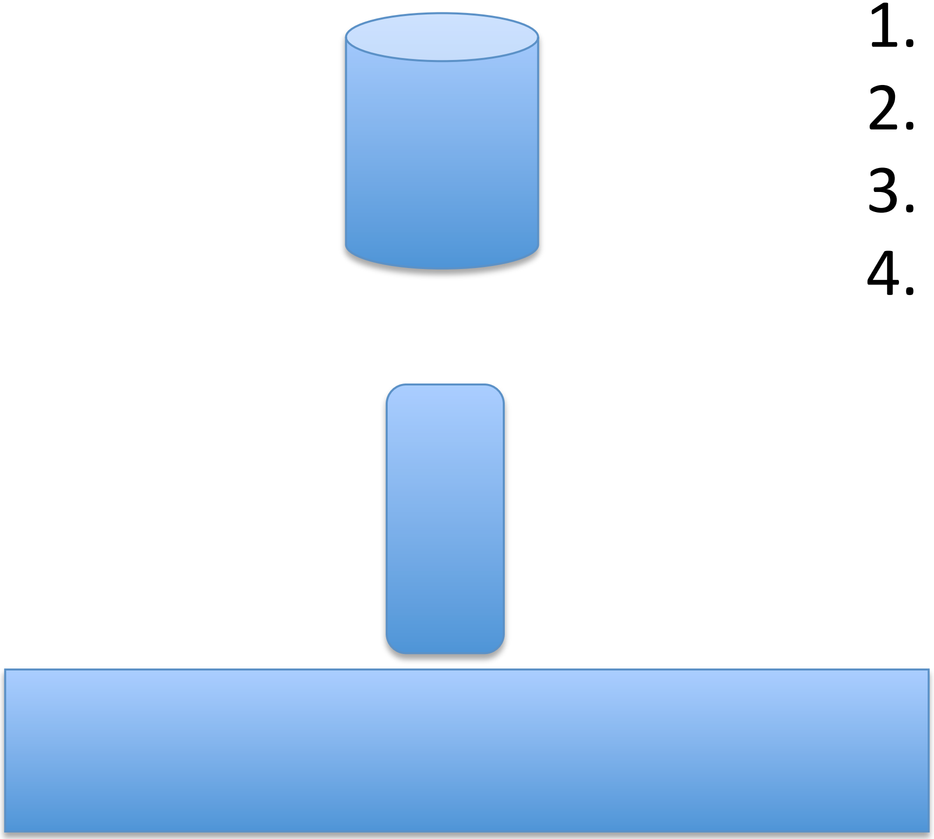
If we cover a pocket radio with an aluminum mesh



1. Nothing happens
2. Sound gets louder
3. Sound gets quieter
4. None of the above

$\frac{1}{1} = \frac{1}{3} + \frac{1}{x}$

$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$

1 μF

$\cancel{C_{eq} = C_1 + C_2}$

$1 = 3 + C_2$; $C_2 = -2$

C_2? add to 3 μF ⇒ $C_{eq} = 1$ μF

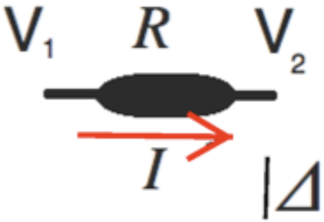
1. 2 μF
2. 4 μF
3. 0.666 μF
4. 1.5 μF
5. Imp.

$$\frac{1}{1} = \frac{1}{3} + \frac{1}{x} \qquad x = 0.66$$

$$\frac{3 \cdot 1}{3 \cdot 1} - \frac{1}{3} = \frac{1}{x}$$

$$\frac{3-1}{3} = \frac{1}{x} \Leftrightarrow \boxed{\frac{2}{3} = \frac{1}{x}} \Leftrightarrow \frac{x}{1} = \frac{3}{2} = 1.5$$

Ohm’s Law, Resistance, Resistively



$V_1 > V_2$

$$|\Delta V| = V_1 - V_2 = IR \underline{\underline{>0}}$$

This is what we have proved:

$$I = \frac{|\Delta V|}{R} = \frac{|\Delta V|}{(\rho \frac{l}{A})}$$

$$I = \frac{|\Delta V|}{R} \quad or \quad |\Delta V| = R\ I$$

This equation is called the Ohm’s Law.

According to the Ohm’s Law:
current and potential difference are directly proportional.

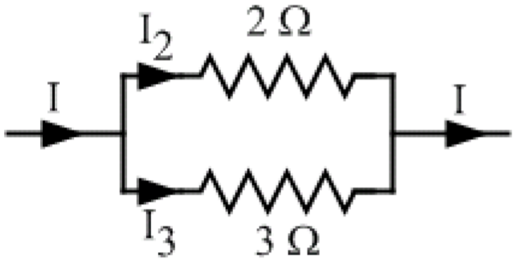
The variable R is called *Resistance* (of a wire, of a device, of a bulb, of a motor, etc.). *Resistance* of a wire is directly proportional to its length l and inversely proportional to its cross-sectional area A : the variable ρ is called *Resistivity* of the material (the metal the wire is made of):

$$R = \rho \frac{l}{A}$$

The junction rule

A junction is a place where three or more current paths meet.

