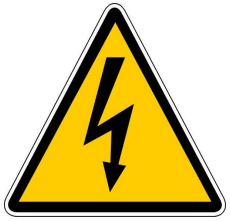
Current Electricity



What we will learn,

3C3	Current electricity Voltage	current as a flow of charge; measuring current; measuring potential difference (voltage) and resistance (for metallic conductors) relationship between voltage, current and resistance; direct and alternating current; heating, chemical and magnetic effects of an electric current; conductors and insulators
3C4	Electric circuits	simple circuits—series and parallel; function of a switch

Conductors and Insulators

An electric current is a flow of electric charge.

Set up a simple electrical circuit and insert various objects/materials into the circuit.
We want to see which materials allow electricity to flow.

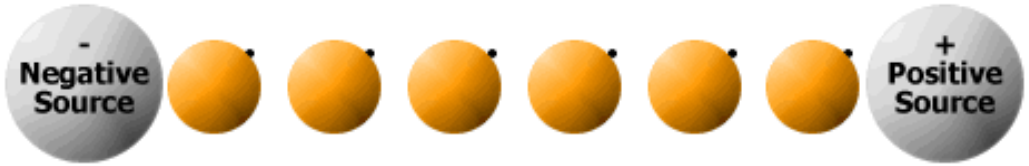
✓ X

Material	Wood	Metal	Plastic	Water	Salt Water
Bulb Lights?					
Conductor					
Insulator					

A substance that allows a current to flow is known as a Conductor
A substance that stops a current from flowing is known as an Insulator

Why/How do you think a conductor allows electricity to flow?

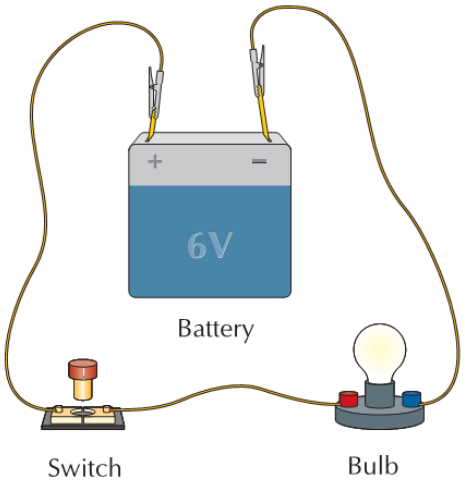
A Conductor has many free electrons that allow the charge to flow.

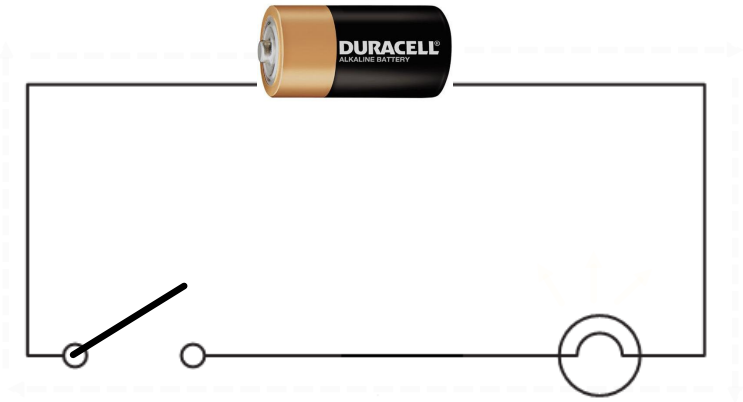


A Resistor does not have many free electrons and flow is stopped.

Electrical Circuit

The Circuit below shows a switch and bulb connected to a battery.
When the switch is open the current will not flow.
When the switch is closed the current will flow and the bulb will light.

