Y8 Electricity Summary Booklet

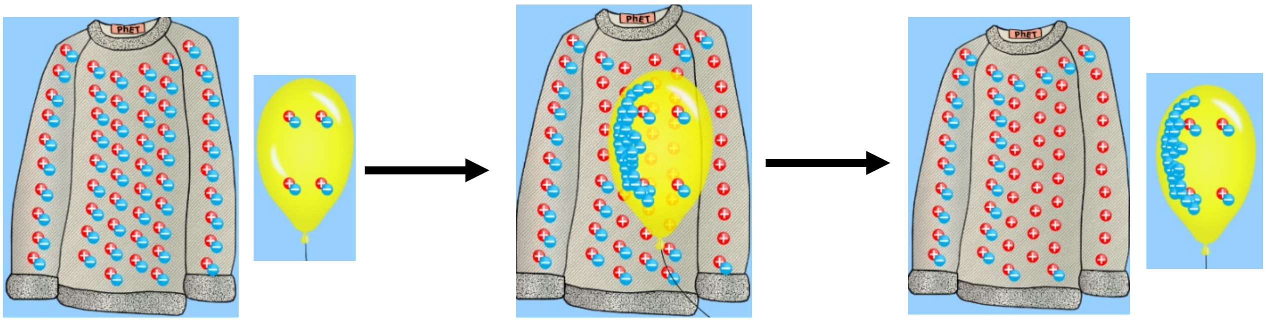
Static Electricity

Materials are made up of atoms. Atoms contain positive and negative charges. Materials are not usually electrically charged because their atoms contain the same amount of positive and negative charge.

Rubbing two materials together may result in them becoming charged. During rubbing, **negatively charged electrons** are rubbed off one material and onto another due to the **friction** between the surfaces.

- The material that **gains electrons** becomes **negatively charged**
- The material that **loses electrons** is left with a **positive charge**

Static electricity is the build-up of **electrical charge** on the surface of an object.



Before Rubbing

Neither object is electrically charged. The particles contain an equal amount of positive and negative charge.

During Rubbing

Friction between the jumper and the balloon causes **negatively charged electrons** to move from the jumper onto the balloon.

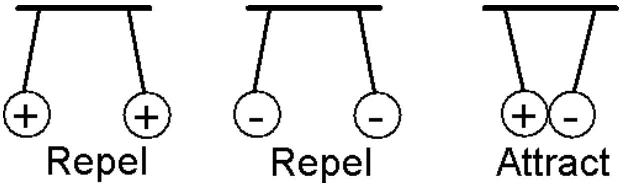
After Rubbing

The jumper has lost electrons and so it has an overall positive charge.
The balloon has gained electrons so it has an overall negative charge. The electrons are "static" on the balloon because the material is an insulator and the electrons cannot move easily.

It's called "static" electricity because the charges remain in one area rather than moving or "flowing" to another area. Static electricity builds up on **insulating materials** like plastic or rubber because the electrons cannot flow through these materials easily.

Materials that have the same charge will **repel**.

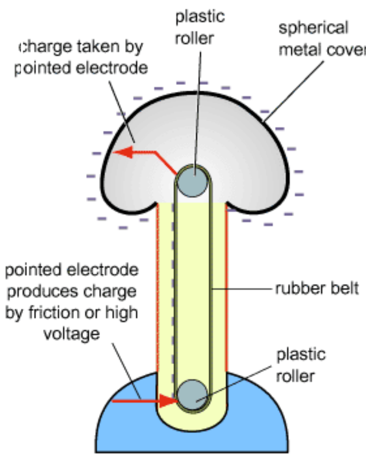
Materials that have opposite charges will **attract**.



Van der Graaf example

The rubber belt of the Van der Graaf becomes charged due to the friction between the belt and the plastic. The charge then passes onto the person touching the dome and spreads over the surface of the body. Each strand of hair has the same charge and so they repel.

Charge is transferred to the metal dome



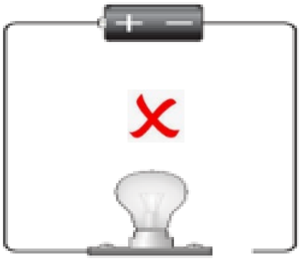
Electrons move onto the rubber belt from the plastic roller due to friction between the materials

Current Electricity

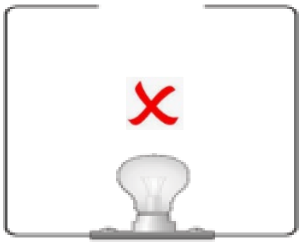
Energy can be transferred from one store to another by an electric current. In electricity, the energy is transferred by a flow of small negatively charged particles called **electrons** moving through wires.