The junction rule: The total current coming into a junction equals the total current going out from a junction.



In the picture, a 2 Ω resistor is in parallel with a 3 Ω resistor. A current I comes into the junction before the resistors, splitting into two currents I_2 through the 2 Ω resistor and I_3 through the 3 Ω resistor.

The junction rule tells us that $\boxed{I = I_2 + I_3}$

Loop Rule

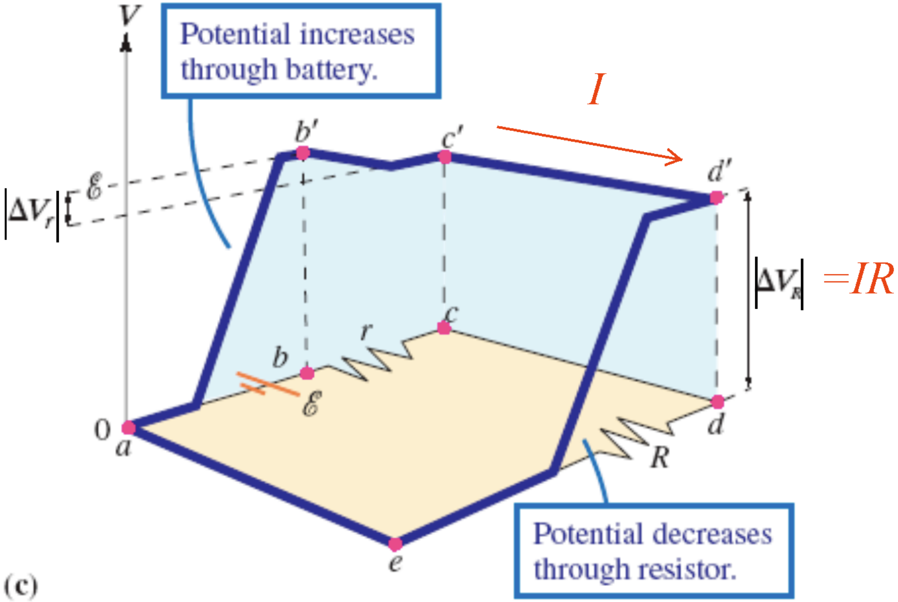
The sum of all the potential differences around a closed loop equals zero.

$$\boxed{\sum \Delta V = 0 \quad \text{for a complete loop}}$$

r = 10 Ohm, R = 20 Ohm, $I = 0.1$ A.

Let's find all the potentials.

Basic single-loop circuit:

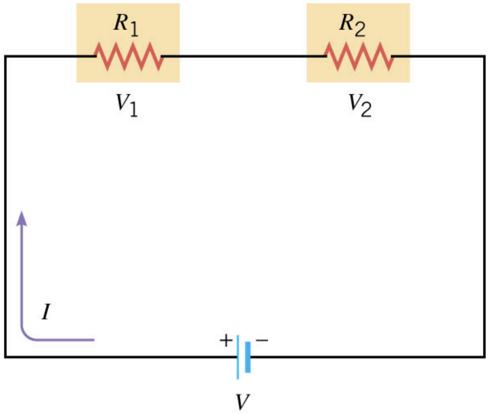


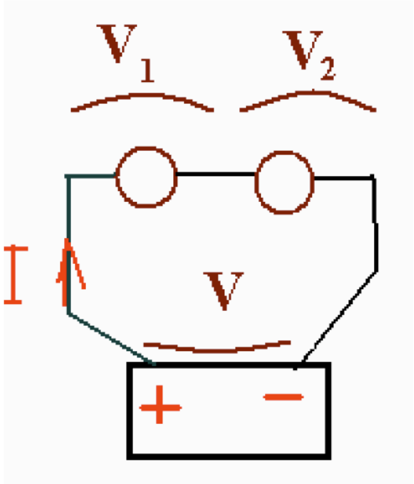
Potential increases through battery.

Potential decreases through resistor.

Current I is the same!

$$V = V_1 + V_2 = \underline{I}R_1 + \underline{I}R_2 = I(R_1 + R_2) = IR_S$$





Series resistors

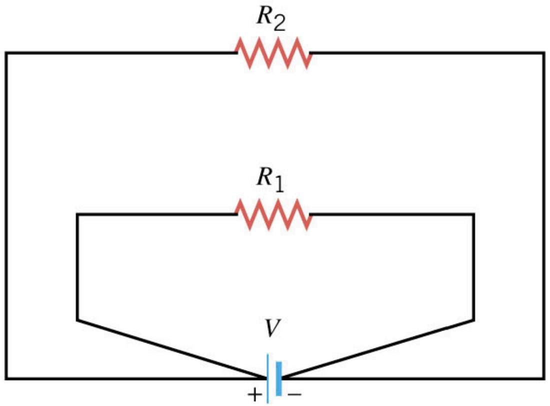
$$\boxed{R_S = R_1 + R_2 + R_3 + \cdots}$$

