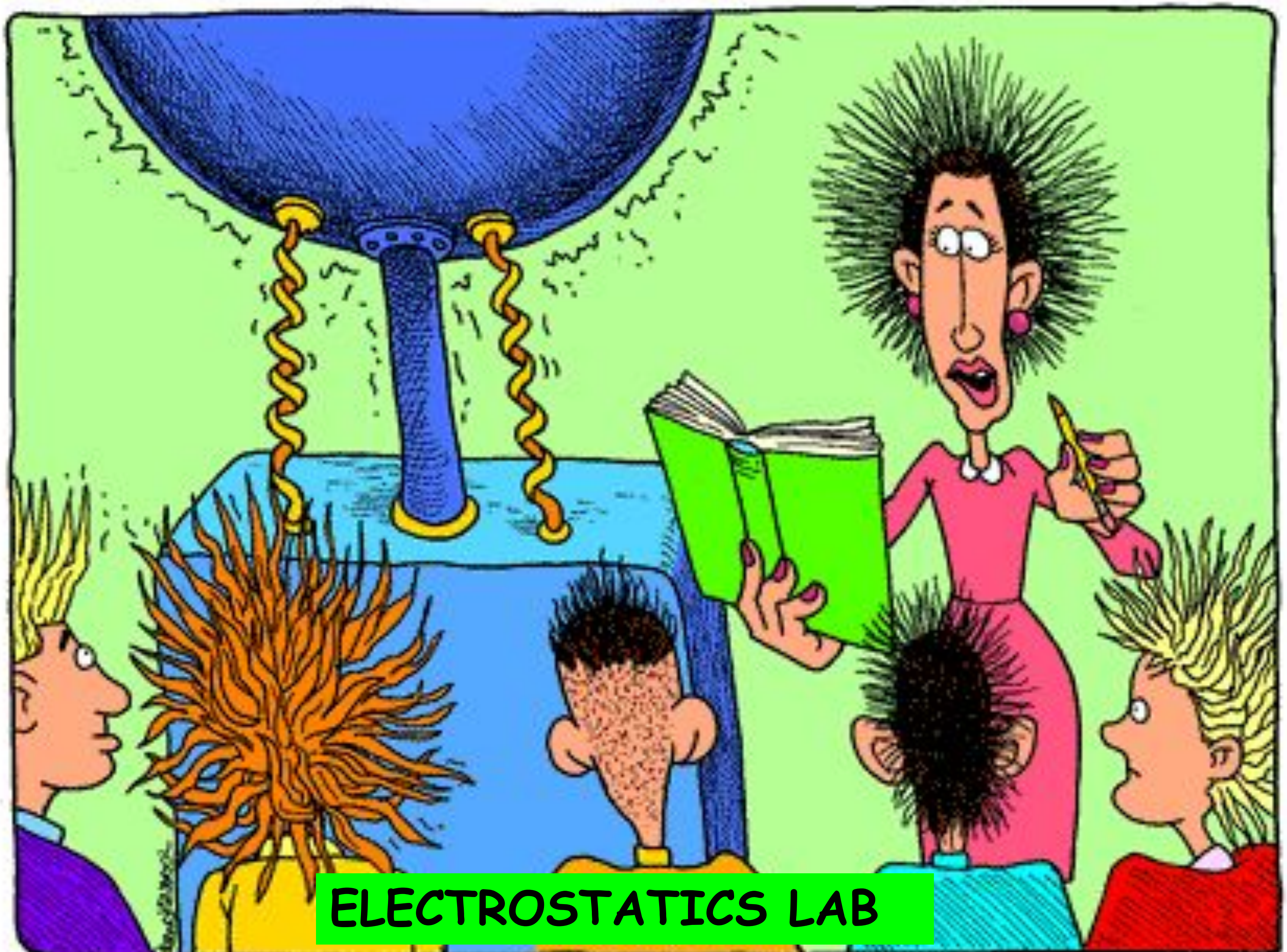
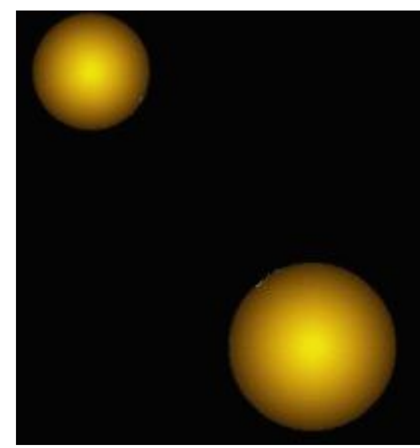

ELECTROSTATICS LAB

Electric Circuits

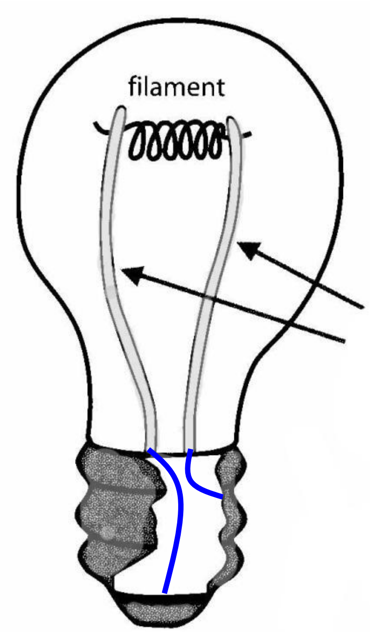
For an electric current to flow between two points, two conditions must be met.

1. There must be a conducting path between the points along which the charges can move.

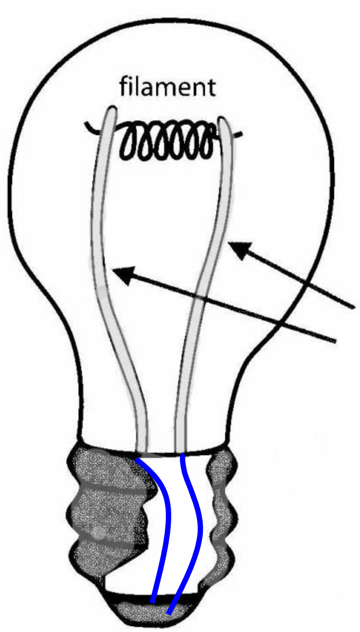
2. There must be a difference of electric potential (volts) between the two points.



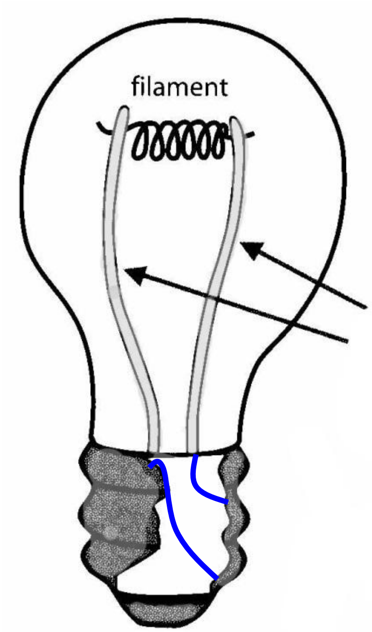
Where do these two wires connect to the base of the light bulb? Which bulb is wired correctly?