For an electric current to flow you need two things:

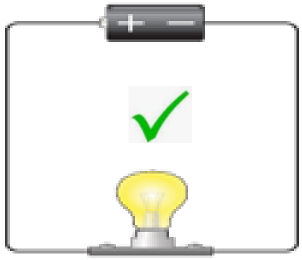
- Something to make the electricity flow, such as a **cell** or a power supply.
- A path for the current to flow in with no gaps. This is called a **complete circuit**.



No current - **Incomplete circuit** due to gap in the wire



No current - **Missing cell**



This is a **complete circuit** with a cell so there is an electric current.

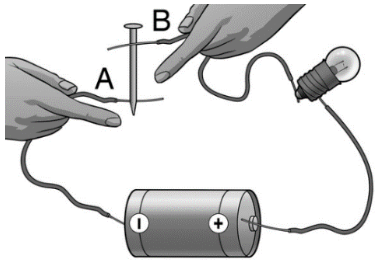
Insulators and Conductors

Electrical current is the flow of **electrons** through a circuit. Electrons **cannot flow** easily through materials that are **insulators.** Electrons **can flow** easily through materials that are **conductors.**

We can test whether a material is an electrical conductor or insulator by inserting the material into a circuit containing a bulb and a cell.

- If the bulb lights up then it shows that the material has completed the circuit and a current can flow. This means that the material is a **conductor**.

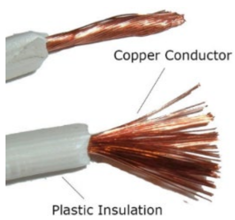
- If the bulb does not light up then it shows that the circuit is still incomplete and the current cannot flow. This means that the material is an **insulator**.



The table below shows the results for some common materials.

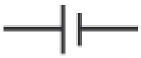
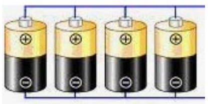
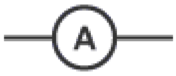
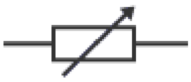
Material	Does the bulb light?	Conductor or insulator?
Copper	Yes	Conductor
Wood	No	Insulator
Aluminium	Yes	Conductor
Plastic	No	Insulator
Glass	No	Insulator
Rubber	No	Insulator

Metals are good conductors of electricity because they already contain a lot of free electrons that can move around easily. Wires are usually made from copper and are surrounded by a layer of plastic for insulation.



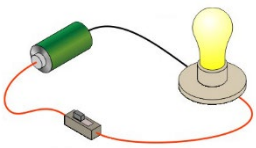
Circuit components and symbols

Circuits are made up of different components. Some of the common circuit components and their functions are listed below.

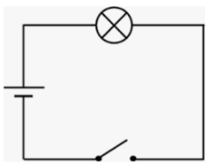
Component	Picture	Symbol	Function
Wire			Connects components in a circuit. Made of metal (as metals are good conductors)
Cell			Transfers energy to the electrons and pushes them through the wires to create an electrical current
Battery			2 or more cells connected.
Bulb			Transfers energy away from the circuit by light and heating
Switch			Can be used to break and complete circuits
Ammeter			A device that measures the current in a circuit. Must be connected in series.
Voltmeter			A device that measures how much energy is being transferred by a current. Must be connected across components in parallel.
Resistor			A component that makes it difficult to the electricity to flow – resistors are used to reduce the size of the current in a circuit.
Variable Resistor			Used to reduce the current flow in a circuit. Its resistance can be changed.

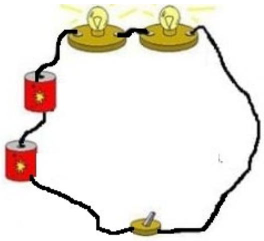
When drawing a **circuit diagram**, we must use a set of standard symbols (shown above). These exact symbols must be used, and **wires should always be represented by straight lines** drawn with a pencil and ruler.