R_s is equivalent resistance

Parallel Wiring

Ohm's Law

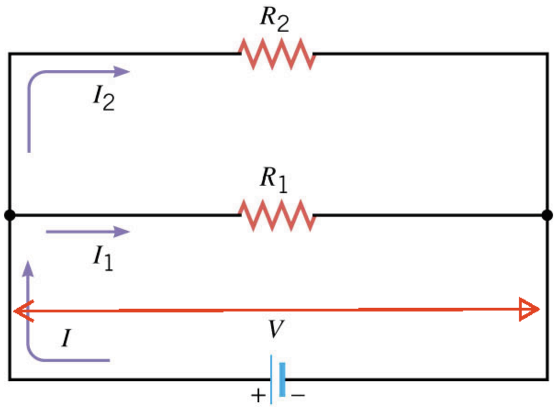
$$I = I_1 + I_2 = \frac{V}{R_1} + \frac{V}{R_2} = V\left(\frac{1}{R_1} + \frac{1}{R_2}\right) = V\left(\frac{1}{R_P}\right)$$



(a)

parallel resistors

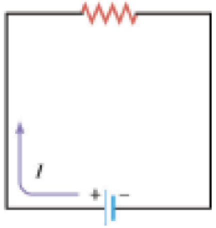
$$\boxed{\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots}$$



(b)

R

R_p is equivalent resistance



Electric Power

The work done by the current on a device is equal to the energy spent to carry the charge through the device.

$$\underline{W = U = Q} * \underline{\Delta V = I} * \underline{\Delta V} * \underline{\Delta t}$$

By a definition: Power = work/time

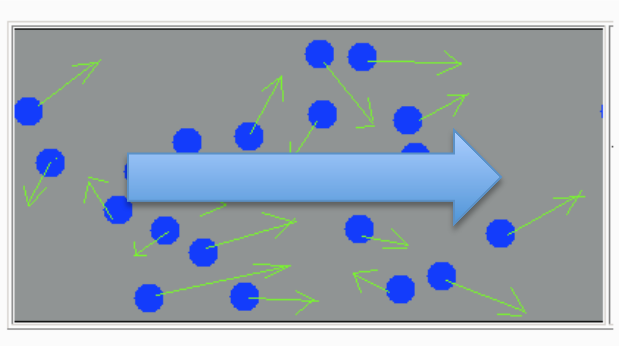
$$P = \frac{W}{\Delta t} = \frac{I \cdot \Delta V \cdot \Delta t}{\Delta t} = I \cdot \Delta V$$

If we use the Ohm's Law ($\Delta V = I * R$), we can get other expressions:

$$\boxed{P = I \cdot \Delta V = I^2 \cdot R = \frac{(\Delta V)^2}{R}}$$

The unit for power is Amp*V = W (Watt)

Conductor in electric field



On average all the electrons are moving (drifting) to the right.

<u>What is the direction of the field?</u>

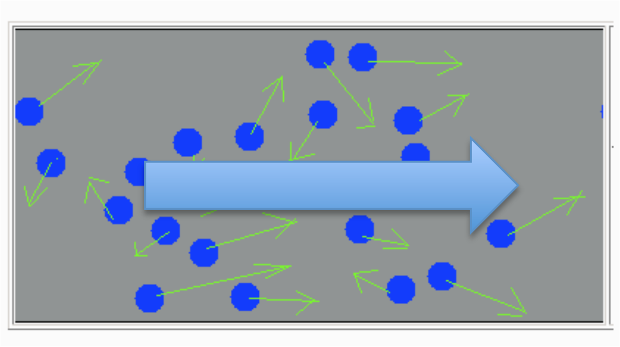
A. to the right

B. to the left

C. up

D. down

Conductor in electric field



On average all the electrons are moving (drifting) to *the right*.

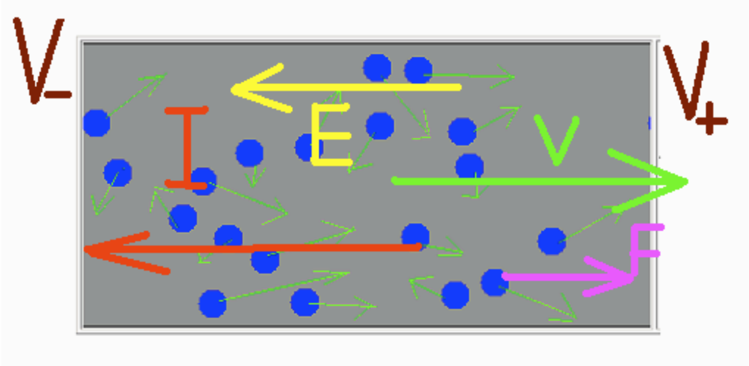
What is the direction of the field?

B. to the left

Electrons are negatively charged: $\vec{F} = e\vec{E}$; $e < 0$

If electrons on average are moving to the right, hence, the electrostatic force is acting to the right, hence the field is supposed to be directed *to the left*.

Curent



Electric field E points to the left; it points from a high potential V_+ to a low potential V_-

Electric force on electrons F points to the right.

Average (drifting) velocity of electrons V points to the right.