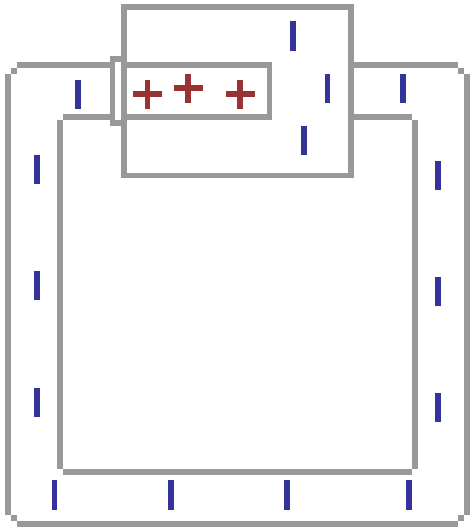




SIMULATION

Simple Electrical Circuits

Circuits must be **complete**. Any break in the circuit and the electricity stops flowing.



Potential Difference – a circuit must have a difference in electrons from one side to another so that the electricity can flow. This is called **voltage**. Voltage is the build up of minus charges. It can be measured using a Voltmeter.

Current – is the way that the electricity moves.
The electrons are pushed around the circuit by the voltage.
An ammeter is used to measure current.
The current flows **through** the wire.

Racing Car Game

This racing car game has no electricity or batteries attached.
All the power to move the cars comes from turning a handle.
The turning handle builds up electrons (**Voltage**).
The voltage pushes electrons around the track causing a **current**.
The current moves the cars around the circuit.

Questions

What happens if you turn the handle with no car on the track?

What happens when you stop turning the handle?

What happens if you put two cars on the same track?

Resistance

Two cars on the same track slows the current so that the cars only move very slowly.
If three cars were placed on the same track, what would happen?

A light bulb on a circuit does the same thing.
The current gets slowed down in the narrow wire and energy builds up.
The energy is converted to heat and light.

This is known as **Resistance**.
Objects that slow current are called **resistors**.

Resistors are put in mobile phone chargers to lower the current.
These stop your phone from getting too much of a charge and damaging it.

Units of Electricity

Volt (V) – is the unit of **voltage**. It is the measure of the push or power of the battery. 6V or 9V etc.

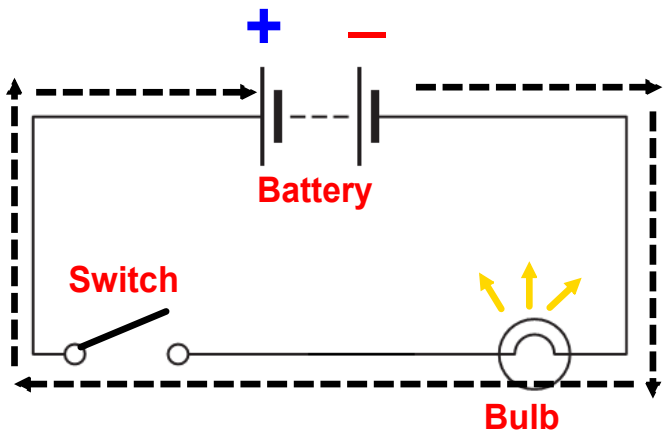
Amp (A) – a measure of **current**. It measures how much electricity passes a point per second.

Ohms – This is the unit of **resistance**. It measures the opposition of part of a circuit to the flow of charge.
The greater the resistance, the smaller the current.

A Resistor

Circuit Diagrams

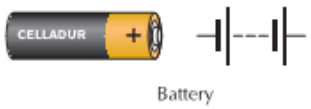
Circuit diagrams are a useful way of showing what a circuit is made of. The diagram shows a battery, a bulb and a switch and the wire connecting them all.



Do you think these diagrams are better than drawing the real parts?

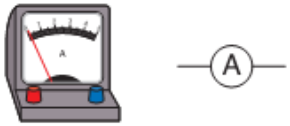
Give some reasons why you think this is a better way of drawing.

Symbols for Electrical Circuits



Battery

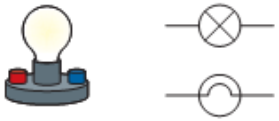
Switch



Ammeter

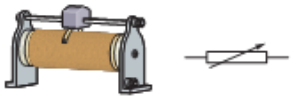
Voltmeter

Earth



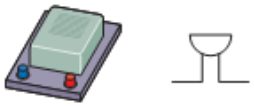
Lamp or bulb

Resistor (fixed)



Variable resistor (or rheostat)

Fuse



Buzzer

Relationship between Voltage, Current and Resistance

In this investigation we will see how voltage, current and resistance effect each other.

