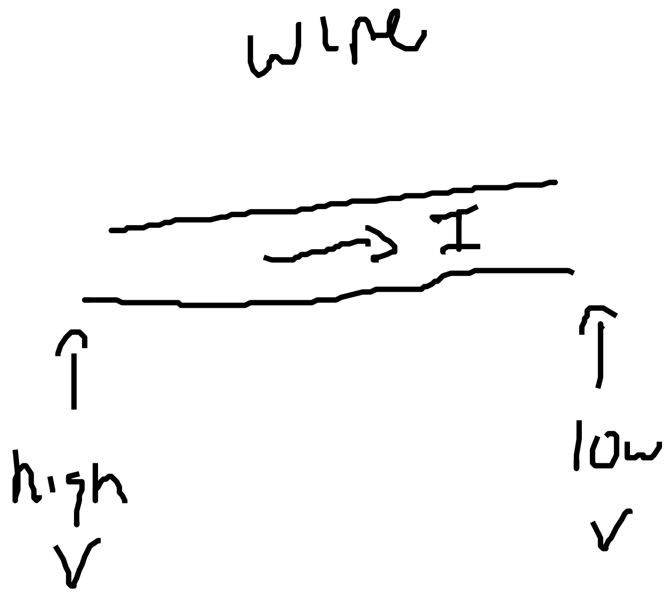


Ohm's Law

$$I = G \Delta V \qquad \Delta V = I R$$

conductance (G) resistance (R)

$$G = \frac{1}{R}$$

Units of R: $\frac{\text{Volts}}{\text{Amperes}}$ = Ohm (Ω) capital omega

Units of G: $\frac{1}{\Omega}$

official SI name

$\frac{1}{\Omega}$: siémens (S)

more fun name

mho (℧)

For a wire:

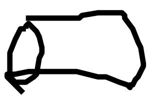
Conductance

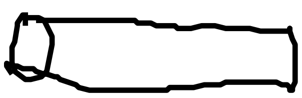
$$G = \sigma \frac{A}{L} \qquad R = \rho \frac{L}{A}$$

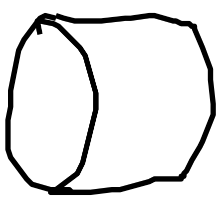
σ : conductivity of material

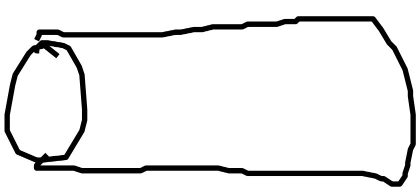
$\rho = \frac{1}{\sigma}$: resistivity of material

copper wires

A) 

B) 

C) 

D) 

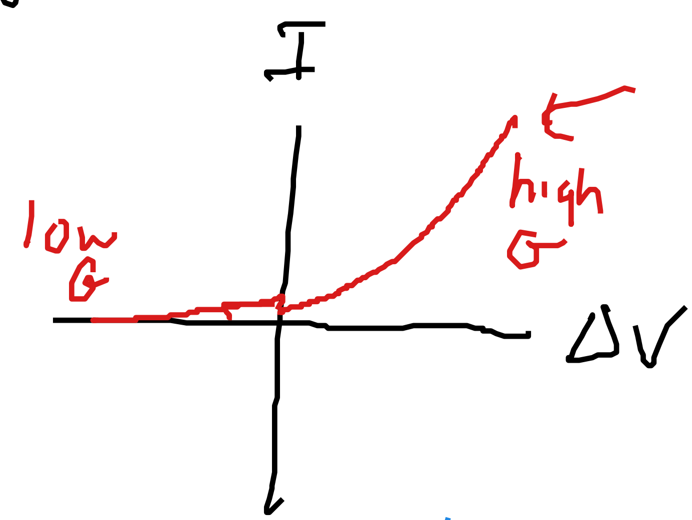
E) All the same

All devices with two terminals (places to hook a battery) have a resistance:

$$R \equiv \frac{\Delta V}{I} \qquad G \equiv \frac{I}{\Delta V}$$

R might depend on ΔV in this case

e.g. diode

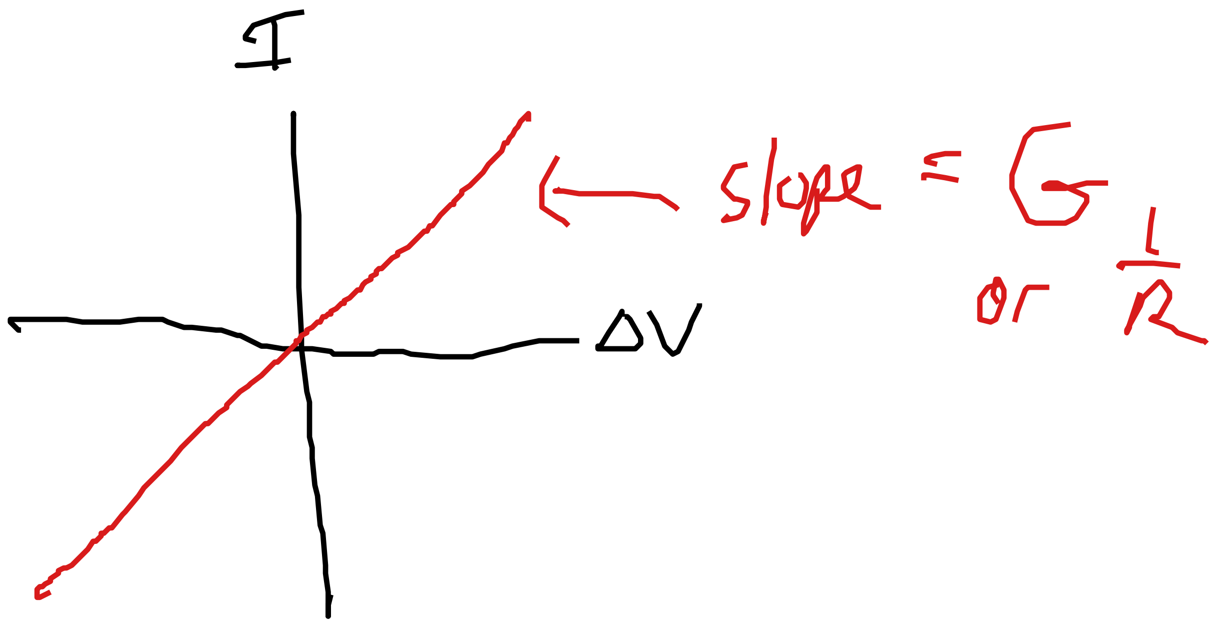


$$\frac{I}{\Delta V} = G(\Delta V)$$

non-ohmic device

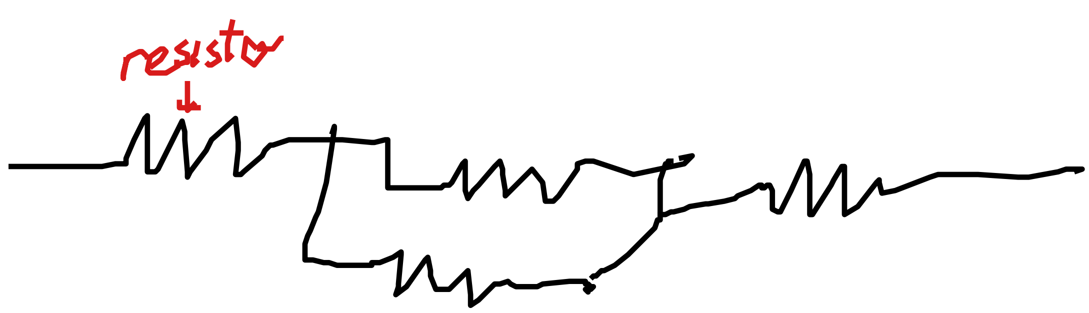
because G & R are not constant

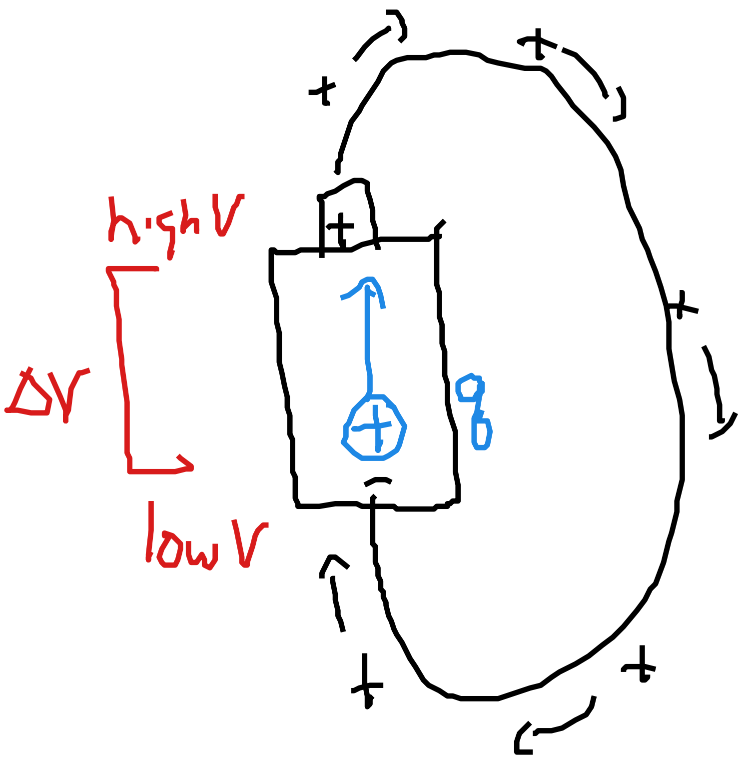
Wires are ohmic devices



Certain devices are designed to be ohmic with a specific resistance **resistors**

Combinations of ohmic devices are also ohmic





Work done by battery on this charge q

$$\Delta PE = q\Delta V$$

power

$$\frac{\text{Work}}{\text{time}} = \frac{(\text{charge})(\Delta V)}{\text{time}}$$

$$\boxed{P = I\Delta V}$$

Units of power: watts (W)

$$1 \text{ Watt} = 1\,\frac{J}{s} = 1\, \underset{\frac{C}{s}}{A} \cdot \underset{\frac{J}{C}}{V}$$

When current flows uphill,

$P = I\Delta V$ must be supplied

by a battery etc.

When current flows downhill,

$P = I\Delta V$ is released

as heat, light, sound, motion, etc

$\uparrow$

for a plain wire

e.g. 3W light bulb connected to two AA batteries (3V)

$$P = I\Delta V$$

