Compare the brightness of bulb **A** with bulb **B**. Bulb **A** is _____ bright (POWER) as bulb **B**. All bulbs are identical.

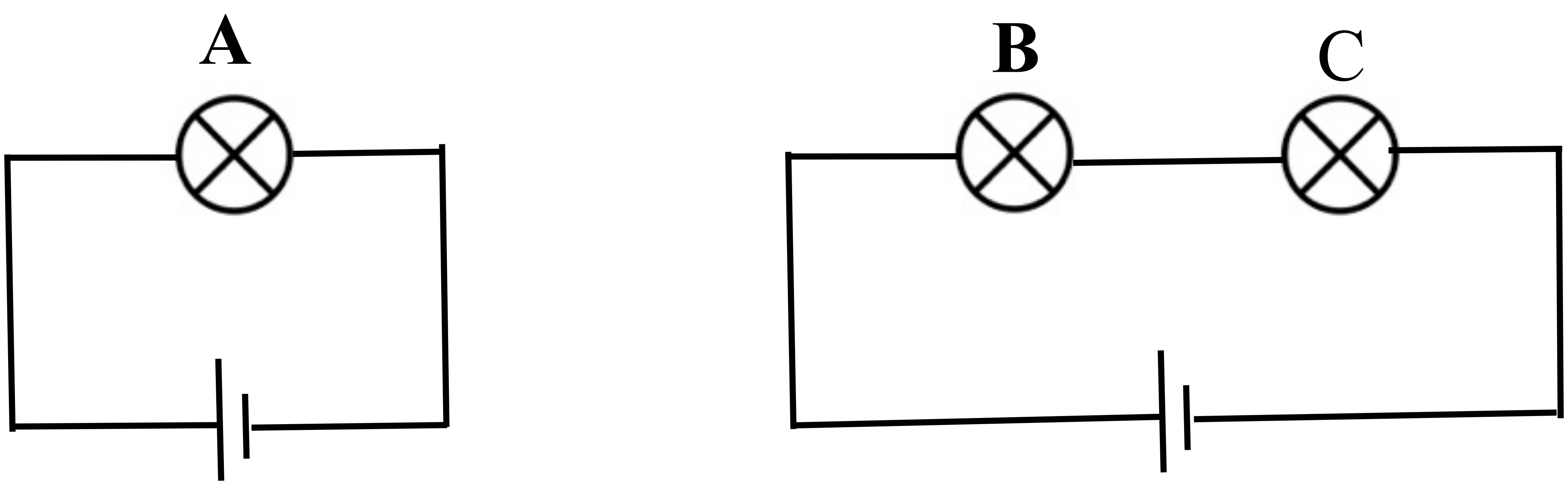
A) Four times as

B) Twice as

C) Equally

D) Half as

E) One fourth (1/4) as



If you increase the resistance C, what happens to the brightness of bulbs A and B?