1

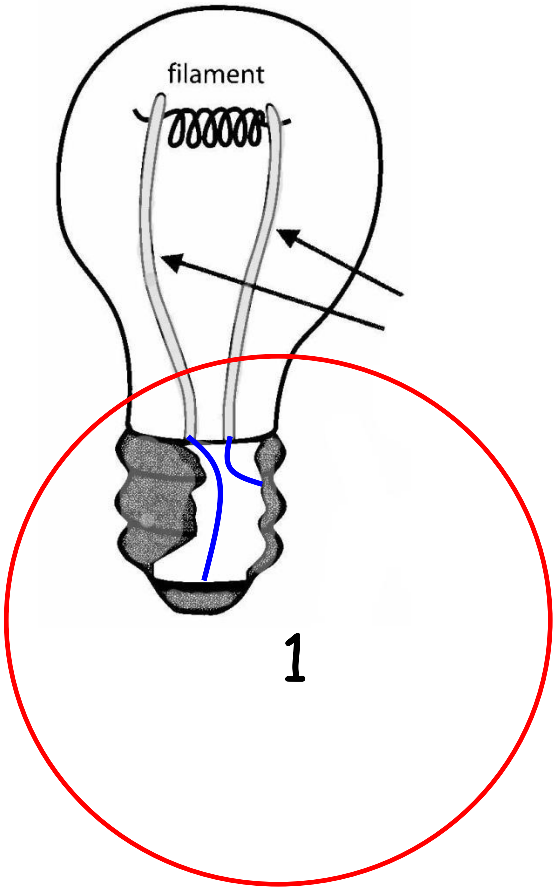


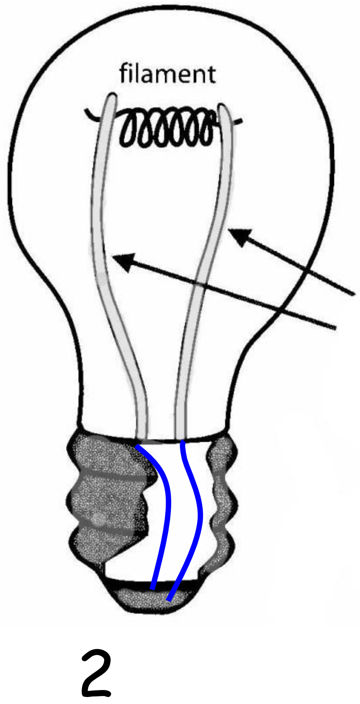
2

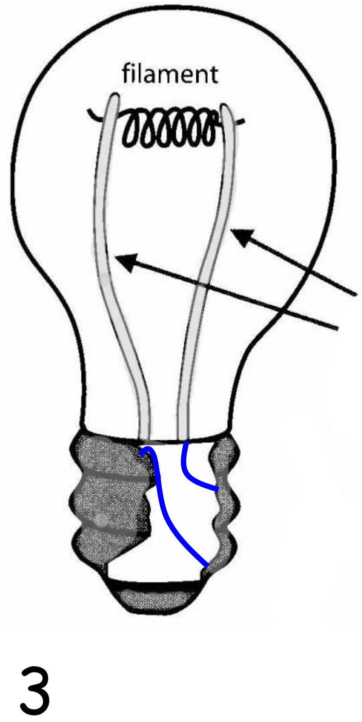


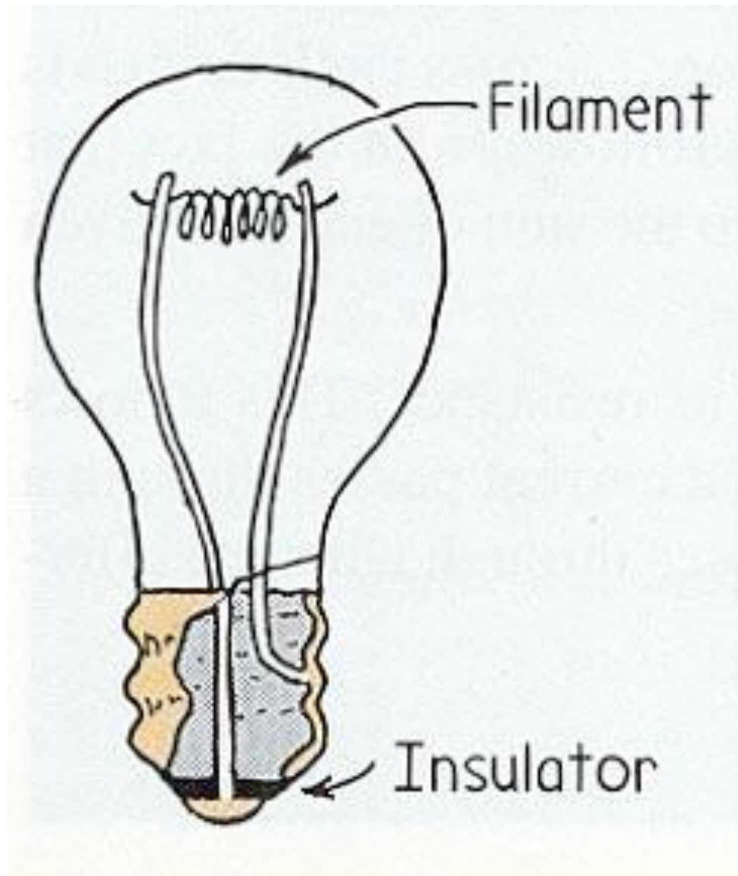
3

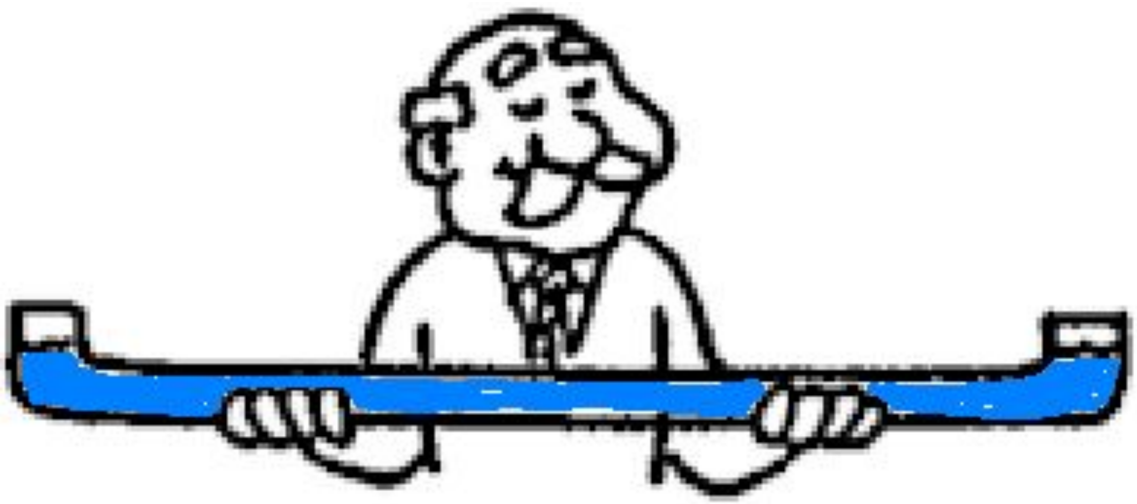
Where do these two wires connect to the base of the light bulb? Which bulb is wired correctly?





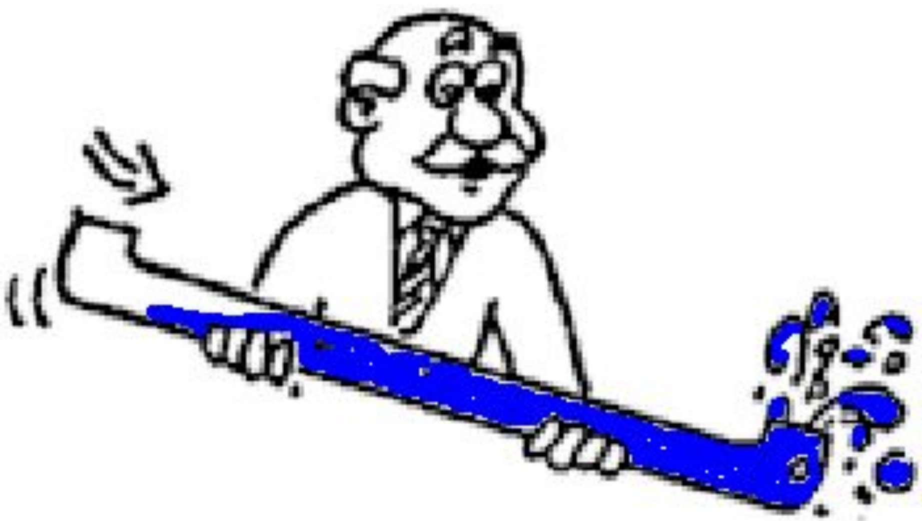



Filament
Insulator



Water doesn't flow in the pipe when both ends are at the same level. That is to say, water will not flow when both ends of the pipe are at the same potential energy.

And so it is with electric current flow.



But tip the pipe, increase the PE of one end so there is a difference in PE across the ends of the pipe, and water will flow.

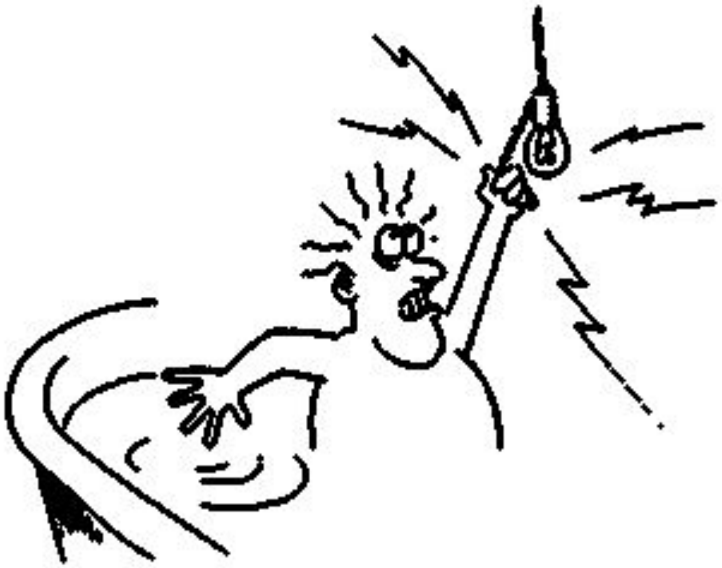
1 ampere (amp) is defined as a current flow of 1 Coulomb per second. It is analogous to water flow rate (gallons/sec)

An ampere is a fairly large amount of current:

0.1 A flowing between your hands across your heart will kill you.

(Fortunately, your body has fairly high resistance so it takes a substantial voltage to drive that much current.)

Andre Marie Ampere (1775-1836)



Don't try this at home kids.

Ohms Law, $V=IR$
or
$I=V/R$

V=potential difference (Volts)

Aka: voltage, voltage drop, ΔV

I= Current (amps)

R = Resistance (ohms)

Electric Power, P

- P= energy/time (J/s) = (Watts)