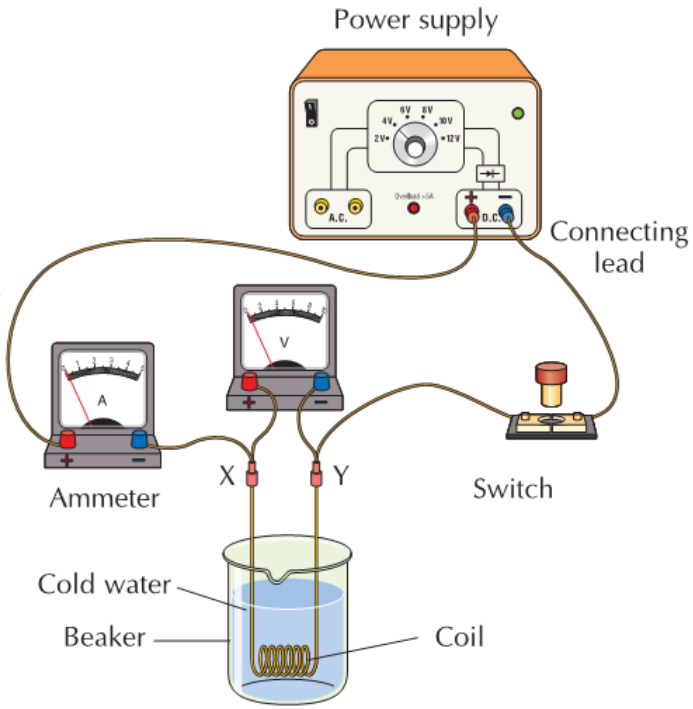
We will set up the following apparatus.