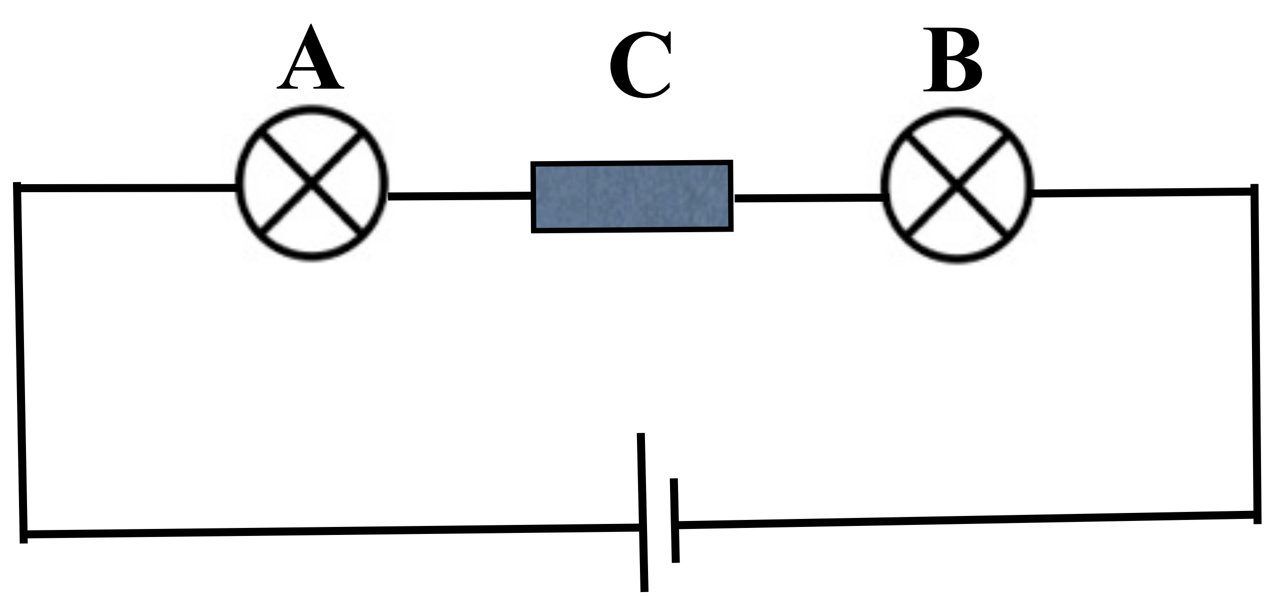
A) A stays the same, B dims

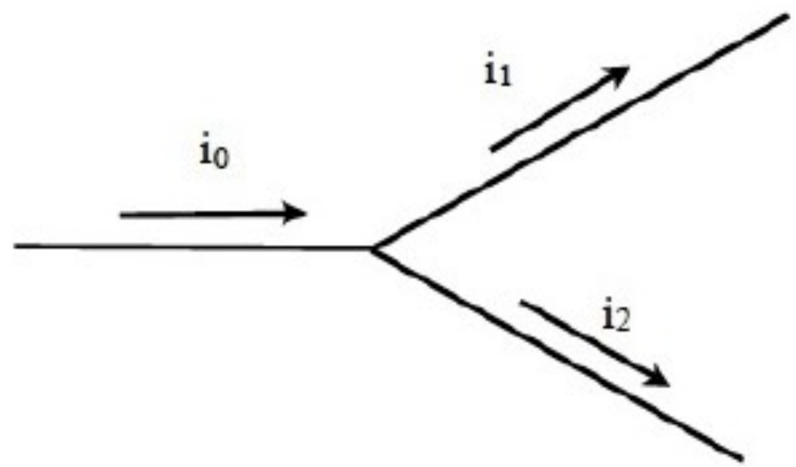
B) A dims, B stays the same

C) A and B increase

D) A and B decrease

E) A and B remain the same





$$i_0 = i_1 + i_2$$

What happens to the brightness of bulbs A and B when the switch is closed? Very difficult problem!