- P= IV
- = I^2R
- = V^2 / R

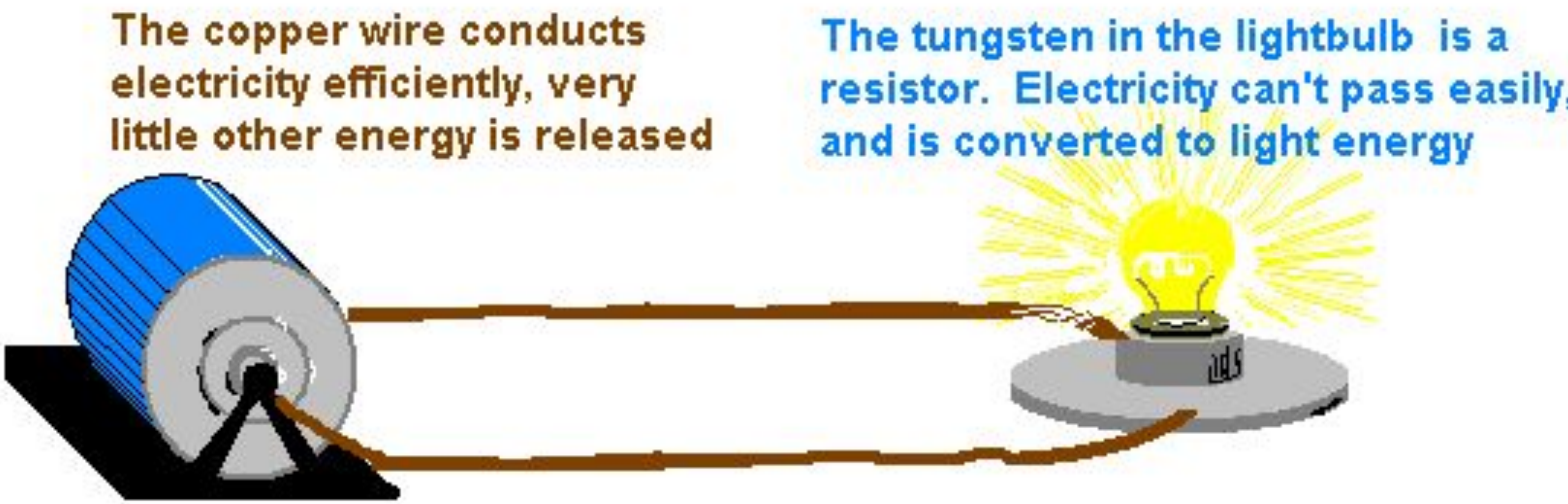
Brightness is related to power used

- $P = I^2R$
  - Thus: the greater the current,
    the greater the brightness and
    power used

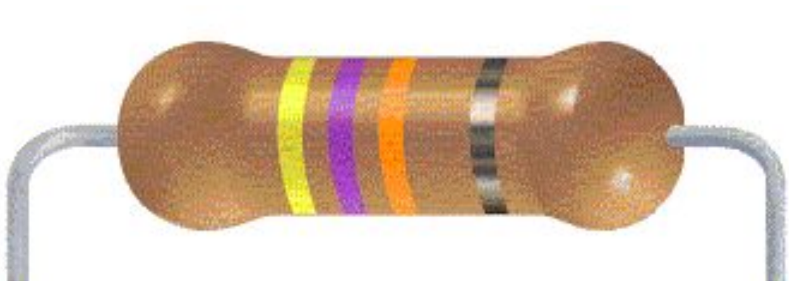
- Ammeters vs voltmeters

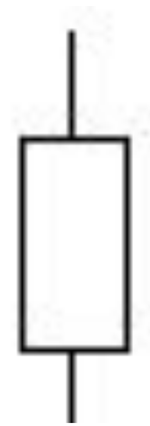
- Ohmic vs non-ohmic resistors

A resistor is anything that electricity cannot travel through easily.



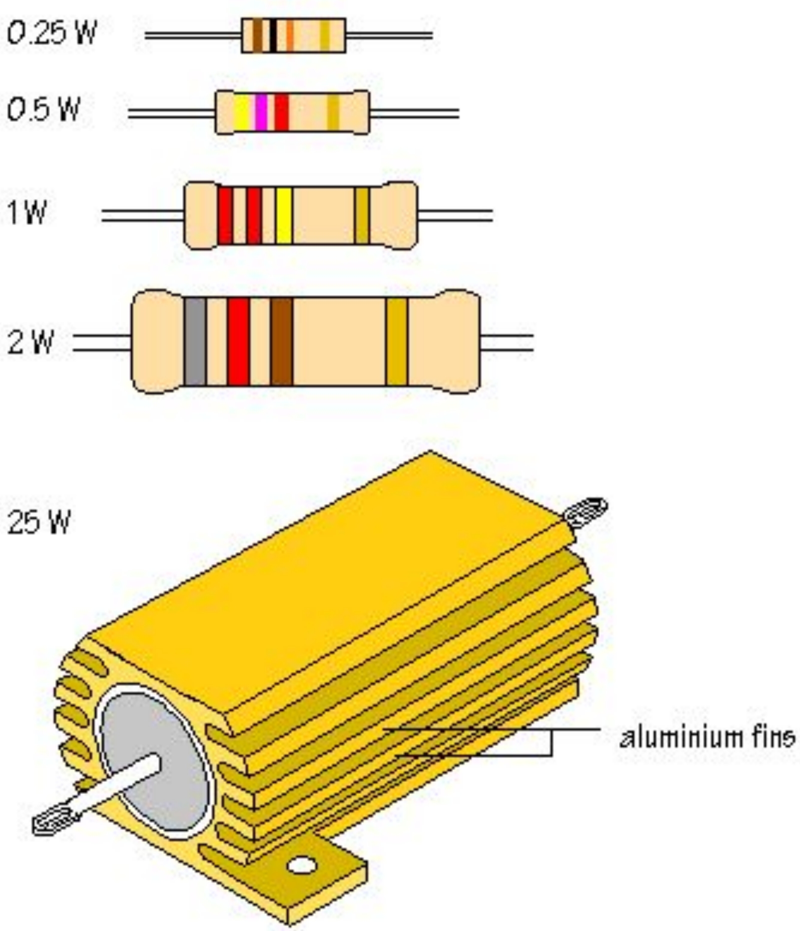
Resistors typically look like this.





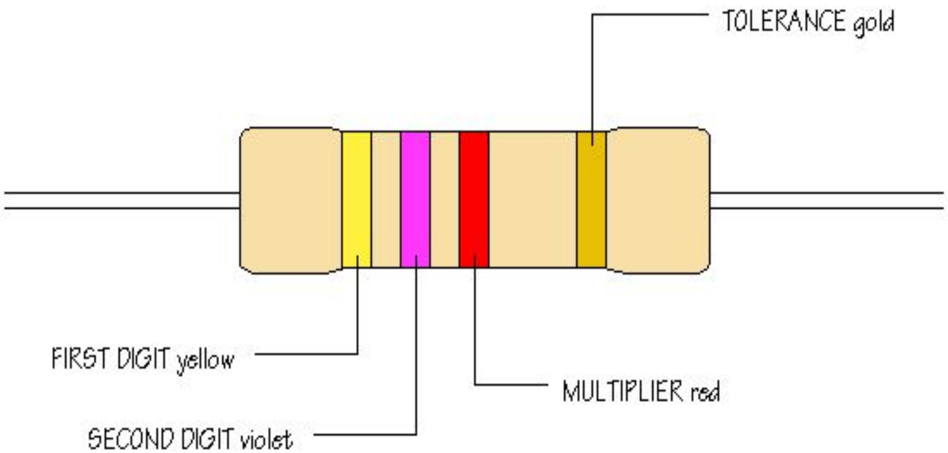
Europe & IB

U.S.A. Japan

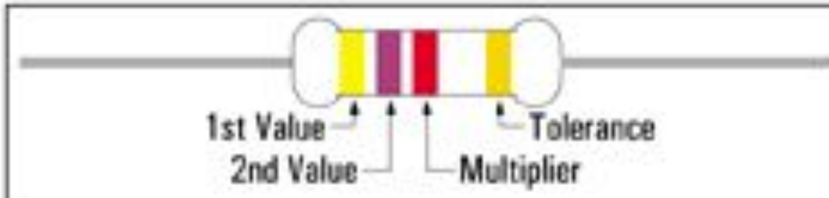


Resistors are rated in terms of their resistance (ohms) and their power carrying ability (watts)

Resistor Color Code



READING RESISTANCE VALUES



Example: 4 7 x100 –5%
4700Ω–5%

COLOR	VALUE	MULTIPLIER	TOLERANCE
Black	0	1	-
Brown	1	10	–1%
Red	2	100	–2%
Orange	3	1K	-
Yellow	4	10K	-
Green	5	100K	–.5%
Blue	6	1M	–.25%
Violet	7	10M	–.1%
Gray	8	100M	–.05%
White	9	1000M	-
Gold	-	1/10	–5%
Silver	-	1/100	–10%
None	-	-	–20%

Resistance and Resistivity

The resistance of a conductor that obeys Ohm's law depends upon three factors:

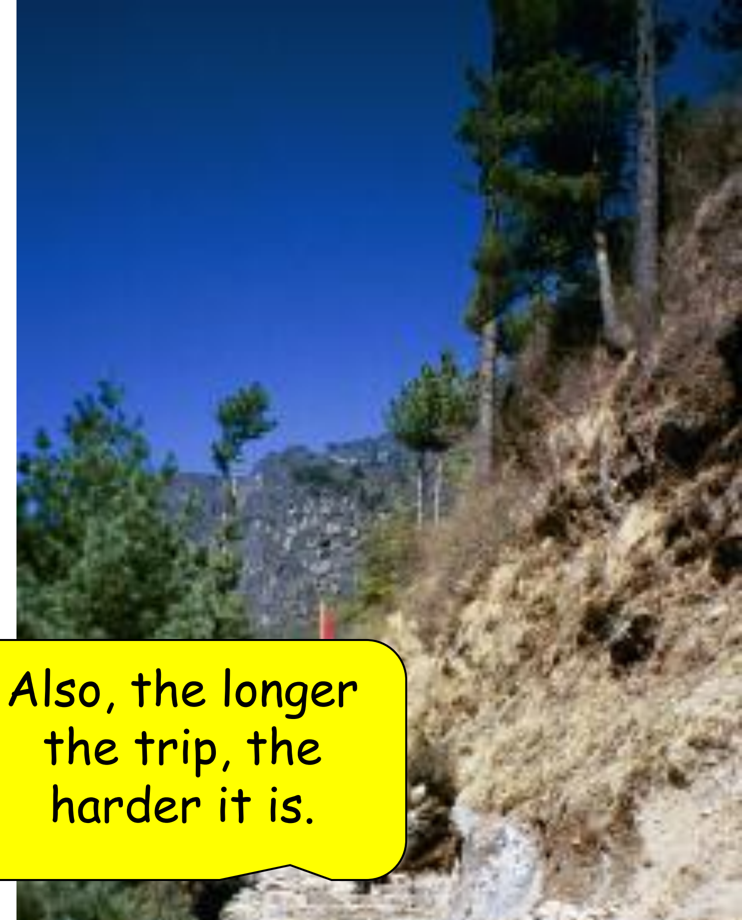
$$R = \rho \frac{L}{A}$$

1. The resistivity of material, **ρ ,** the ability to carry an electric current, varies with temperature (units: Ωm)

2. Its length (**L**): The longer the conductor, the greater its resistance.

3. Its cross-sectional area (**A**). The thicker the conductor the less its resistance.

It's much easier to travel on an open highway than a rocky trail.