1. Attach the wire coil to the power supply.

2. Attach the Ammeter after this and connect back to the power supply.

3. Finally we have to attach the Voltmeter to either side of the coil so we can measure the drop in voltage.

SIMULATION

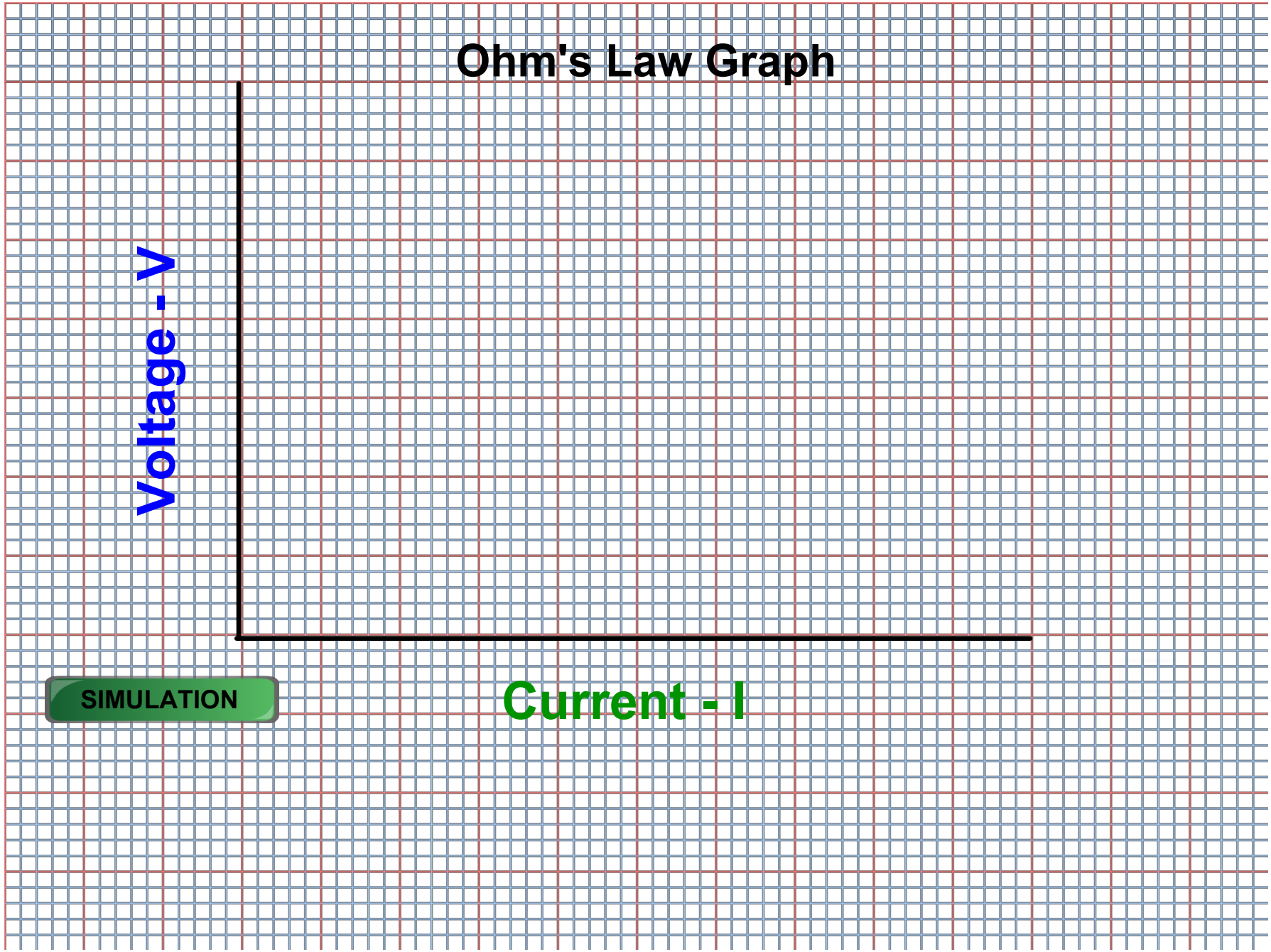


Ohm's Law Experiment

Voltage V						
Current I						
Resistance R						

V = Volts
I = Amps
Ω = Ohms

$$\frac{\text{Voltage (V)}}{\text{Current (I)}} = \text{Resistance (R)}$$


Ohm's Law Graph
Voltage - V
Current - I
SIMULATION

Results/Conclusions

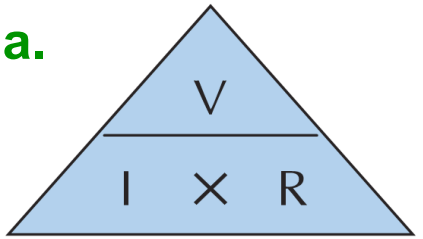
What happens to the current when we increase the Voltage?

What happens to the current when we decrease the Voltage?

What word do we use to describe the relationship?

Do you remember the formula from the previous page?

There is an easier way to remember this formula.



Calculations

Example 1

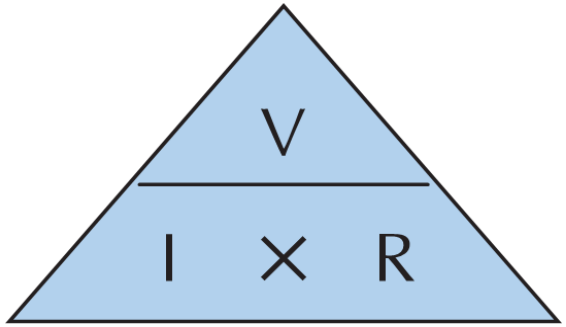
A battery provides a potential difference of 9 volts across a metallic conductor of resistance 5 ohms. Calculate the current flowing.