For example:

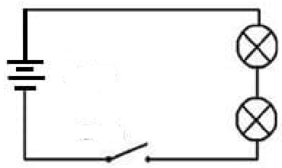


1 cell connected to a switch and a bulb would be represented by the diagram on the right.





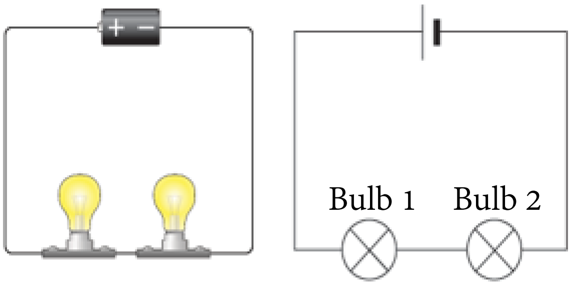
A battery of 2 cells connected to a switch and 2 bulbs would be represented by the diagram on the right



Series circuits

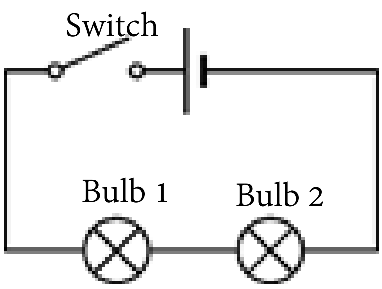
There are two types of circuit we can make, called **series** circuits and **parallel** circuits.

- If all of the components are joined together in **one loop** then it is called a **series** circuit. There is only one path for the current to flow through.

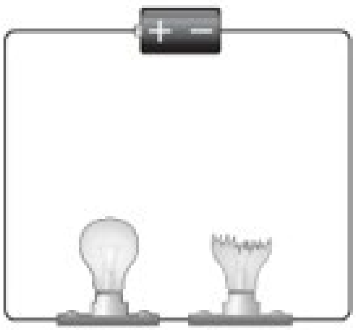


A circuit containing a cell and 2 bulbs in **series**. There is only one path for current to flow. Each electron will always pass through both bulbs.

If there is a gap anywhere in a series circuit then the current will not flow. Gaps may be created by opening a switch or a bulb breaking.



In this **series** circuit the switch controls both bulbs. If the switch is open, the circuit is incomplete the current cannot pass through either bulb. If the switch is closed, the circuit is complete and the current passes through both bulbs.



When one bulb breaks in this **series circuit**, a gap is created and so the circuit is incomplete. This means a current cannot flow anywhere in the circuit and so neither bulb glows.

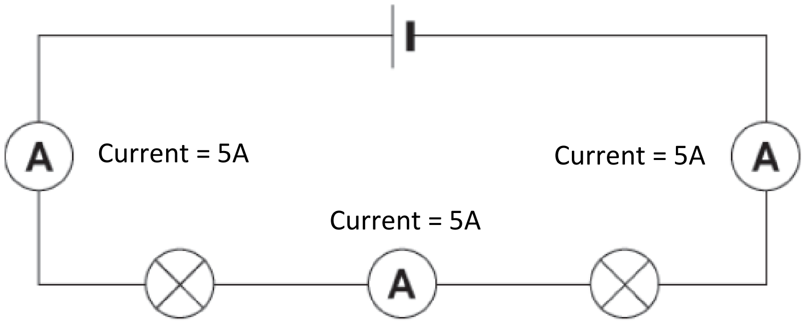
Current in series circuits

Current is a measure of the amount of charge flowing per second. The **unit** for current is amperes or "**amps**". The unit is usually written as "A". For example 20A is a bigger current than 5A.

We measure the current in an electric circuit using a device called an **ammeter**.

Ammeters must always be connected **in series** (in the same loop as the components).

- The amount of current is the **same everywhere** in a **series** circuit. This is because there is only one path the electrons can take and so the rate of charge flow must be the same everywhere.



An ammeter will give the same value of current no matter where it is placed in a series circuit.