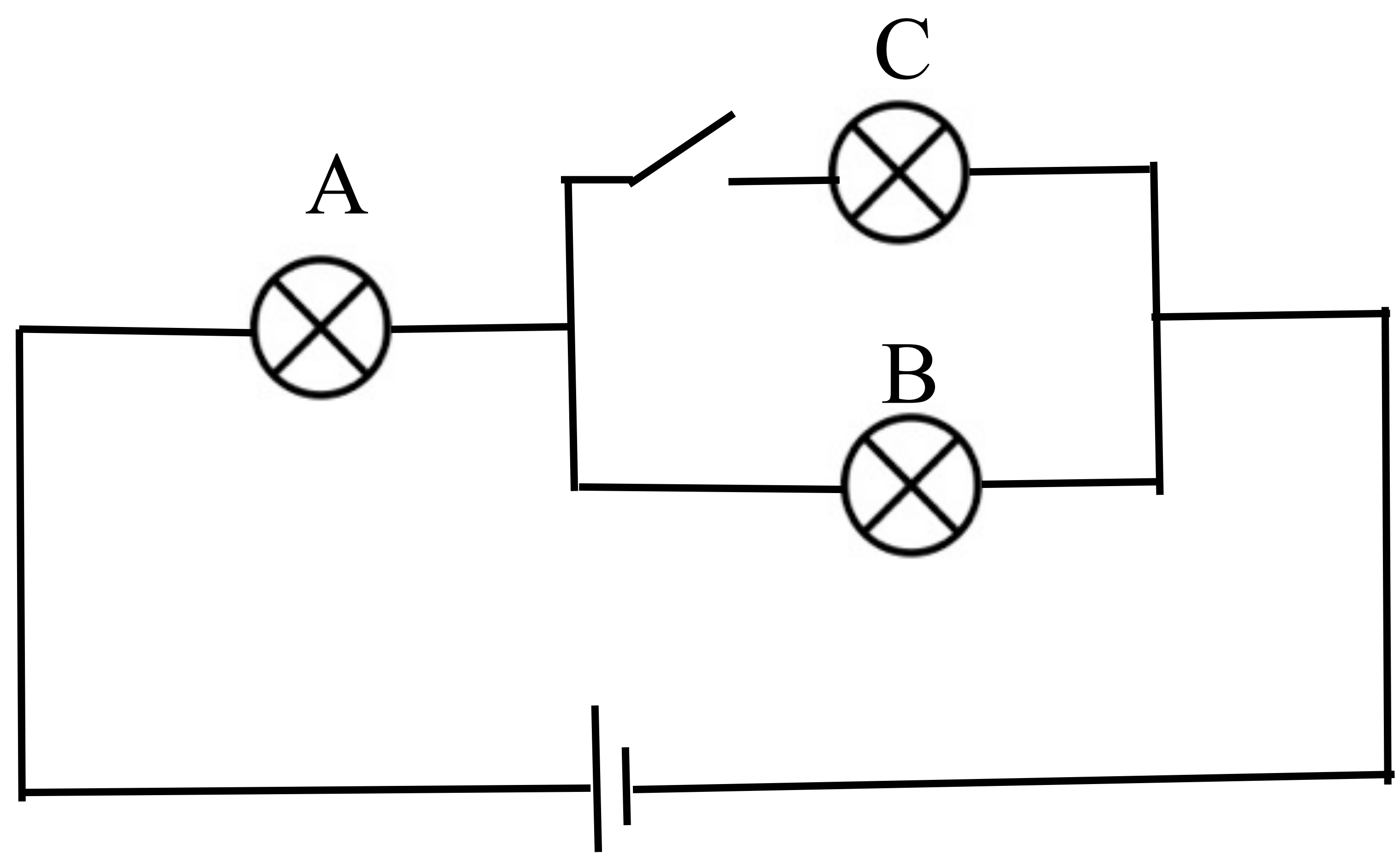
A) A stays the same, B dims

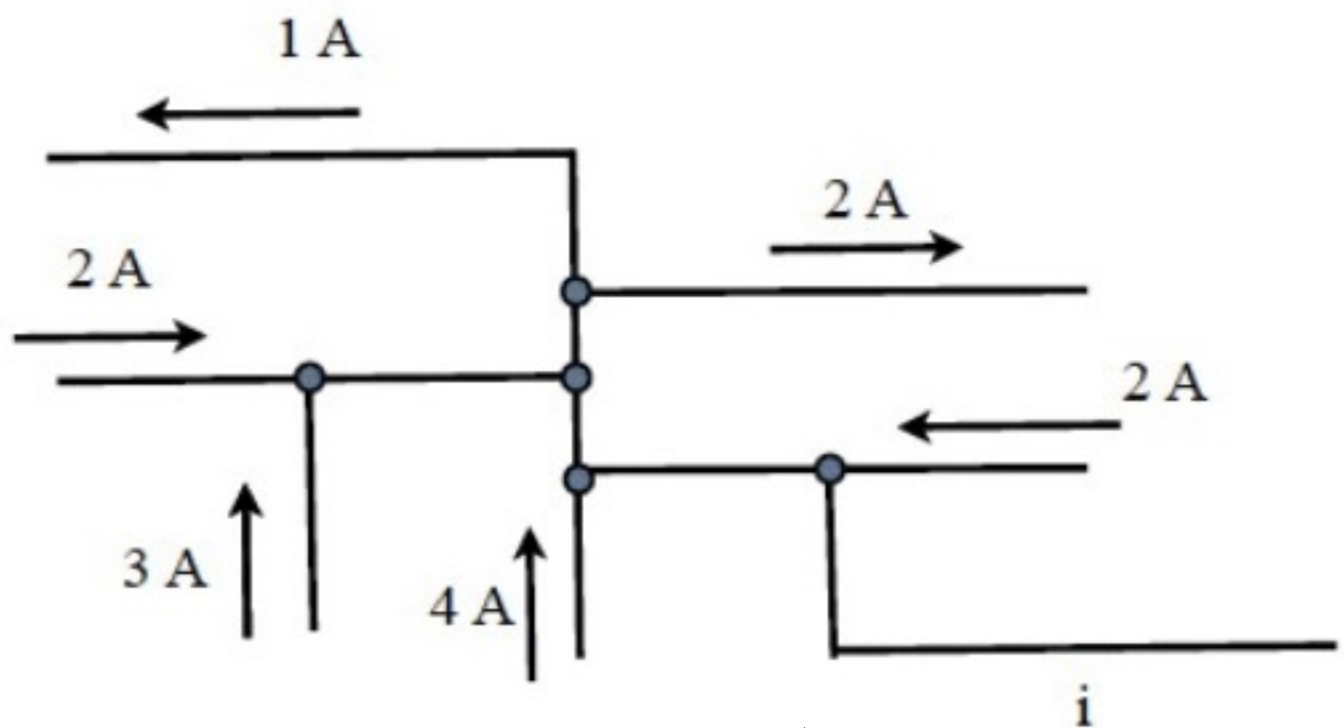
B) A brighter, B dims

C) A and B increase

D) A and B decrease

E) A and B remain the same





Answer: A) 8 A

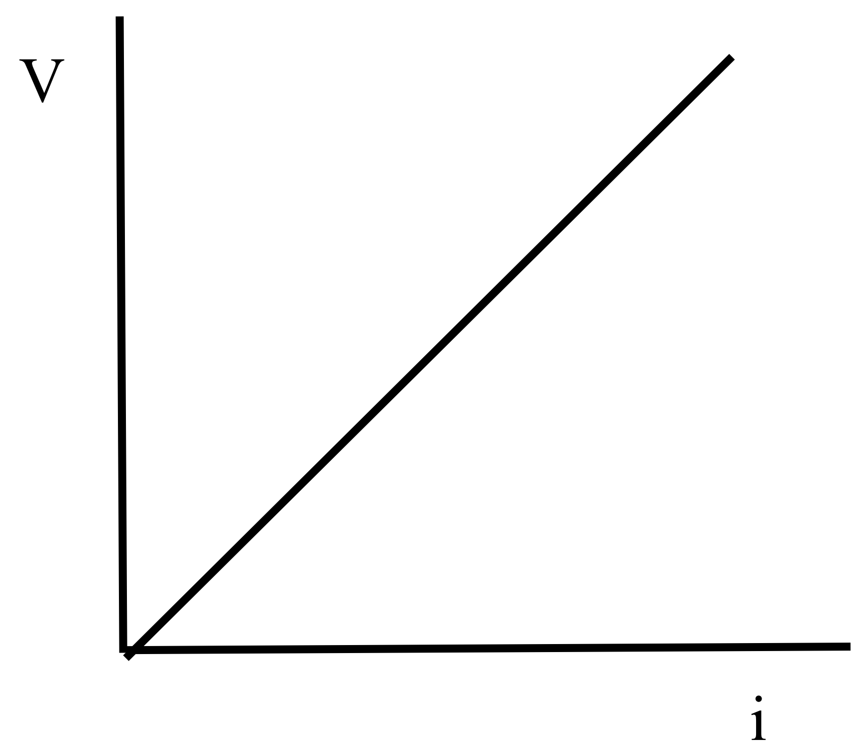