Use the triangle in *Fig. 45.7*. We are looking for the current, *I*. We cover *I*, in the triangle. We are left with the formula for *I*,

$$I = V \div R$$

$$= 9 \div 5$$

$$= 1.8 \text{ A}$$



Example 2

What voltage is needed to drive a current of 1.5 A through a resistor of resistance 8 Ω?

Using the triangle in *Fig. 45.7*, cover the quantity you are looking for, *V*,

$$V = I \times R$$

$$= 1.5 \times 8$$

$$= 12 \text{ V}$$

Page. 357, Q.45.7, 45.8

Example 3

A bulb in a circuit is connected to an ammeter that reads 0.8 A. A voltmeter across the bulb reads 5 V. What is the resistance of the bulb?

Using the triangle in *Fig. 45.7*, cover the quantity you are looking for, *R*,

$$R = V \div I$$

$$= 5 \div 0.8$$

$$= 6.25 \ \Omega$$

Series Circuits and Parallel

Does anyone watch a TV series?

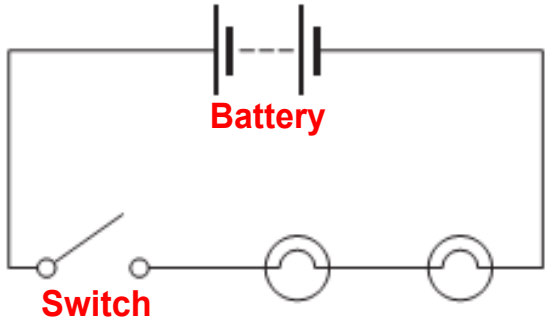
What does series mean?

In a tv series the shows happen in order or in a row.

In a circuit the bulbs can be in a row or in series.

How many bulbs are in this circuit?

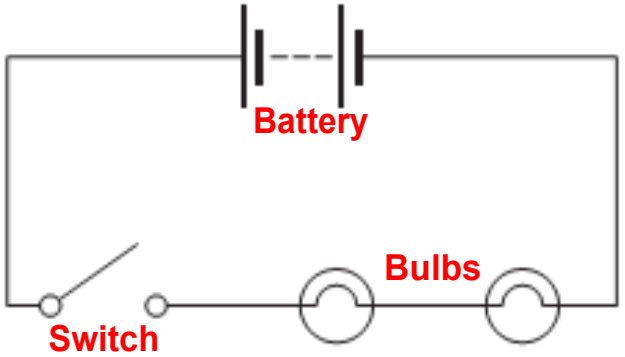
What will happen if we add another bulb?



Series Circuits

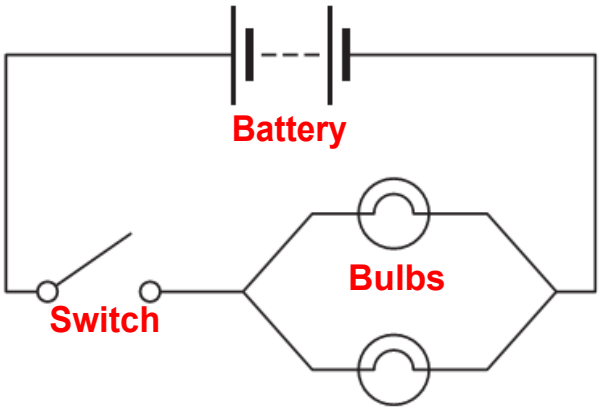
In a circuit where the bulbs are in series we have to see the effect of adding new bulbs to the circuit.

What do you think will happen?
Will they get brighter, stay the same or fade?



Parallel Circuits

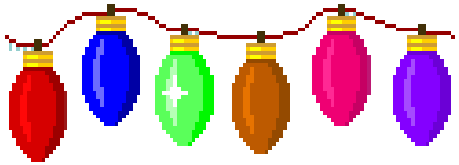
SIMULATION



In this circuit the bulbs are in parallel circuits. We also have to see the effect of adding new bulbs to the circuit.

What do you think will happen?
Will they get brighter, stay the same or fade?