Current I points to the left (in the direction of the field!).

(from a higher potential to a lower potential)

(through a *passive* element!)

Current

Current is the rate of flow of charge. The symbol is I. The unit is the ampere (A), or amp for short.

Amp = C/s

$$I = \frac{\Delta Q}{\Delta t}$$

$$\Delta Q = I\,\Delta t$$

Although current in most cases consists of flowing electrons, the direction of the current on a circuit diagram is shown as the flow of positive charges.

How many electrons per second pass through a section of wire carrying a current of 2.10 A?

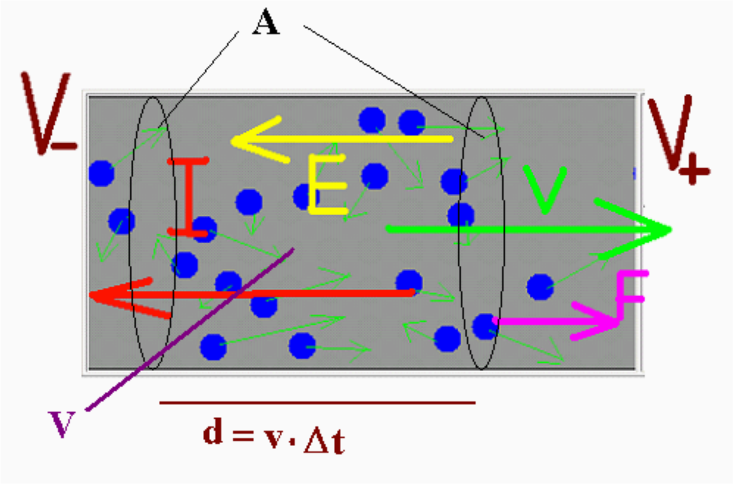
1. **1.1 x10^{18} electrons/s**
2. **4.4x10^{18} electrons/s**
3. **8.8 x10^{18} electrons/s**
4. **13.2x10^{18} electrons/s**

$$I = \frac{\Delta Q}{\Delta t} \rightarrow \quad 2.1 = \frac{\Delta Q}{1s} \rightarrow \underline{\Delta Q} = \underline{2.1}\,C = \underline{N_e}\, e$$

$$\boxed{I = \frac{Q}{t}}$$

$$N_e = \frac{Q}{e} \;;$$

Current



(so many V's!)

$$\boxed{I = \frac{\Delta Q}{\Delta t}} \qquad \Delta Q = eN_e \qquad N_e = V * n$$

V is the volume of the conductor between two cross-sectional surfaces;

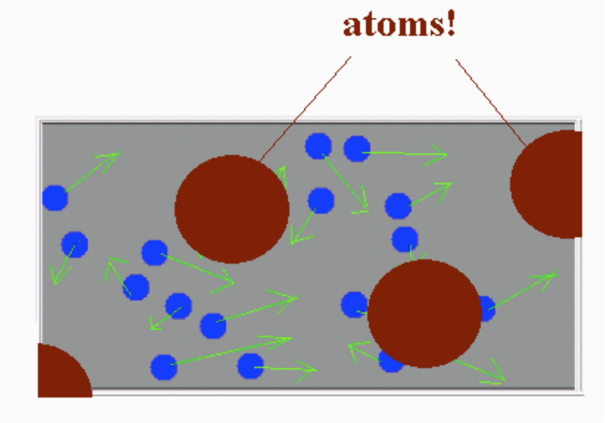
n is the number electrons per m^3 (density of electrons)

Volume $V = A*d$ and $d = v*\Delta t$ (velocity times time) =>

$$\boxed{I = eAnv}$$

To increase/decrease current we can increase /decrease cross-sectional area A; or electron density n; or drift velocity v.

Nature of resistivity



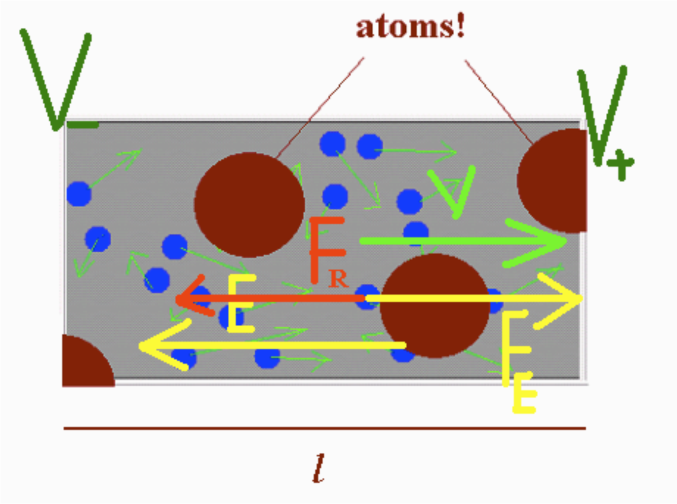
What does prevent electrons from being constantly accelerated by the electric field?

ATOMS!

Atoms provide a “frictional” force on electrons and slow them down.

Current experiences resistive force, every wire has some resistance to current.