Voltage

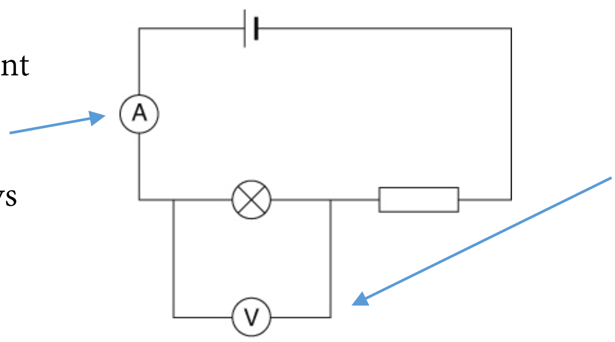
Voltage is the energy that is transferred to or from an electrical charge when it moves through a component. The voltage from the cell can be thought of as providing the "push" the electrons need to transfer energy through the circuit.

The **unit** for voltage is **volts**, usually written as "**V**". For example, a 15V cell provides more energy to the circuit than a 2V cell.

Voltage is measured using a device called a **voltmeter**. A voltmeter must be connected in a circuit on either side of the component you are investigating, in its own loop This is called connecting in **parallel.**

This ammeter is measuring the current through the circuit.

Ammeters are always connected **in series** (in the same loop)



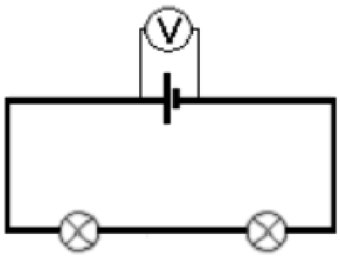
This voltmeter is measuring the voltage of the bulb (the amount of energy transferred by the charge at the bulb)

Voltmeters are always connected in **parallel** (connected either side of the component you are measuring)

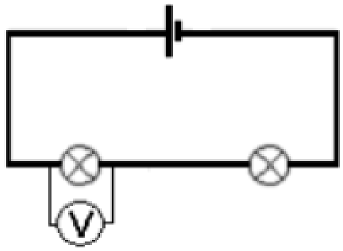
Voltage in series circuits

The voltage provided by the cell, is shared between the other components in a series circuit.

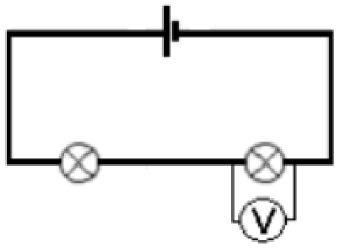
For example,



Voltage across the cell = 6V



Voltage across bulb 1 = 3V



Voltage across bulb 2 = 3V

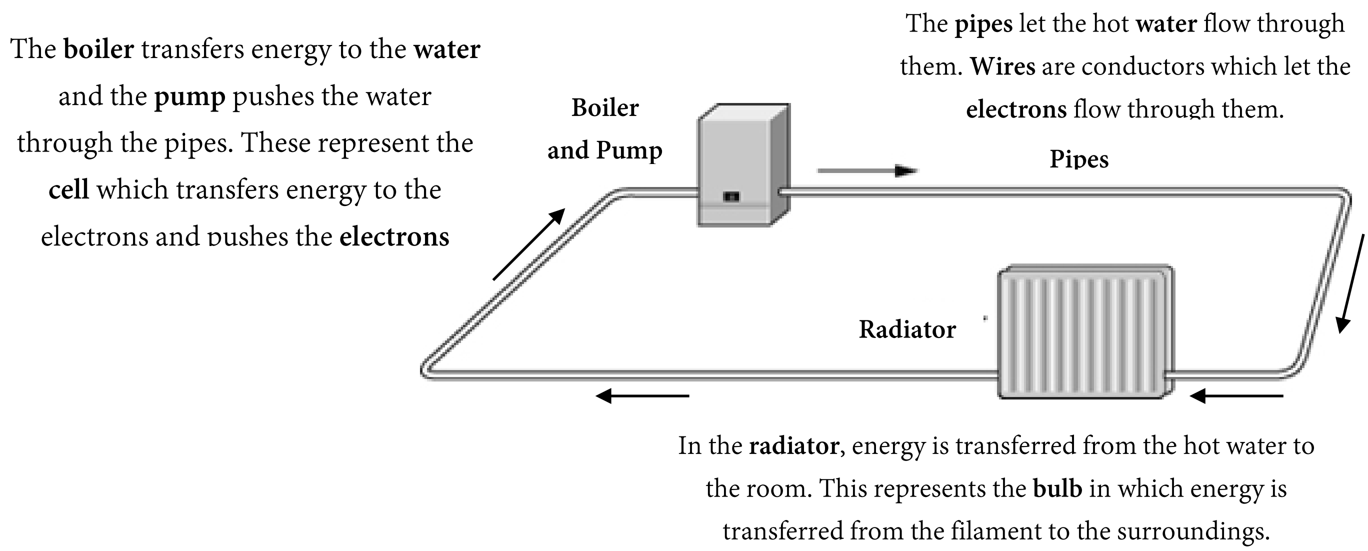
In this example, the cell provides a voltage of 6V. This is shared between the 2 bulbs and each uses 3V.

