric Power input ... $P = V * I$ (W)



Energy output (Heat) ... $Q = I^2 * R * t$
Power output ... $P = I^2 * R$

Power and Energy in Electric Circuits

As the current passes through the resistance the energy of electric charges is being lost and converted into heat and light

$$P_{\text{dissipated}} = I^2 * R$$

The power supplied by the battery is:

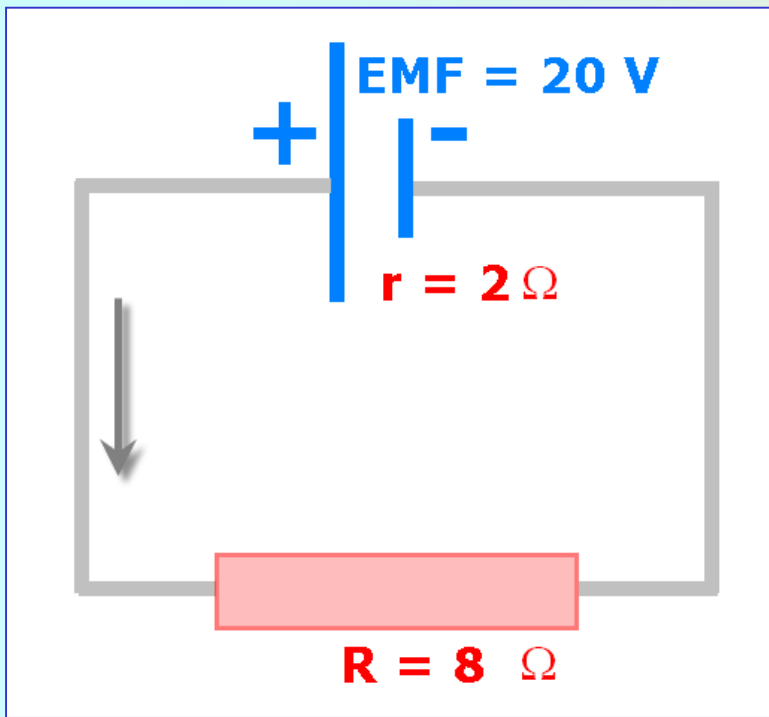
$$P_{\text{supplied}} = \varepsilon \text{ (EMF)} * I$$

The balance of energy is:

$$P_{\text{supplied}} = P_{\text{dissipated in the circuit}} + P_{\text{dissipated inside the battery}}$$

$$\varepsilon * I = I^2 * R + I^2 * r$$

Ohm's Law

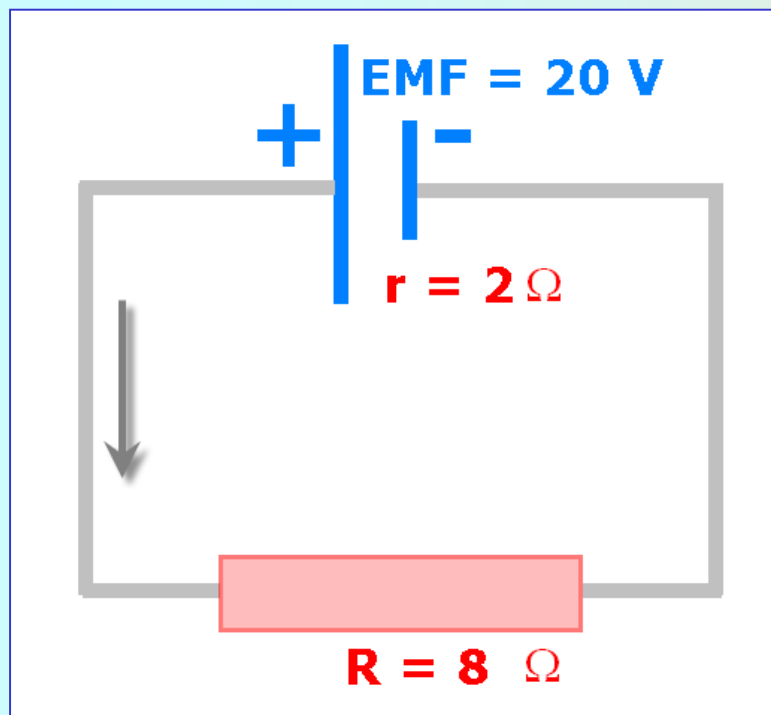


Exercise

In this circuit, determine

- the current
- the power supplied
- the power dissipated inside the battery
- the power dissipated in the circuit
- the energy dissipated by the resistance in 2 hours

Ohm's Law



Solutions

a) the current

$$I = \frac{\varepsilon}{R + r} \rightarrow I = \frac{20 \text{ V}}{8 \Omega + 2 \Omega} = 2 \text{ A}$$

b) power supplied

$$P_{\text{supplied}} = \varepsilon (\text{EMF}) * I = \\ = 20 \text{ V} * 2 \text{ A} = 40 \text{ W}$$

c) power dissipated inside the battery

$$P_{\text{dissipated}} = I^2 * r = (2 \text{ A})^2 * 2 \Omega = \\ \text{inside} \\ = 8 \text{ W}$$

d) power dissipated in the circuit

$$P_{\text{dissipated}} = I^2 * R = (2 \text{ A})^2 * 8 \Omega = \\ \text{in the circuit} \\ = 32 \text{ W}$$

e) the energy dissipated by the resistance in 2 hours

$$E_{\text{dissipated}} = P * t = 32 \text{ W} * 7200 \text{ s} = \\ \text{in the circuit} \\ = 230400 \text{ J} = 230400 \text{ J} \frac{1 \text{ kW-h}}{3600000 \text{ J}} = 0.064 \text{ kW-h}$$