Current vs. Potential difference



$$I = eAnv$$

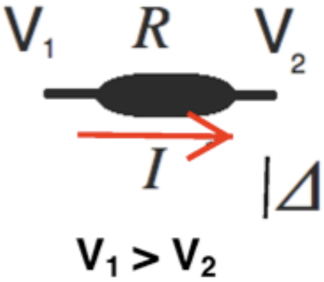
$$v = \beta * F_R$$

$$F_R = e|\Delta V|/l$$

↓↓

$$\boxed{I} = eAn\beta e\frac{|\Delta V|}{l} = e^2 n\beta\frac{A}{l}|\Delta V| = \frac{|\Delta V|}{R} = \boxed{\frac{|\Delta V|}{(\rho\frac{l}{A})}}$$

Ohm’s Law, Resistance, Resistively



$$|\Delta V| = V_1 - V_2 = IR$$

This is what we have proved:

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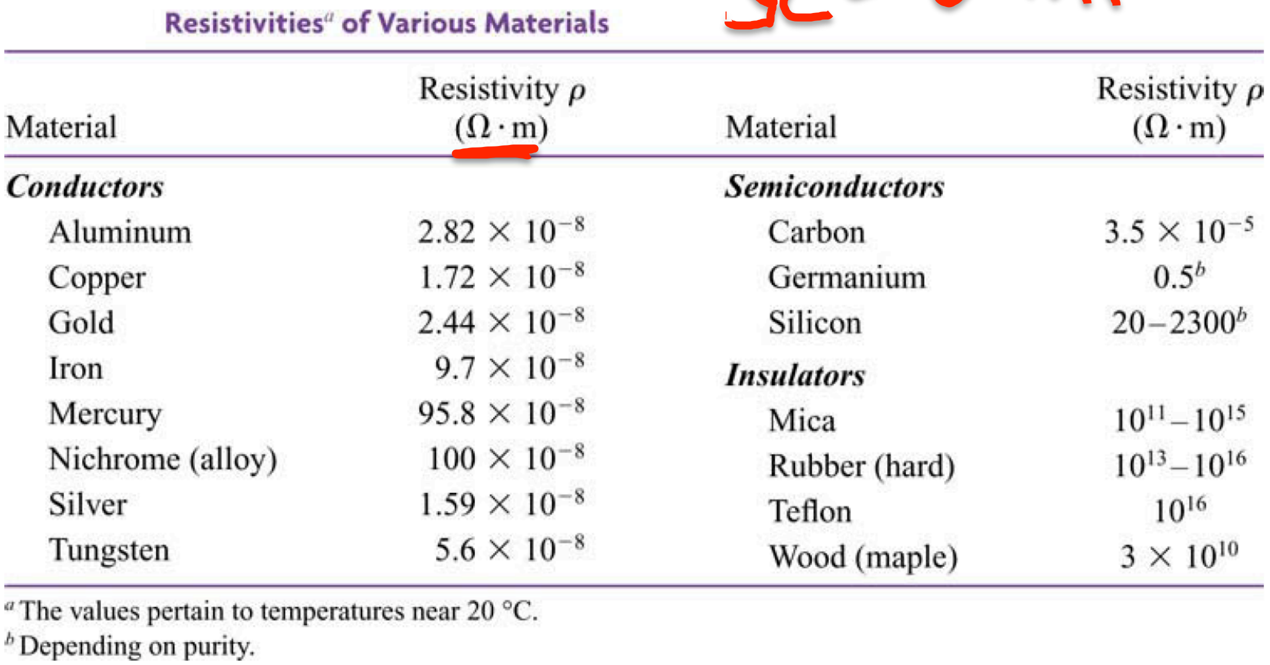
According to the Ohm’s Law:

current and potential difference are directly proportional.

The variable R is called *Resistance* (of a wire, of a device, of a bulb, of a motor, etc.). *Resistance* of a wire is directly proportional to its length l and inversely proportional to its cross-sectional area A : the variable ρ is called *Resistivity* of the material (the metal the wire is made of):

$$R = \rho \frac{l}{A}$$

Ω = Ohm



Resistivities[a] of Various Materials

Material	Resistivity ρ ($\Omega \cdot m$)	Material	Resistivity ρ ($\Omega \cdot m$)
Conductors		***Semiconductors***	
Aluminum	2.82×10^{-8}	Carbon	3.5×10^{-5}
Copper	1.72×10^{-8}	Germanium	0.5[b]
Gold	2.44×10^{-8}	Silicon	$20–2300$[b]
Iron	9.7×10^{-8}	***Insulators***	
Mercury	95.8×10^{-8}	Mica	$10^{11}–10^{15}$
Nichrome (alloy)	100×10^{-8}	Rubber (hard)	$10^{13}–10^{16}$
Silver	1.59×10^{-8}	Teflon	10^{16}
Tungsten	5.6×10^{-8}	Wood (maple)	3×10^{10}

[a] The values pertain to temperatures near 20 °C.