Also, the longer the trip, the harder it is.

It's much easier to travel on an open highway than a rocky trail.

To calculate the resistivity of a material at any temperature ....

(Don't write this down...)

$$\rho = \rho_o [1 + \alpha(T-T_o)]$$

In this equation, resistivity is referenced to some standard resistivity ρ_o at some standard temperature To.

In terms of resistance ...

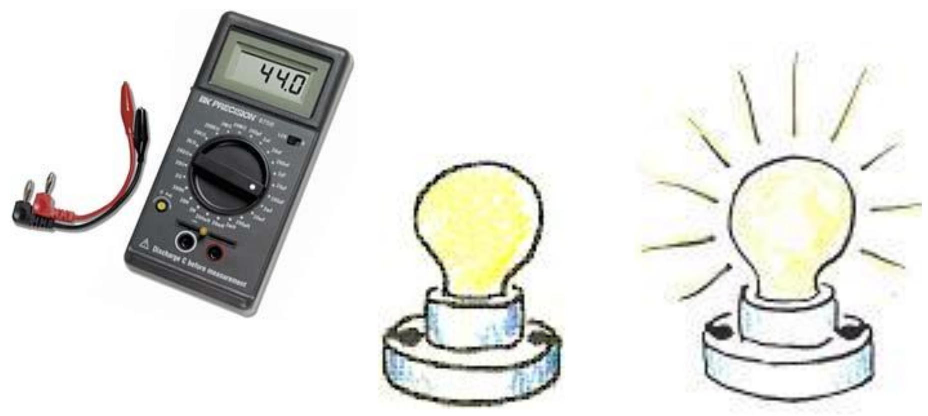
$$R = R_o [1 + \alpha(T - T_o)]$$

Instead, write:

As Temp. ↑ , R ↑

Would the resistance of an unlit light bulb measured with an ohm meter be more or less than a lit bulb?

1. More.
2. Less.
3. They're both the same.



Would the resistance of an unlit light bulb measured with an ohm meter be more or less than a lit bulb?

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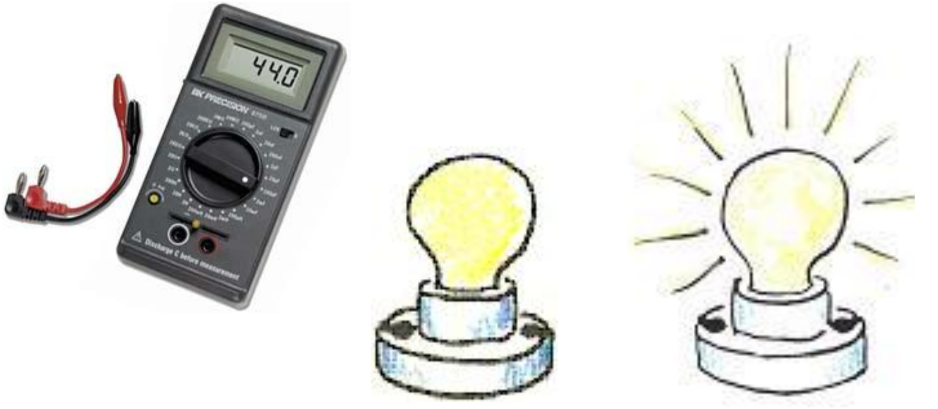
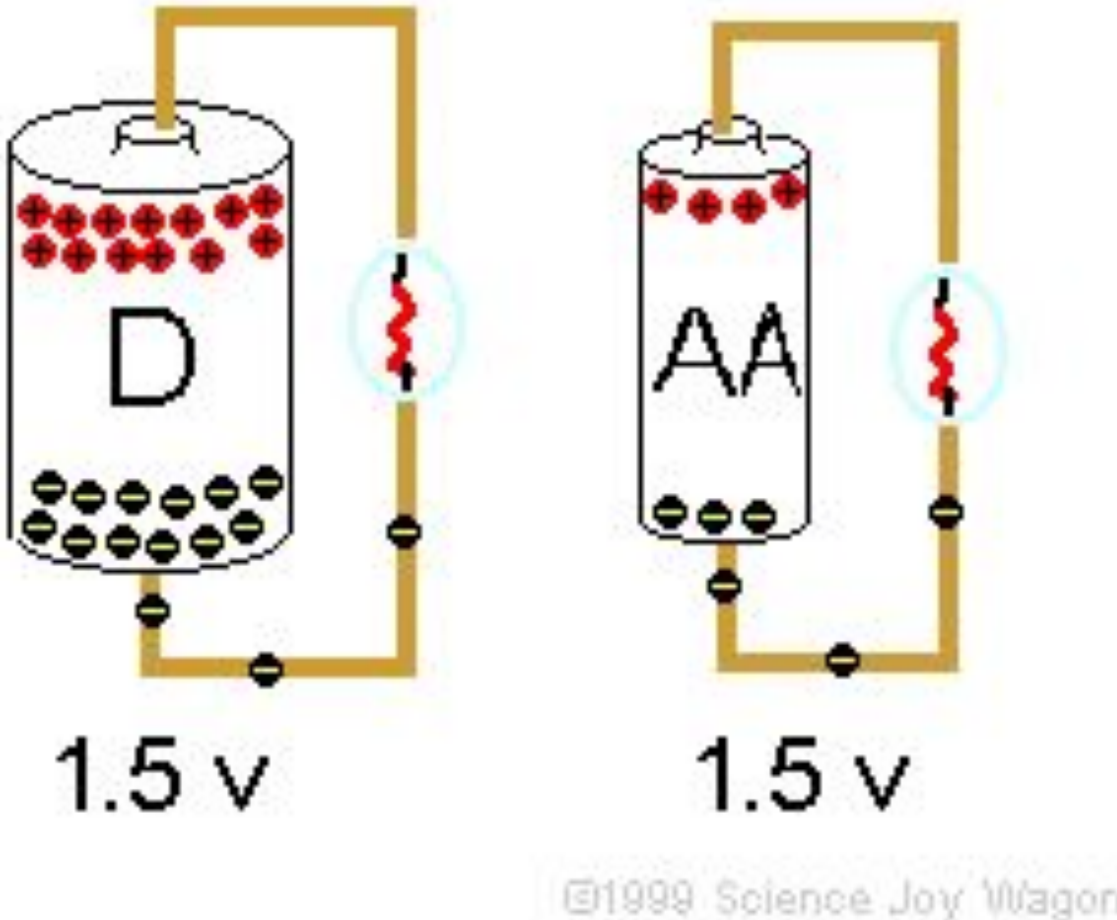
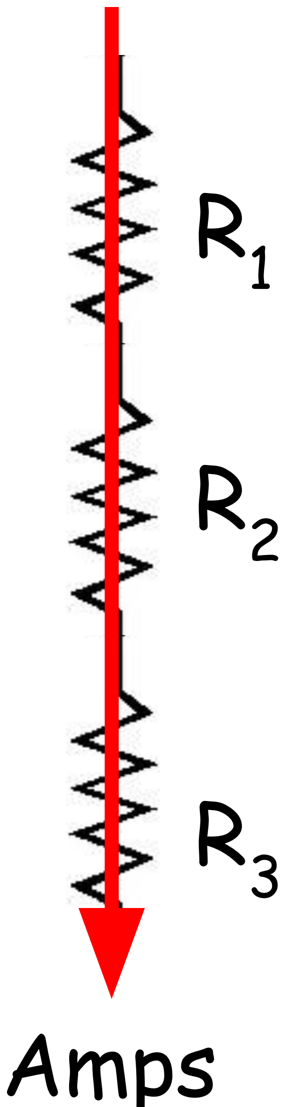