B) 6 A

C) 4 A

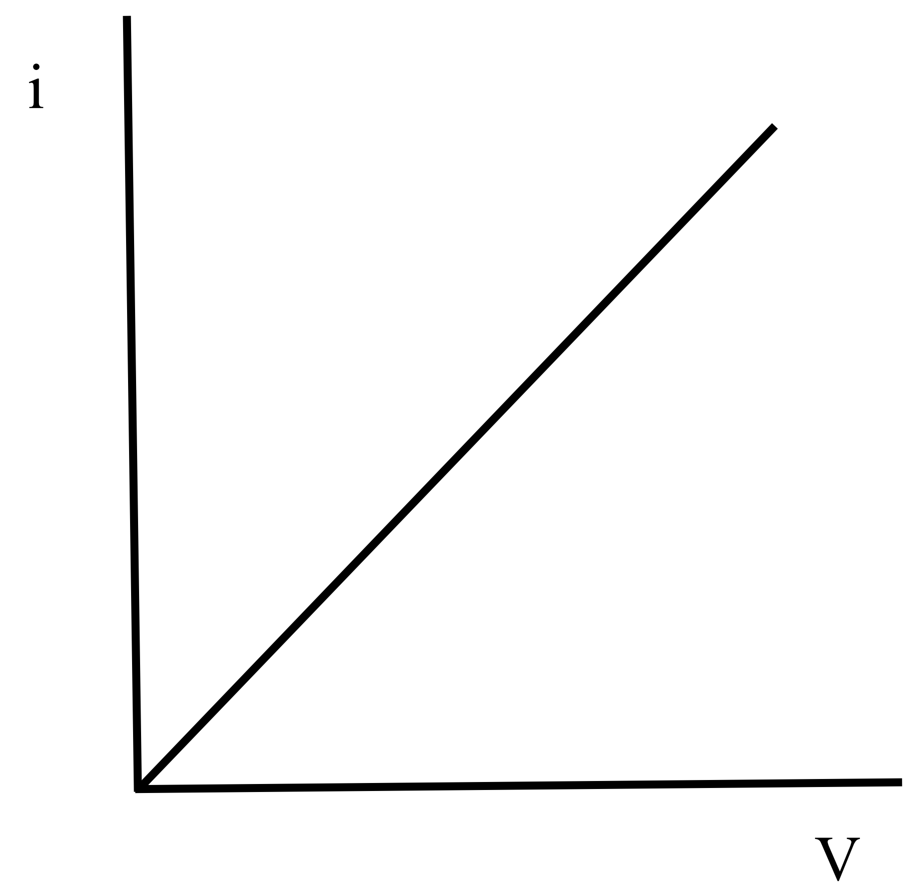
D) 2A

Every algebraic equation can also be represented as a geometric shape on a graph. Thus Ohm's Law can be represented as

$$V = iR$$



The slope or gradient of this line is the resistance R.