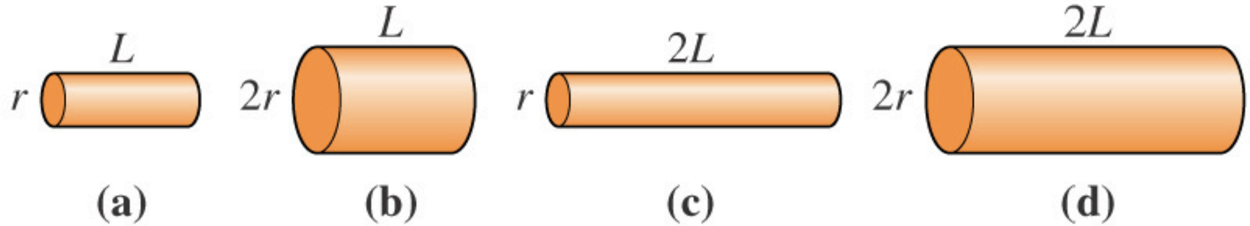
[b] Depending on purity.

$$R = \rho \frac{L}{A}$$

$$R = \rho \cdot \frac{1\,m}{1\,m^2}$$

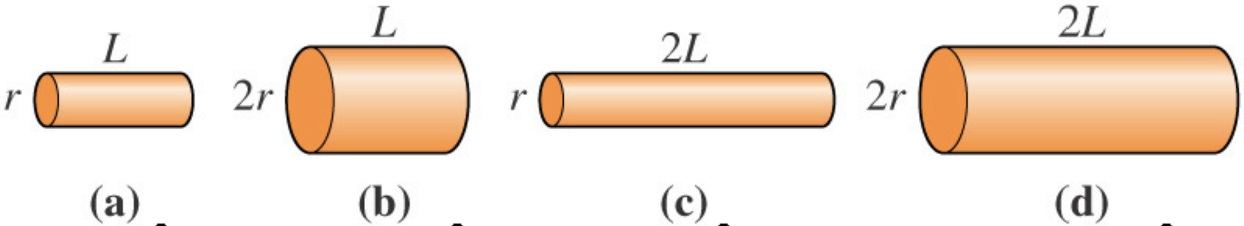
Conductors a to d are all made of the same material. Rank in order, from largest to smallest, the resistances R_a to R_d.

$$R = \rho \frac{L}{A}$$



1. $R_a > R_c > R_b > R_d$
2. $R_b > R_d > R_a > R_c$
3. $R_c > R_a > R_d > R_b$
4. $R_c > R_a = R_d > R_b$
5. $R_d > R_b > R_c > R_a$

Conductors a to d are all made of the same material. Rank in order, from largest to smallest, the resistances R_a to R_d.



(a) L / r^2 = “1”

(b) $L / (2r)^2$ = “1/4”

(c) $(2L) / r^2$ = “2”

(d) $(2L) / (2r)^2$ = “1/2”

1. $R_a > R_c > R_b > R_d$
2. $R_b > R_d > R_a > R_c$

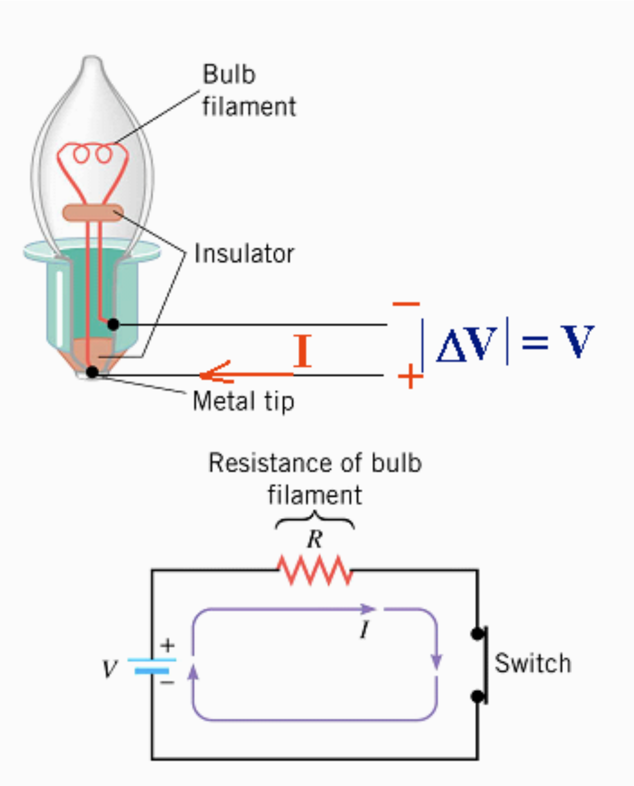
[✓ **3.** $\boldsymbol{R_c > R_a > R_d > R_b}$]

4. $R_c > R_a = R_d > R_b$
5. $R_d > R_b > R_c > R_a$

Flashlight

The filament in a light bulb is a resistor in the form of a thin piece of wire. The wire becomes hot enough to emit light because of the current in it. The flashlight uses two 1.5-V batteries to provide a current of 0.40 A in the filament. Determine the resistance of the glowing filament.