- If one bulb was removed, the remaining bulb would use all 6V and would be twice as bright (as twice as much energy is being transferred to the bulb)
- If one bulb was added, the 6V would have to be shared between 3 bulbs and each bulb would only receive 2V. This means that less energy is transferred to each bulb and so each would be dimmer.

Electricity models

A **model** is a way of showing or representing an idea. In science, we use models to help us think about complicated ideas. We can use models to help us to think about what happens in electric circuit.

One model for a circuit is a central heating system. The boiler and pump represent the cell, the pipes represent the wires and the radiators represent the bulbs.

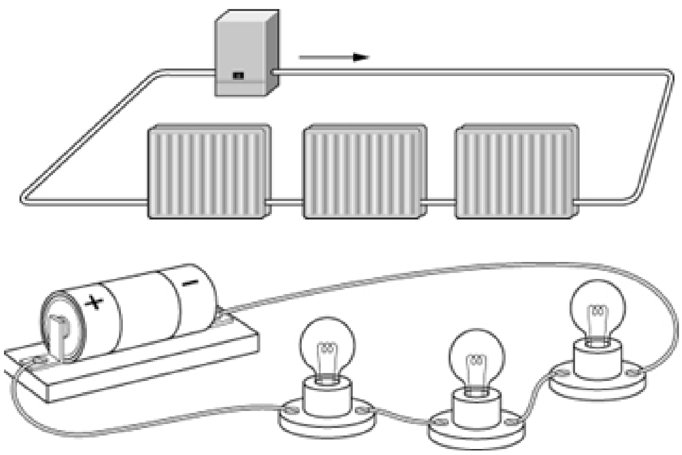


We can use a good model to make **predictions** about what might happen in an investigation.

For example, if you were to measure the amount of water flowing into the radiator and the amount of water flowing out of the radiator you would get the same value as all of the water stays in the pipes. This explains why current is the same everywhere in a series circuit.

We could also use this model to predict what would happen if we add more bulbs to a series circuit. Adding more radiators would make it harder for water to flow around the system, and each radiator would not be as hot as the energy would have to be shared between them.

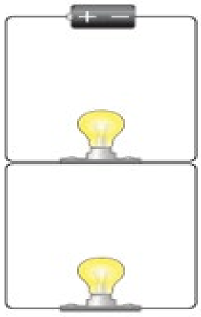
This would lead us to predict that adding another bulb to a series circuit would make the current smaller and each bulb would be dimmer as the energy has to be shared between the bulbs.

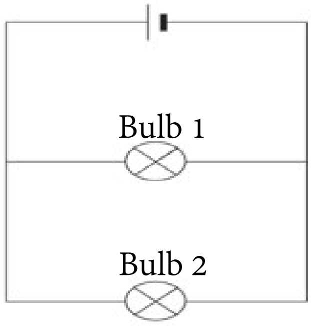


Parallel circuits

There are two types of circuit we can make, called **series** circuits and **parallel** circuits.

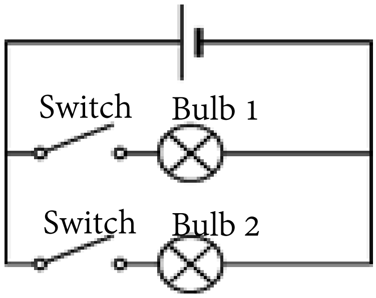
- In a **parallel circuit** there is **more than one path** for the charges to flow. The circuit contains components on two or more **branches** that split apart and join up again.





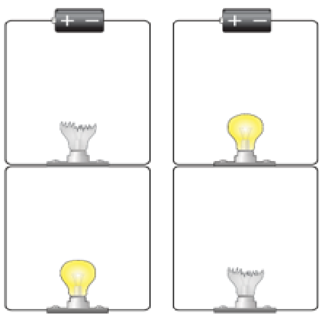
A circuit containing a cell and 2 bulbs in **parallel**.