The slope of the line is 1/Resistance.

We know that Electric Field, measured in Newtons/Coulomb = Potential, measured in Volts ÷ Distance (measured in metres).

Therefore a Newton/Coulomb is identical to a Volt/metre and we can now call the units of electric field Volts per metre!

You can identify an unknown metal by measuring its conduction properties, **its resistivity**, as illustrated in this example.

A wire of length 2.35 metres and diameter = 1.63 mm carries a current of i = 1.24 Amperes. The wire dissipates energy (you can measure the heat by measuring the temperature rise) of 48.5 mW. Of what is the wire made?

$\rho_{Ag} = 1.62 \times 10^{-8}$
$\rho_{Cu} = 1.69 \times 10^{-8}$
$\rho_{Al} = 2.75 \times 10^{-8}$
$\rho_{Fe} = 9.68 \times 10^{-8}$

A 100 W light bulb is connected to a standard 220 V household electrical system.

a) Assuming electricity costs about 2 Rand per kw-hr, what does it cost to leave the light burning continuously for a month?

b) What is the resistance of the bulb?

c) What is the current in the bulb?

d) Is the resistance different when the bulb is turned off?

A) Yes   B) No

To cause a current to flow on a continuous basis, a continuous source of energy is needed. A common source is a *battery*. A battery can push a current around a circuit. But this takes energy and the battery needs a source for the energy it supplies to create the current. In a battery, that energy comes from a chemical process, changing chemical energy into electrical energy.

In going around the circuit, the current loses energy. When it comes to the negative terminal of the battery, the battery then lifts the charges up to the positive terminal, using chemical energy to do the work required to lift positive charge from the negative terminal to the positive terminal, opposite to the electric field. The battery works like a *lift* or *escalator* to bring the charges up to a higher level.

Some people believe that charge is "stored" in a battery. We use words like discharge and recharge batteries as if we use charge up and then put it back.
Batteries do ***not*** store charge, they store energy. This energy is in the form of chemicals. It can be transformed into the mechanical energy of pushing electrons through a wire, into thermal energy as the wire gets hot, or into light energy if there is a bulb somewhere. Many forms of energy are possible but all come from the chemicals in the battery.

Inside the battery, charge is moving. Moving charge always encounters a resistance, as the charges have to “push” their way through the material. Even in the battery this is true. So there is even some resistance within the battery. The battery’s inherent potential, the amount of chemical energy is called its emf. This is not a good or accurate term (electromotive force) as it is not a force but an energy. Still, it is the historical term. The symbol for it is a script E, .

If we call this resistance inside the battery, its internal resistance and denote it by *r* to distinguish it from the external circuit resistances *R*, then the actual voltage available for the circuit will be $V_{real} = emf - ir$ where *i* is the current flowing. The battery’s potential will be equal to the emf (the number printed on it) only when the current is zero.

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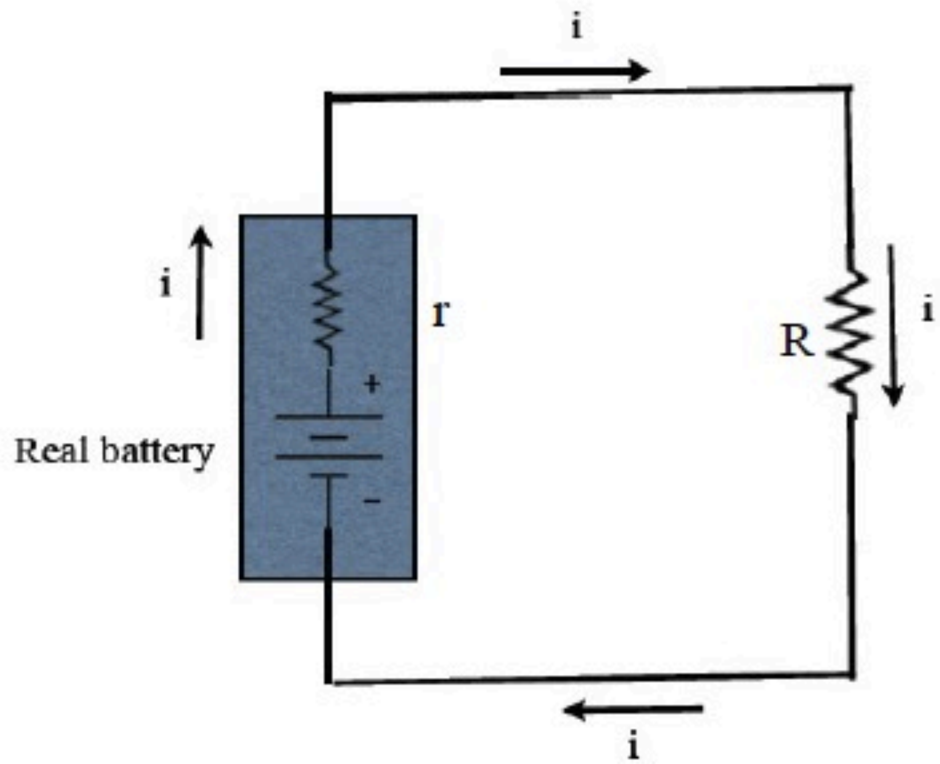
It is not a dream of motor cars and high wages merely, but a dream of social order in which each man and each woman shall be able to attain to the fullest stature of which they are innately capable, and be recognised by others for what they are, regardless of the fortuitous circumstances of birth or position.