D
AA
1.5 v
1.5 v
©1999 Science Joy Wagon

Combining (adding) Resistors



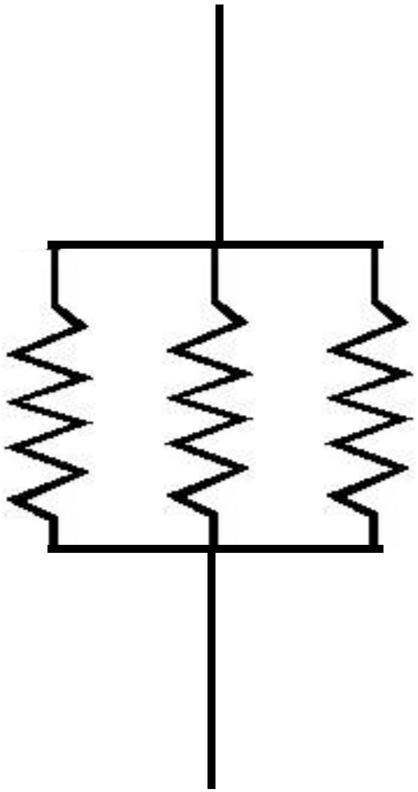
Series Resistors

$$R_{total} = R_1 + R_2 + R_3$$

The current (amps) through all resistors in series is the same

Q

Combining (adding) Resistors

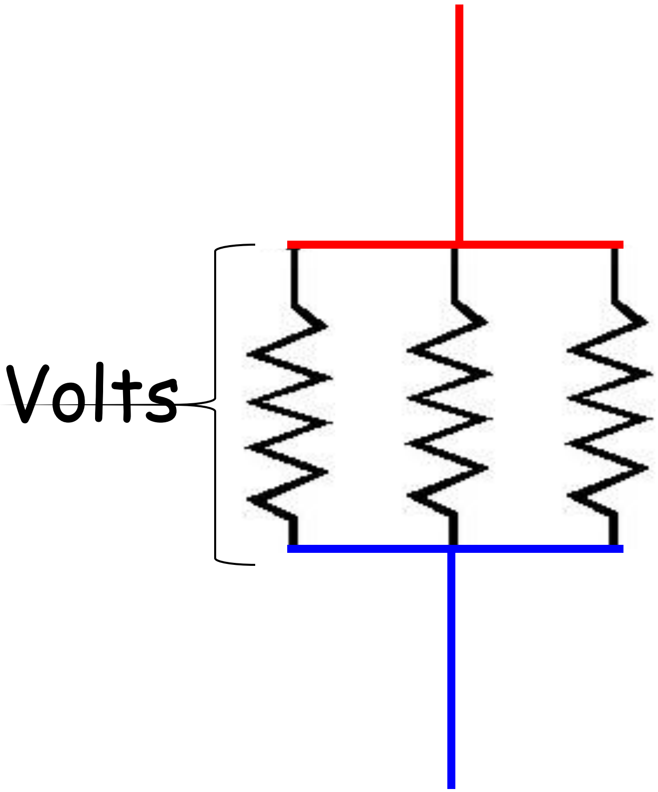


Parallel Resistors

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

The voltage across all parallel resistors is the same.

Combining (adding) Resistors



Parallel Resistors

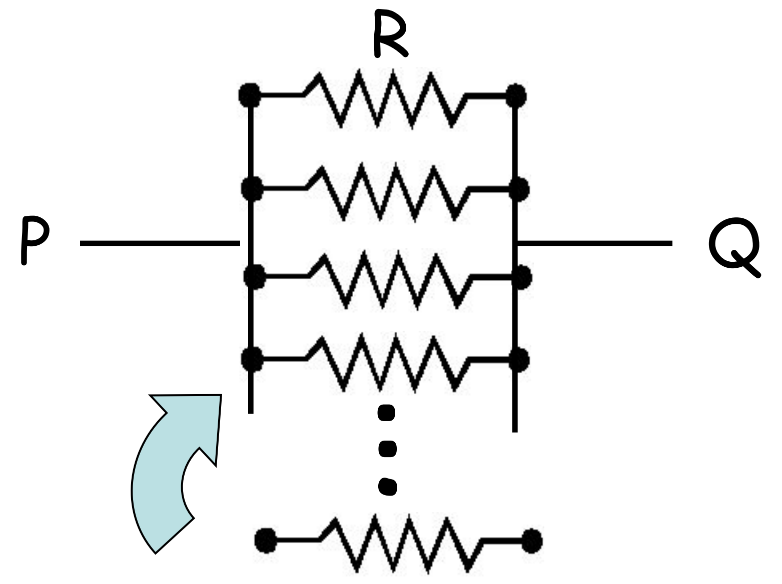
$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

The voltage across all parallel resistors is the same.

Q

As more identical resistors R are added to the parallel circuit shown, the total resistance between points P and Q …

1. Increases
2. Remains the same
3. Decreases



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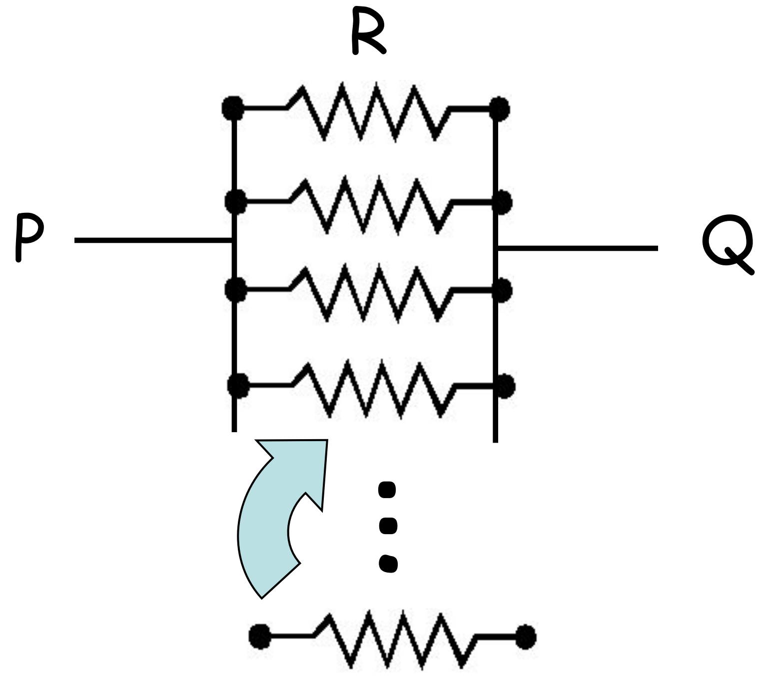
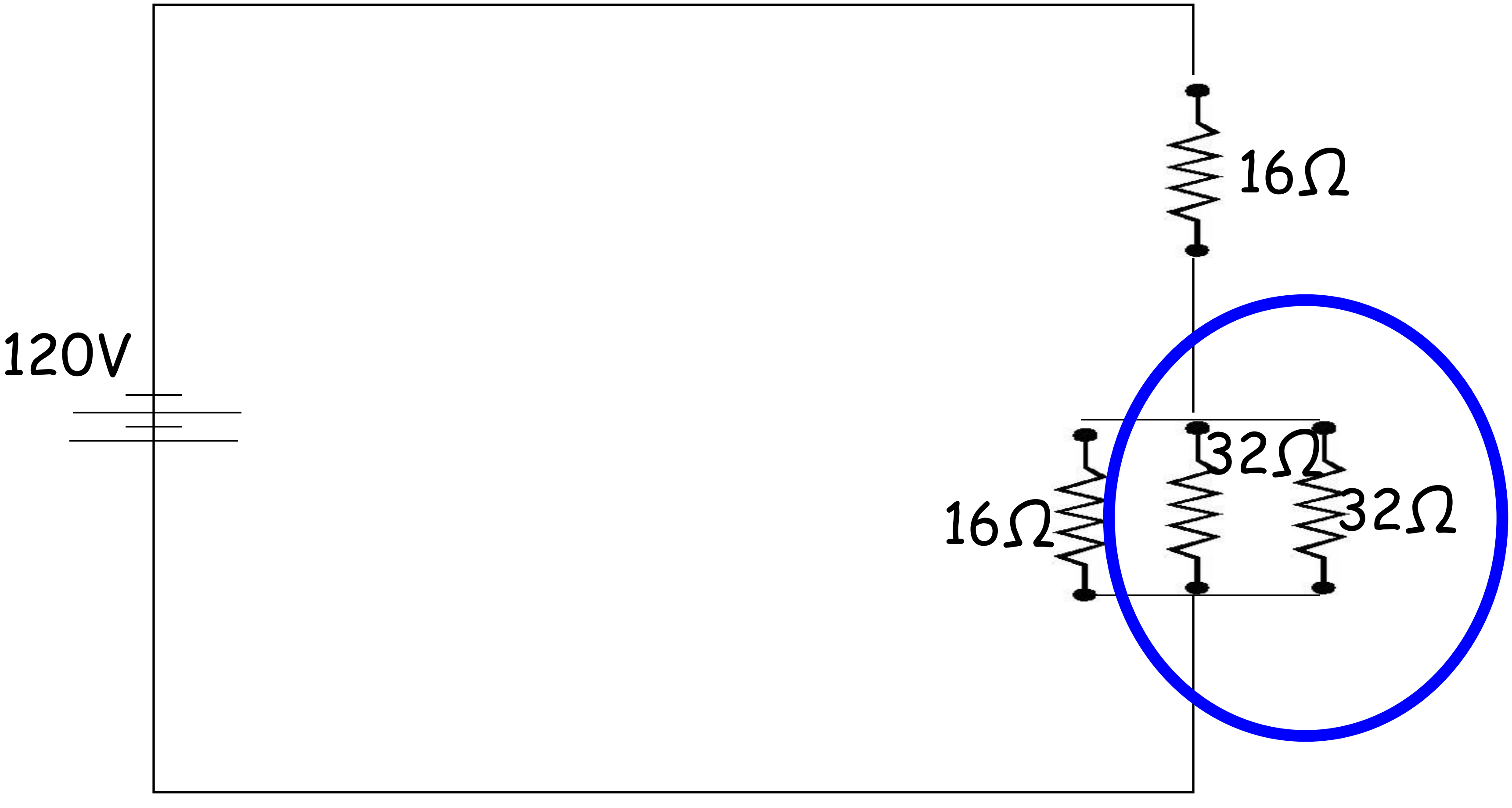
1. Increases 2. Remains the same 3. decreases