There is more than one path for the current to take and so it must split when the circuit branches. After leaving the cell, electrons will **either** pass through bulb 1 before returning to the cell, **or** they will pass through bulb 2 before returning to the cell.



Bulbs connected in a **parallel** circuit can be controlled by different switches.

- Switch A controls bulb 1. When switch A is closed it completes the loop that bulb 1 is part of and a current can flow through the bulb.
- Switch B controls bulb 2. When switch B is closed it completes the loop that bulb 2 is part of and a current can flow through the bulb.

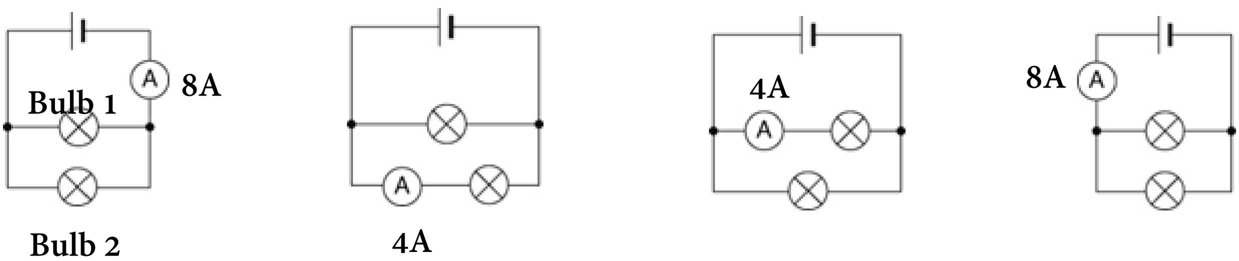


Parallel circuit - when one bulb breaks there is still a complete circuit for current to flow and so the other bulb remains lit.

Lights in houses are usually connected in a parallel circuit so that different switches can control different bulbs and so that it doesn't affect off all of the bulbs when one bulb breaks.

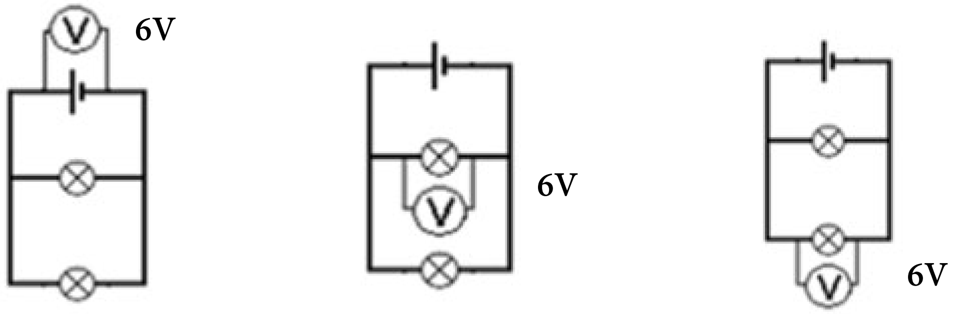
Current and voltage in parallel circuits

In a parallel circuit the current is split at each branch. This means that the total current through the whole circuit is the sum of the current through each branch.



In this example, 8A of current passes through the cell. At the split, 4A goes through one branch through bulb 1 and the rest goes through the other branch through bulb 2. The current then returns to 8A where the branches meet.

In a parallel circuit, the voltage across each component in parallel is the same.



In this example, the cell supplies 6V. As the electrical charge can only go through one of the loops, it only passes through 1 bulb before returning to the cell. This means that each bulb is provided with 6V.

Resistance

The **resistance** of a component is a measure of how difficult it is for an electrical current to flow through it.

- High resistance = hard for electricity to flow = small current
- Low resistance = easy for electricity to flow = large current.

High resistance path – It is difficult for the people to get past the obstacle and so they get through the course

Low resistance path – It is easier for the people to get past the obstacle and so they get through the course

All circuit components have a resistance, including wires. Thicker, short wires have a lower resistance than thinner, long wires.

Each time a bulb, or resistor, is added to a series circuit, the current goes down (and so the total resistance of the circuit has increased)

Each time a bulb, or resistor, is added into a parallel circuit the overall current increases. This is because it is easier for the current to flow with more branches because there are more paths for the electrons to take.