If you get to solve it for yourself, you are doing the thinking. There is an “aha!” kind of sensation: “I’ve figured it out!” - and it’s not that someone just told it to me. And because I can figure it out now that means I can figure it out on the exam, I can figure it out for the rest of my life.

Circuit Loop Rule

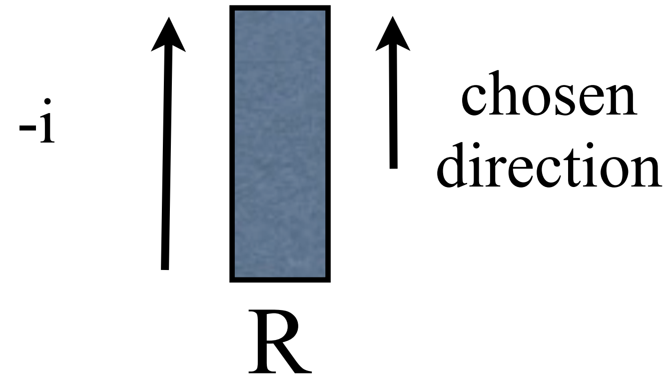
This is the crucial step in analysing any circuit problem, of which you will see many.

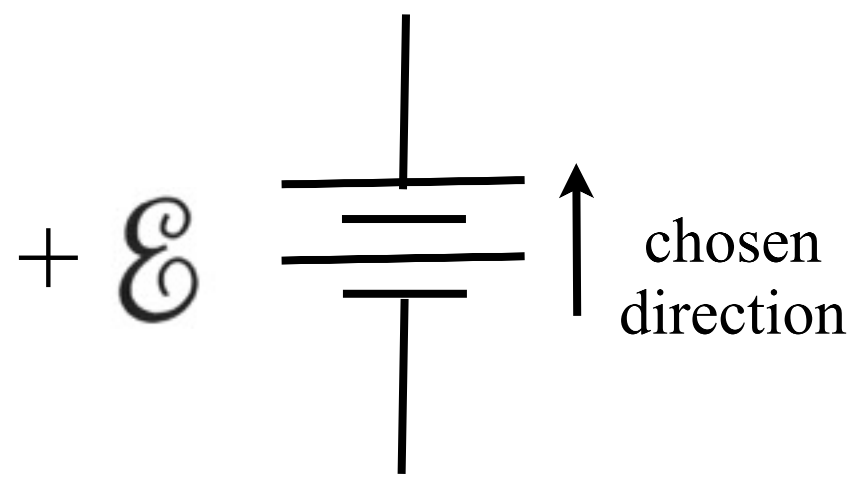
To find the potential difference between any two points in a circuit, start at one point and go around the circuit, following any path you choose and in any direction you choose, and add algebraically the changes in potential that you encounter.



Going around this loop in a clockwise direction, and realising that the voltage decreases through every resistor, we have $\mathcal{E} - ir - iR = 0$ or $i = \mathcal{E}/(R + r)$

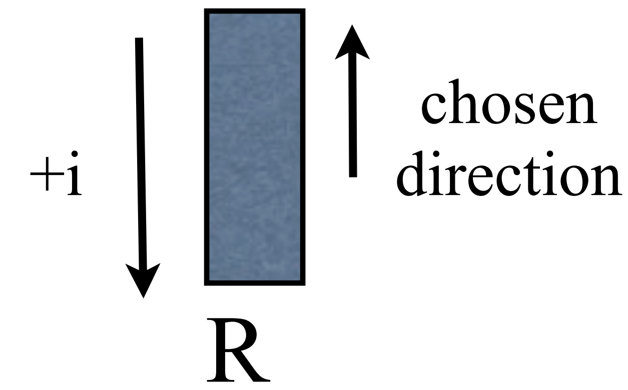
Voltage gets smaller going through the resistor