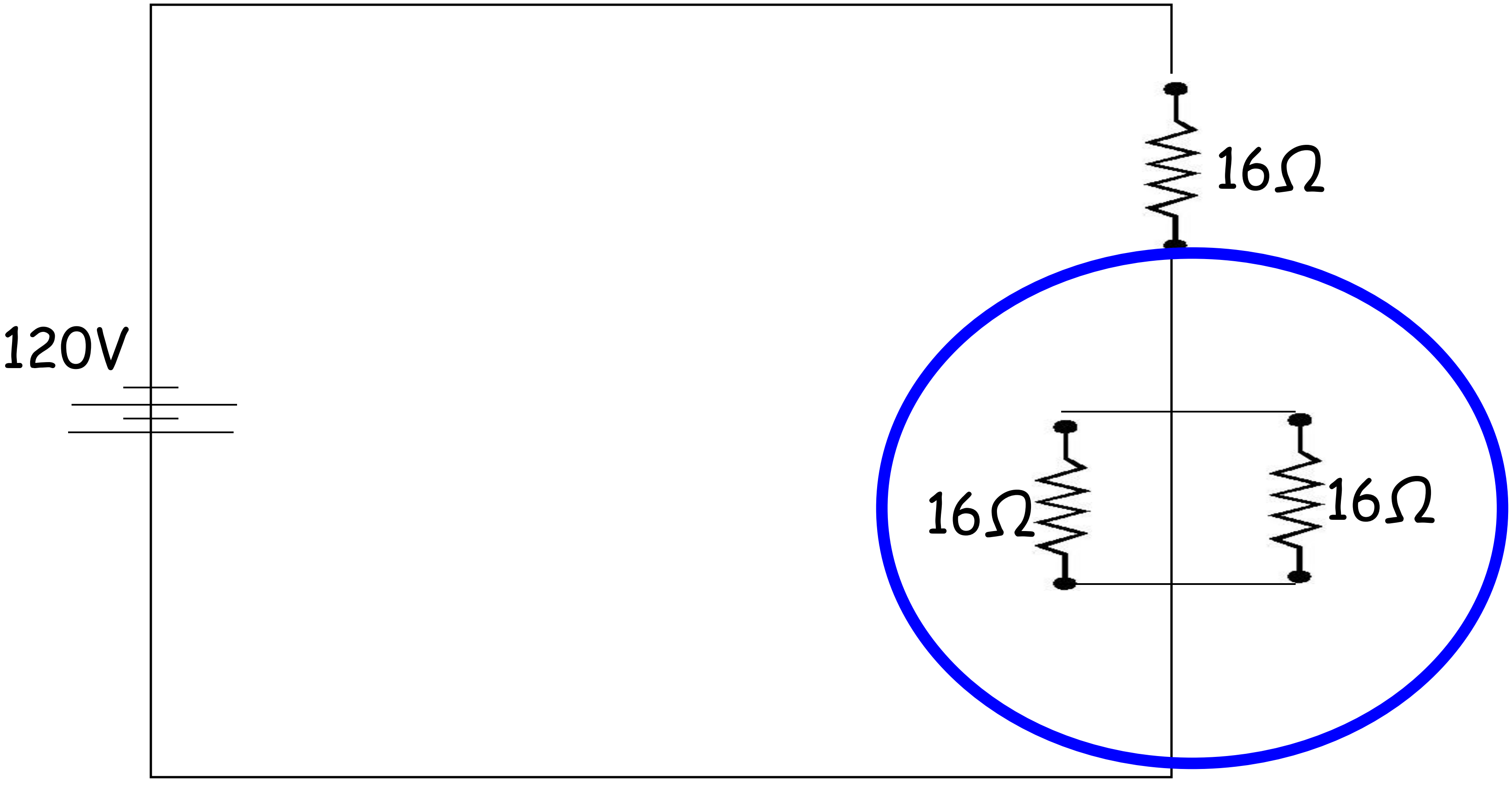


Q

Combination circuits: Find the usual stuff

(R_{total}, I_{total}, voltage drop across each resistor, current through each resistor)