$$3W = I(3V) \rightarrow I = 1A$$

For a resistor we can combine this with Ohm's Law

$P = I\Delta V \qquad \Delta V = IR$

$I = \Delta V G$

$P = I^2 R \qquad P = G(\Delta V)^2$

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

Which has less resistance?

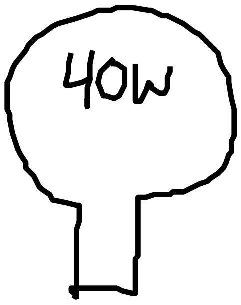
A) 40W light bulb

B) 60W light bulb

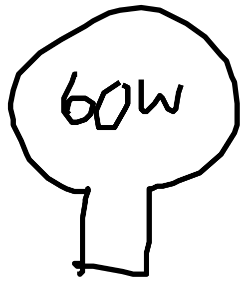
"40W" means "when connected to the wall" which supplies 120V.

ΔV is same for both. $P = \frac{(\Delta V)^2}{R}$ ← same

higher → P, R ← lower



$$P = I\Delta V$$
$$(40) = I(120)$$
$$I = \frac{1}{3}A$$
$$= 0.3A$$



$$P = I\Delta V$$
$$(60) = I(120)$$
$$I = \frac{1}{2}A$$
$$= 0.5A$$

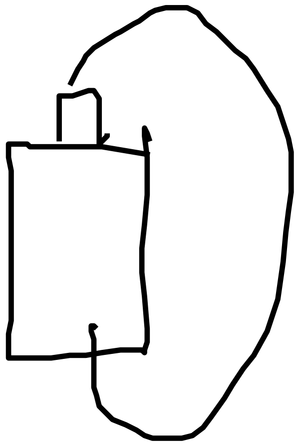
Wires usually have low resistance

lab: $160\ m\Omega/m$

house wiring: $6.5\ m\Omega/m$

minimize energy loss during transmission

ideal wire: $0\ \Omega$



wire

low Ω

power output of wire is huge

$$\underset{\text{huge}}{} \rightarrow P = \frac{(\Delta V)^2}{R} \begin{array}{l} \leftarrow \text{fixed by battery} \\ \leftarrow \text{tiny} \end{array}$$

short circuit