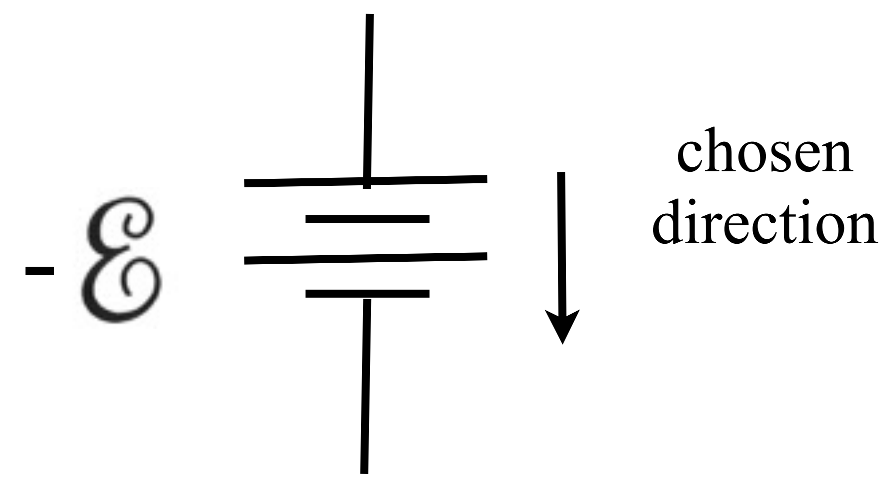




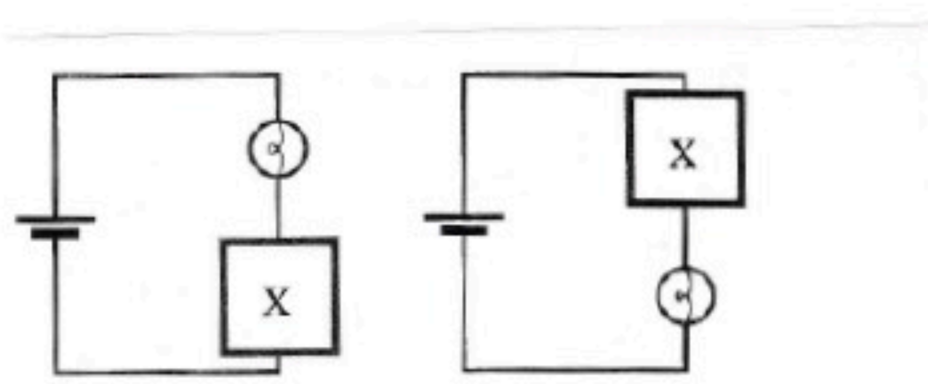
Voltage gets bigger going through the the battery

Voltage gets bigger going through the resistor





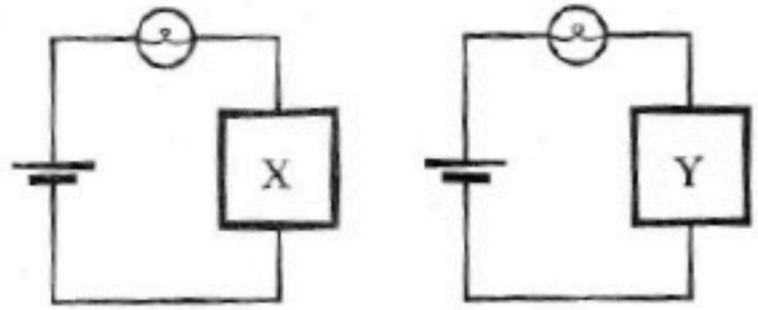
Voltage gets smaller going through the the battery



Which bulb is brighter?

A = left picture
B = right picture
C = both the same
D = need more information

Using the same choices, which current is greater?



The bulb on the left is brighter than the bulb on the right.
Compare the resistance of X with that of Y