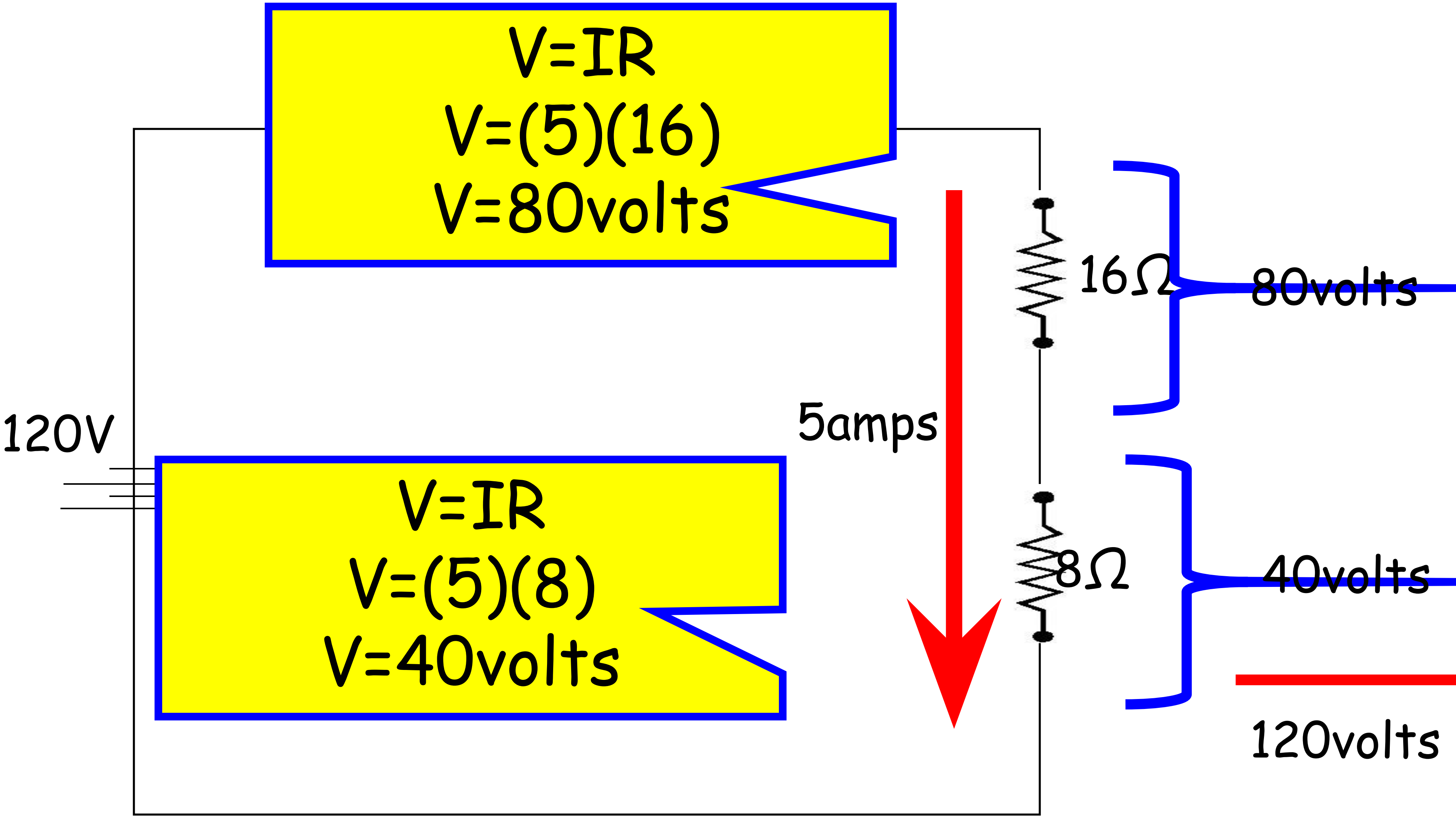
120V
16Ω
16Ω
16Ω

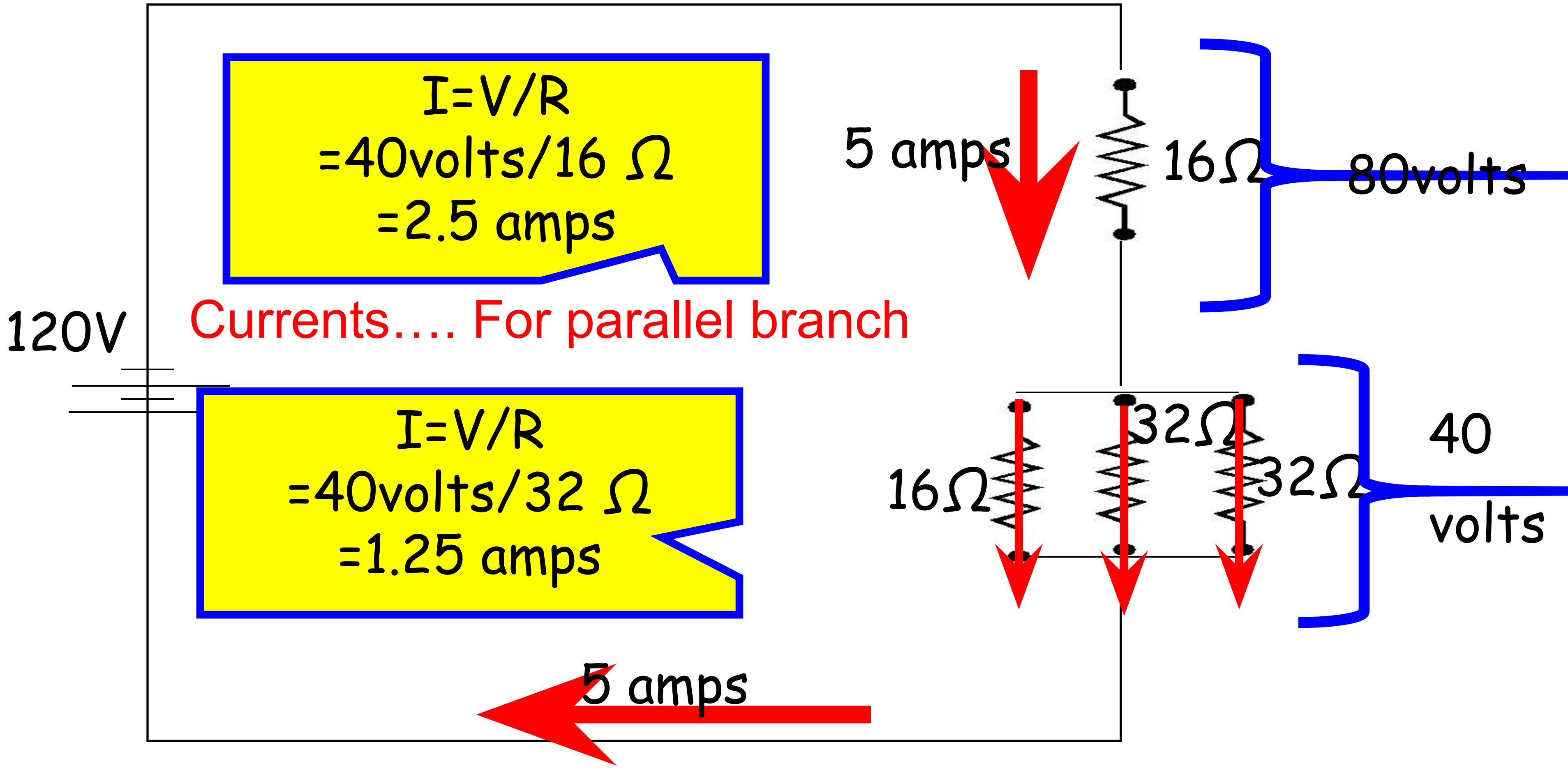

120V
16Ω
8Ω

$I = V/R$

$I = 120v/24\Omega$

$I = 5$ amps

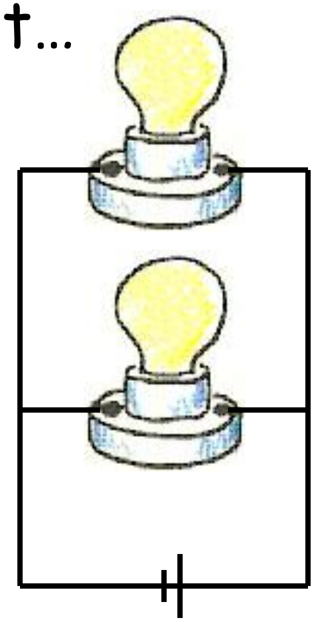

V=IR
V=(5)(16)
V=80volts
16Ω
80volts
120V
5amps
V=IR
V=(5)(8)
V=40volts
8Ω
40volts
120volts


120V
I=V/R
=40volts/16 Ω
=2.5 amps
Currents…. For parallel branch
I=V/R
=40volts/32 Ω
=1.25 amps
5 amps
16Ω
80volts
32Ω
16Ω
32Ω
40
volts
5 amps

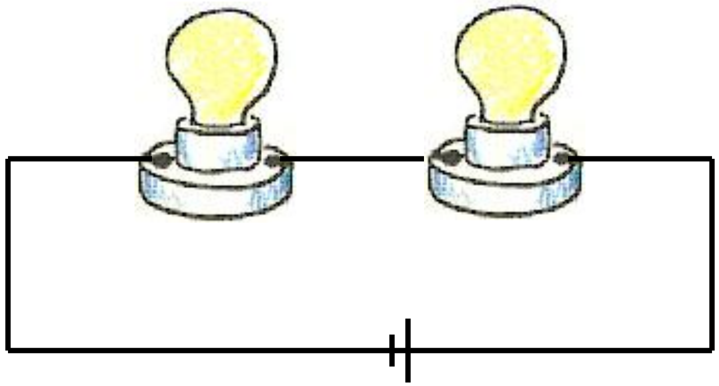
stop

When one bulb is unscrewed, the other bulb will remain lit in which circuit…

1. I
2. II
3. Both
4. Neither



Circuit I

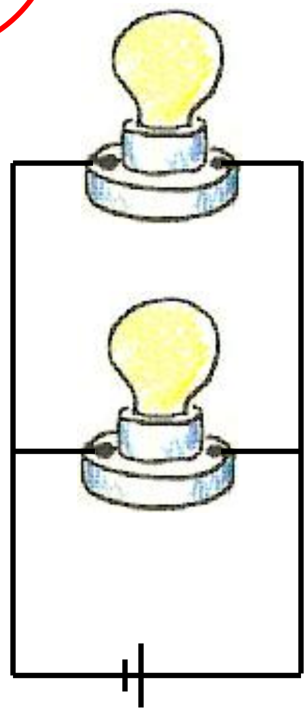


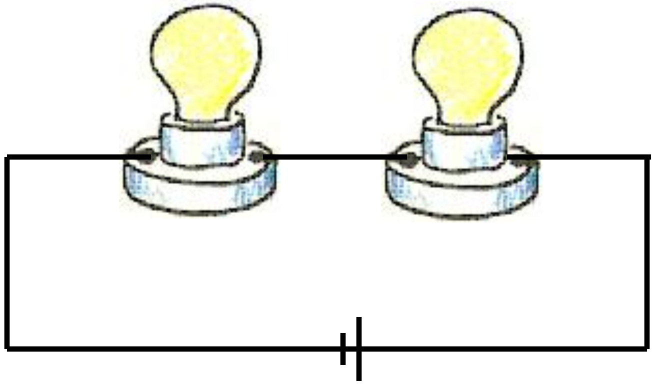
Circuit II

When one bulb is unscrewed, the other bulb will remain lit in which circuit…

1. I 2. II 3. both 4. neither

Circuit I





Circuit II

STOP - Day 1

Electric Power, P

- P= energy/time (J/s) = (Watts)

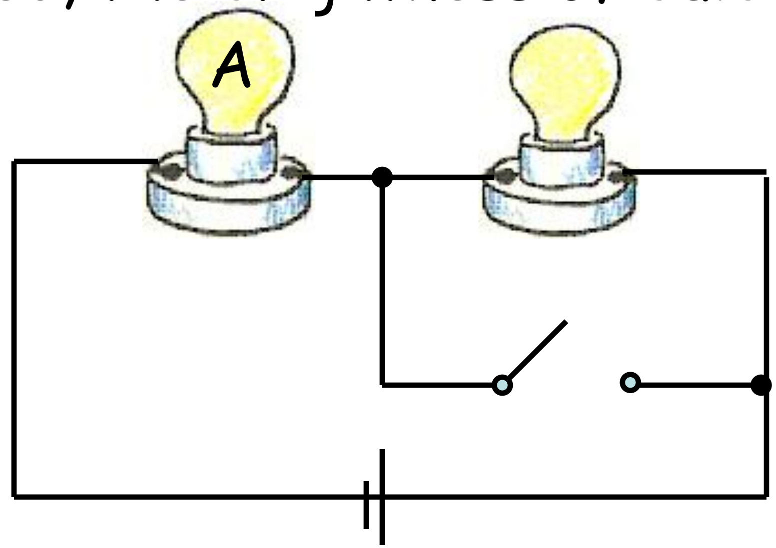
- P= IV
- $= I^2R$
- $= V^2 / R$

Brightness is related to power used

- $P = I^2R$
  - Thus: the greater the current,
    the greater the brightness and
    power used

The circuit below consists of two identical light bulbs burning with equal brightness and a single 12V battery. When the switch is closed, the brightness of bulb A…

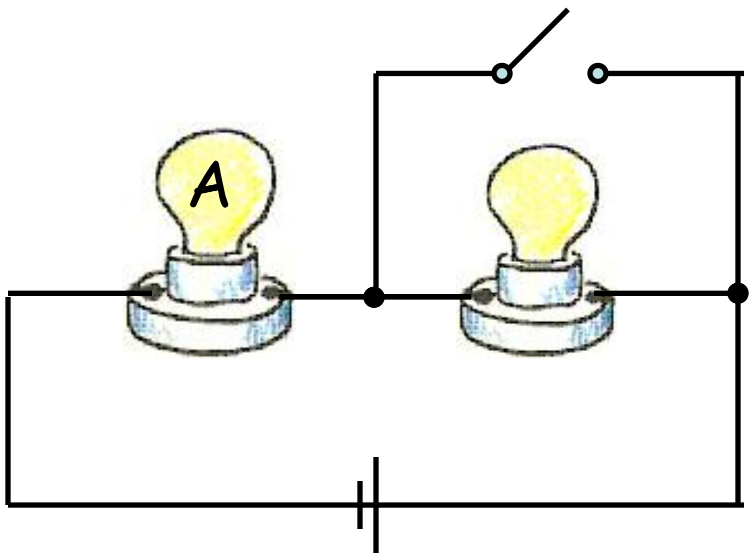
1. Increases
2. Decreases
3. Remains unchanged



The circuit below consists of two identical light bulbs burning with equal brightness and a single 12V battery. When the switch is closed, the brightness of bulb A…