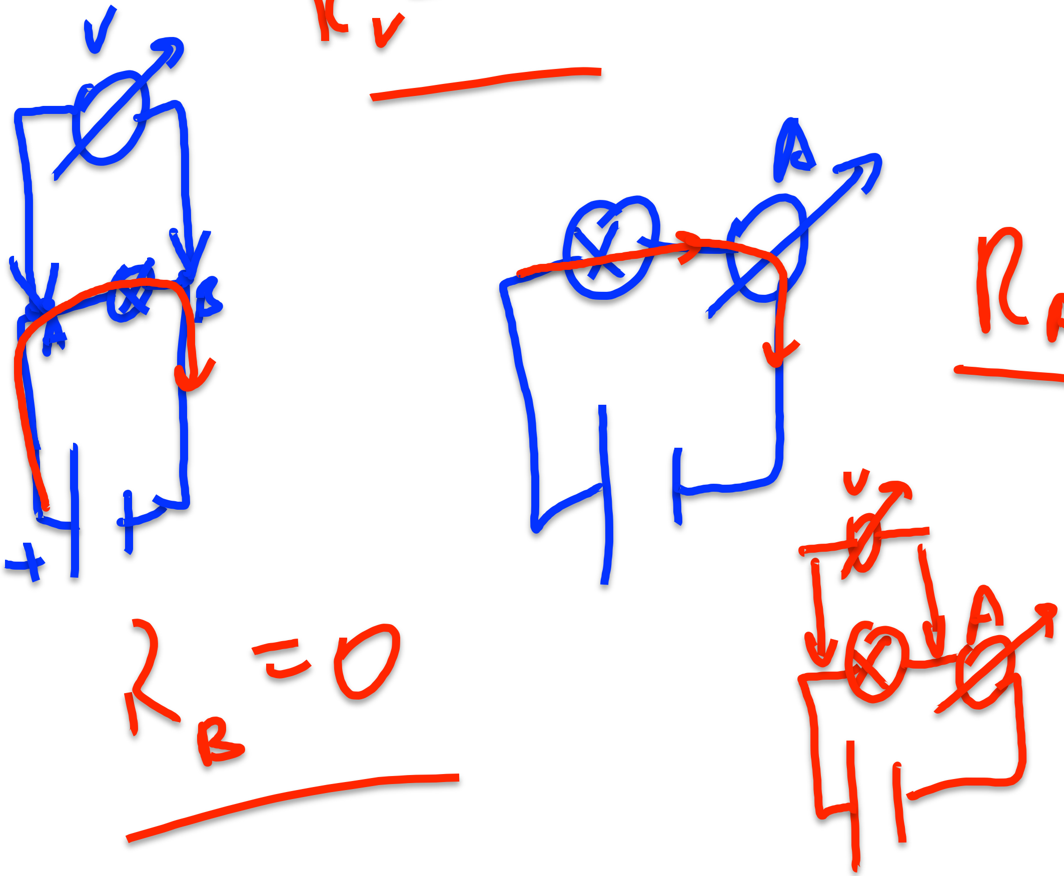
$$R = \frac{V}{I} = \frac{3.0\,\text{V}}{0.40\,\text{A}} = 7.5\,\Omega$$