A: X > Y

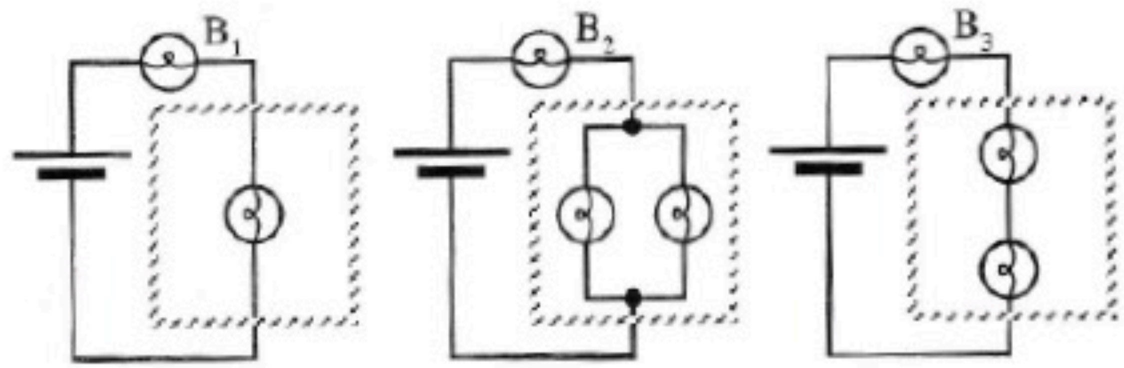
B: X < Y

C: X = Y

D: more information needed.

Using same choices, compare the currents through X and Y.

Using the same choices, how does the current through the bulb compare in each case.



The batteries and bulbs are all identical.

Which bulb is brightest?

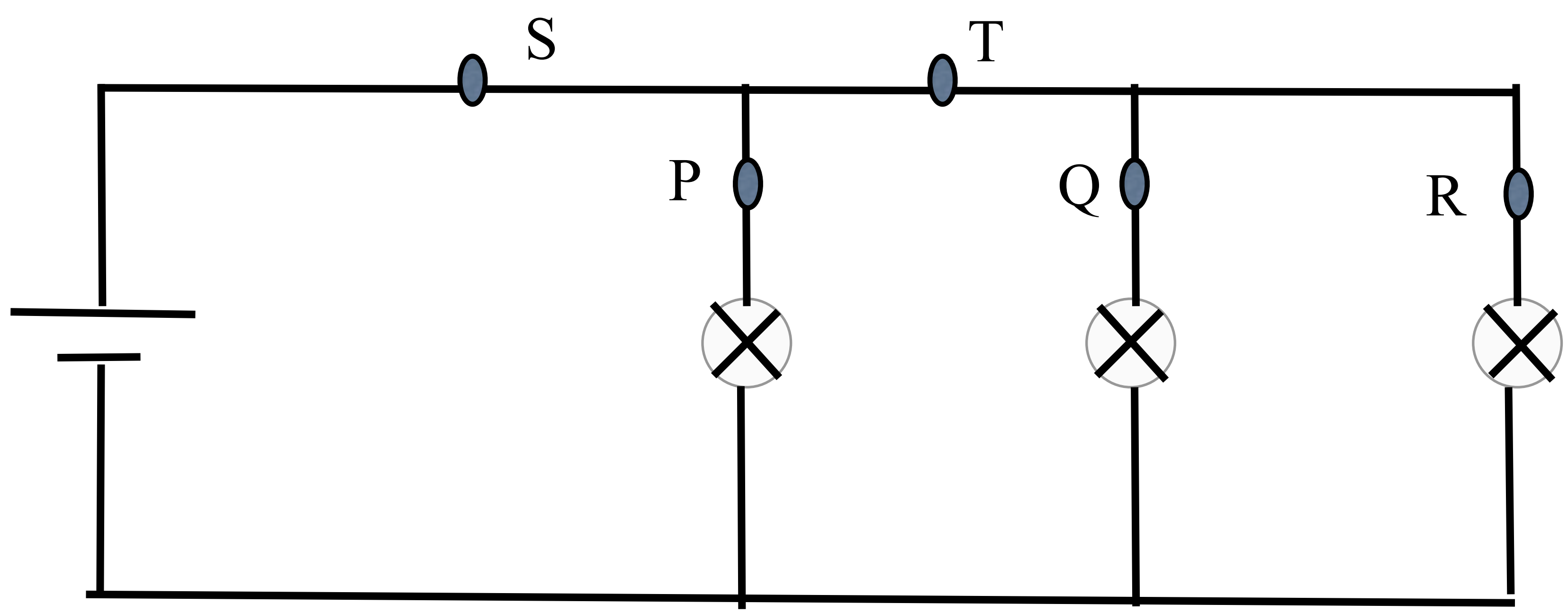
A: B_1

B: B_2

C: B_3

D: more information needed

Using the same choices, which circuit has the greatest current provided by the battery?



In the circuit shown, all the bulbs are identical. The current at P is 0.2 amps. What are the currents at

a) Q
b) R
c) S
d) T

A) 0.0 Amps
B) 0.2 Amps
C) 0.4 Amps
D) 0.6 Amps

The circuit shows two identical resistors connected in parallel to a battery with no internal resistance. How do the readings on the Voltmeter V and the ammeter A change when the switch S is closed?

	Voltmeter	**Ammeter**
A)	increases	decreases
B)	stays the same	increases
C)	decreases	increases
D)	stays the same	decreases