1. Increases 2. decreases 3. remains unchanged

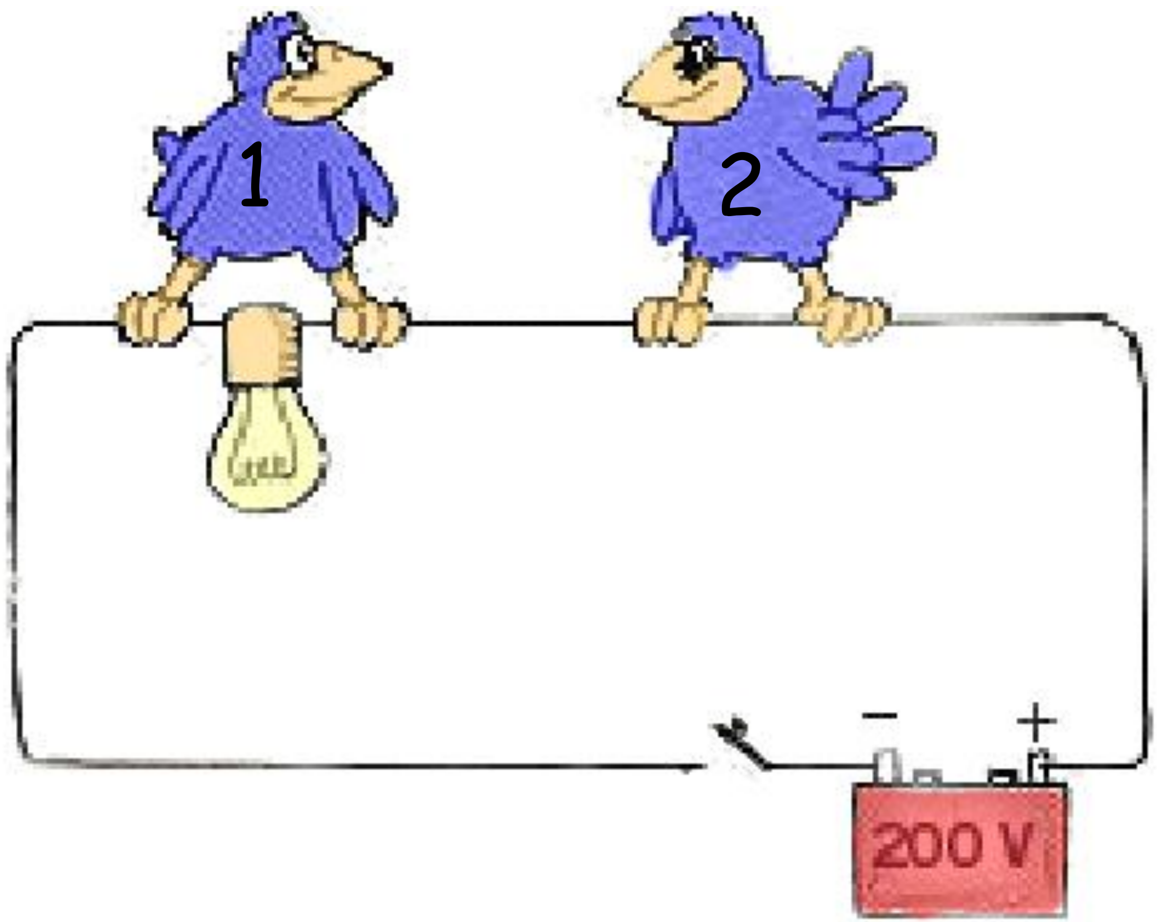
When the switch is closed, bulb B goes out because all of the current goes through the wire parallel to the bulb. Thus, the total resistance of the circuit decreases, the current through bulb increases, and it burns brighter.



Q

Which bird is in trouble when the switch is closed?

1) Bird 1   2) bird 2   3) neither   4) both



Charge flows through a light bulb. Suppose a wire is connected across the bulb as shown. When the wire is connected…

1. All the charge continues to flow through the bulb, and the bulb stays lit.
2. Half the charge flows through the wire, the other half continues through the bulb.
3. Essentially all the charge flows through the wire and the bulb goes out.
4. None of these.

Q

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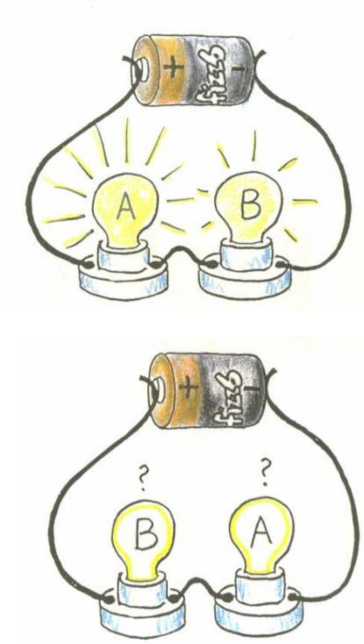
3. Essentially all the charge flows through the wire and the bulb goes out.

When the series circuit shown is connected, Bulb A is brighter than Bulb B. If the positions of the bulbs were reversed…

1. Bulb A would again be brighter
2. Bulb B would be brighter
3. They would be equal brightness



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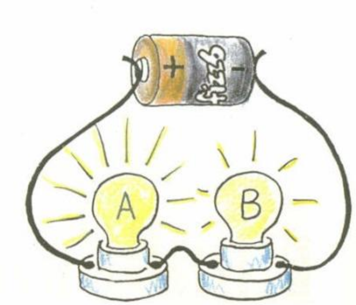
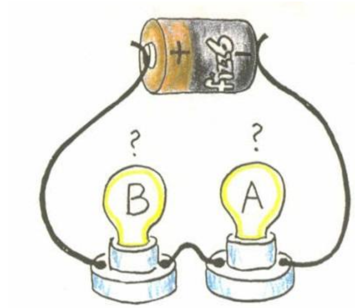


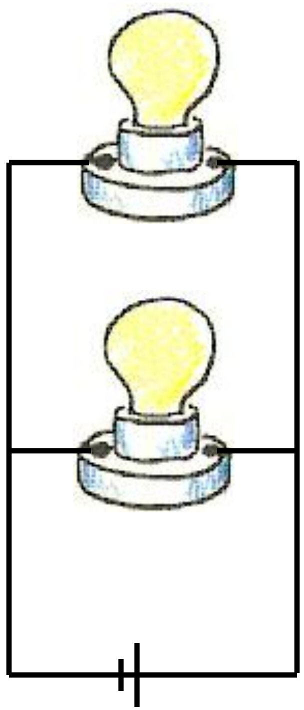


The bulbs are connected in series, so the same current passes through both of them. Different brightnesses indicate different filament resistances. Bulb A is NOT brighter because it is "first in line" for the current of the battery! After all, electrons deliver the energy, and they flow from negative to positive --- in the opposite direction!

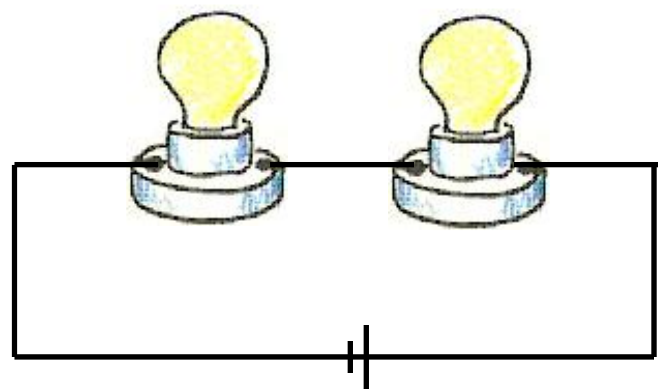
If the four light bulbs in the figure below are identical, which circuit puts out more light?

1. I 2. II 3. Same

Circuit I



Circuit II



If the four light bulbs in the figure below are identical, which circuit puts out more light?

1. I   2. II   3. Same

Circuit I

Circuit II

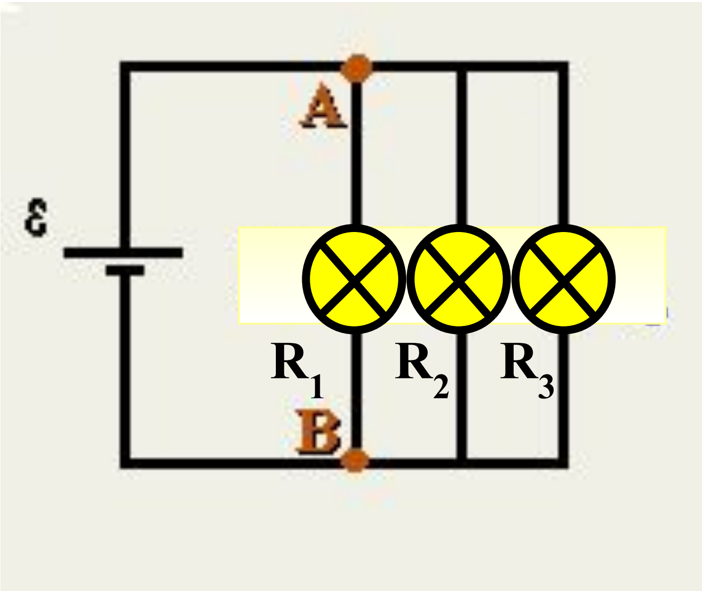
The circuit with the greatest total current!

Circuit I has lower Resistance,

thus greater Current! $P=I^2R$

Given: R1=1Ω; R2=2 Ω; R3=3 Ω. Rank the bulbs according to their relative brightness

1. $R_1 > R_2 > R_3$
2. $R_1 > R_2 = R_3$
3. $R_1 = R_2 > R_3$
4. $R_1 < R_2 < R_3$
5. $R_1 = R_2 = R_3$



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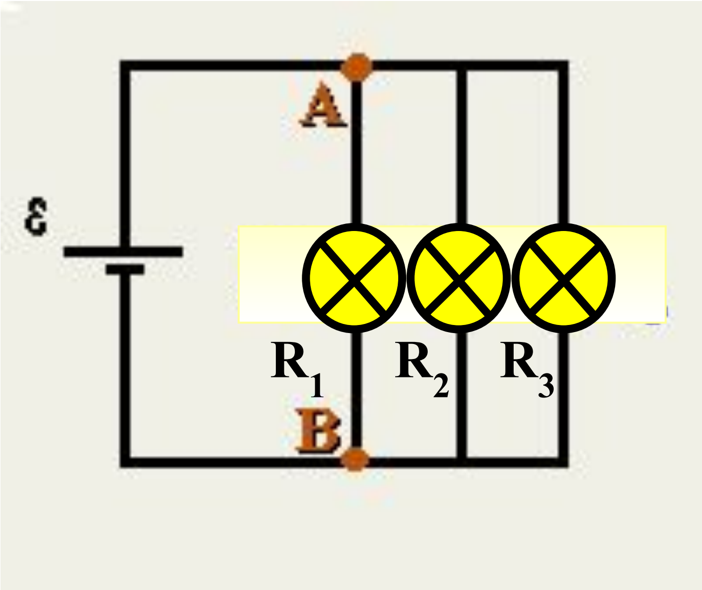

$$P = IV = I^2R = \frac{V^2}{R}$$

Q