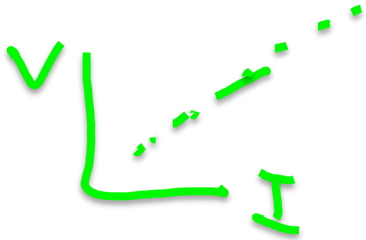


$R_V = \infty$

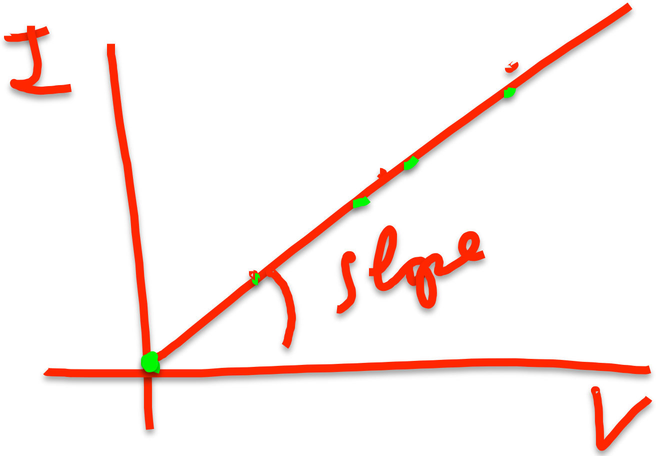
$R_A = 0$

$r_B = 0$





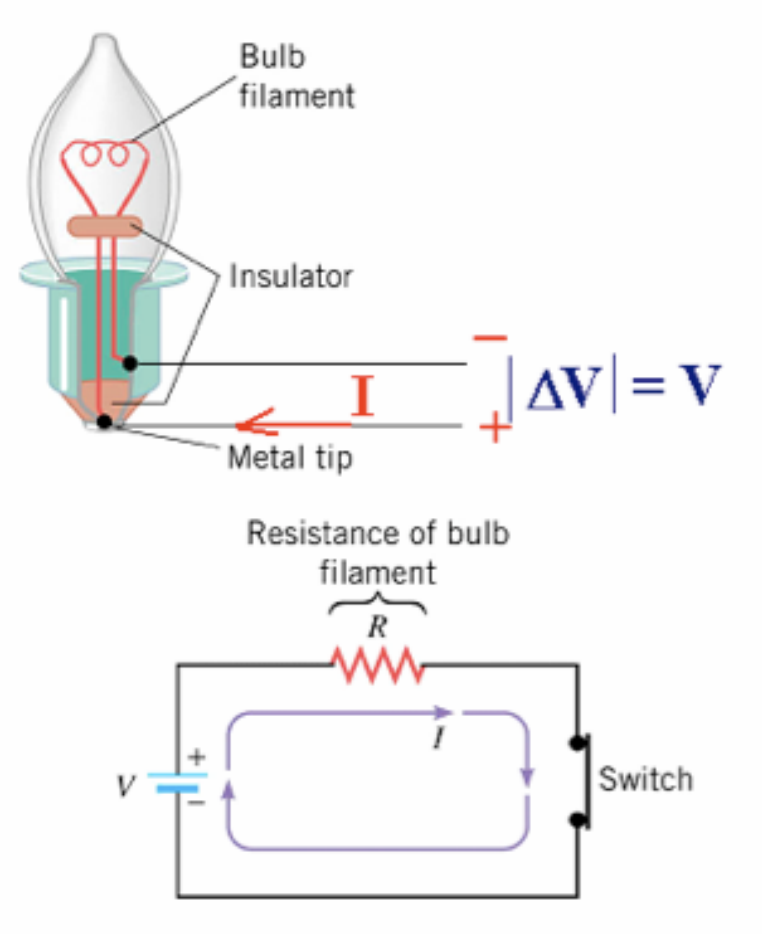
V	I



$$\boxed{I = \frac{V}{R}} = \boxed{\frac{1}{R}}\,V$$

$$Y = \underline{m}x + \boxed{b}$$

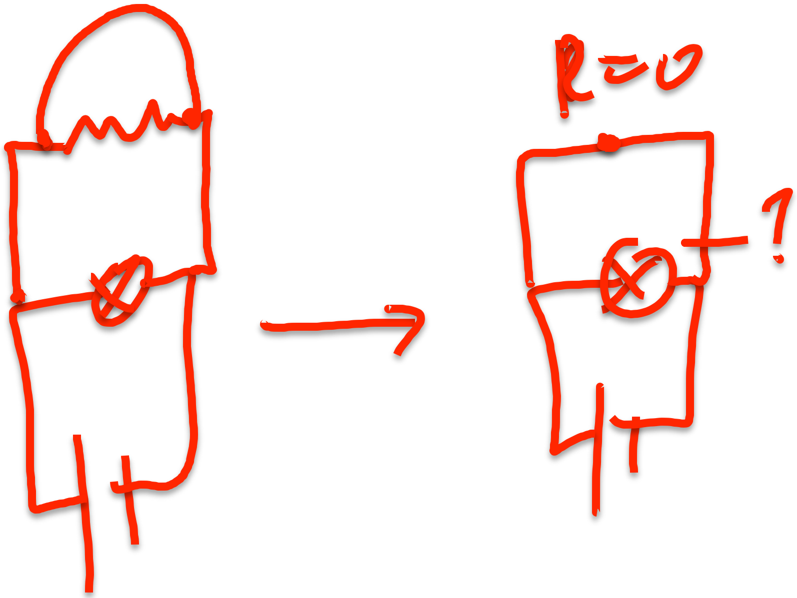
1. R 2. $\frac{1}{R}$ 3 $\frac{V}{R}$ 4. ?



Due to electric current traveling through the filament of the bulb a flashlight is on.

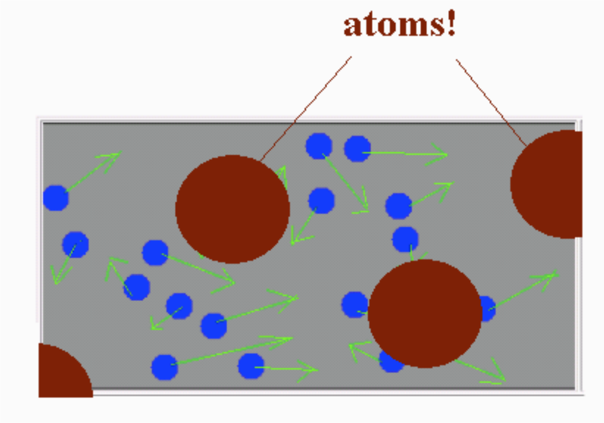
Does the current do work?

1. Yes
2. No



1. Nothing
2. Brighter
3. Dimmer

Work of an electric curent



When moving through a conductor, electrons constantly encounter atoms and hit them making atoms moving/shaking faster!

Potential difference create electric field => E field creates a force on electrons making them moving creating current => E field does a work on electrons => electrons hit atoms => electrons transfer energy to atoms => electrons do work on atoms => current does work on atoms = >

current does work!