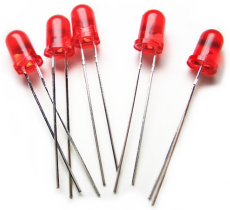
Problems with bulbs in series



In old **Christmas tree lights** the bulbs are in series.
If one bulb blows then the **current stops** flowing in all bulbs.
The bulb must be found and changed.

In modern lights the bulbs are **parallel** and don't go out if one bulb blows.

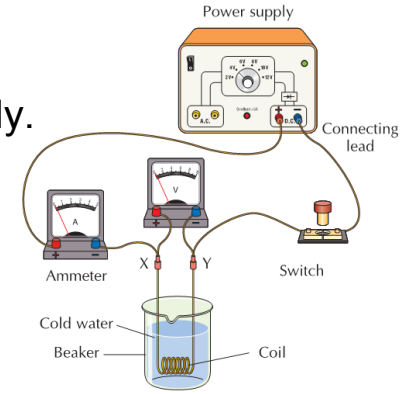
Also, modern bulbs are **LEDs** which last longer and use less electricity than the old type bulbs.



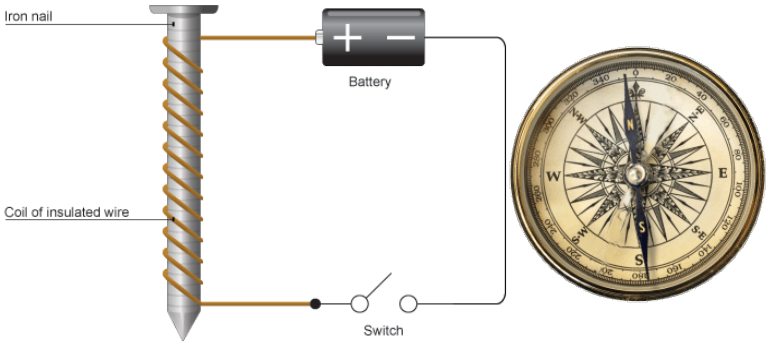
Effects of an Electric Current

1. **Heating effect** - Copper lets the current flow easily.
   Nichrome is a metal wire that resists the current and heats up quickly.
   It is used in electric fires as a heating element.

   Can you think of other uses/applications of the heating effect?



2. **Magnetic effect** - Do you recall what an electric current did to a compass needle?



A current in a wire creates a magnetic field and makes an **Electromagnet**.

Electromagnets are used in, motors, bells, transformers, loudspeakers, scrap-yards and computers.

3. **Chemical effect** - the chemical effect of electricity can be see in Hydrogen cars.
The **electrolysis** of water means that the H_20 is split into H_2 and O_2.
The **Hydrogen** is then used to power the car and it has no emissions except for water.

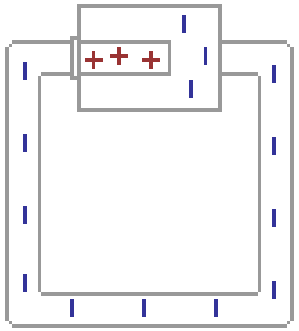
Electrolysis

Is used to purify metals, to remove unwanted hair, used in electroplating to make cutlery, kettles, car bumpers,etc.
Cheap metal is covered in a thin layer of another metal to make it look better and protect it.

Direct and Alternating Current

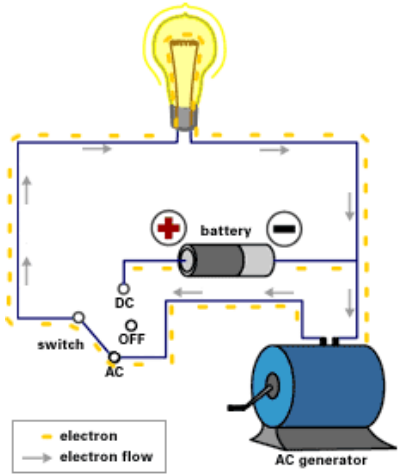
Direct

A Battery uses a direct current (DC)
It pushes the electrons in **one direction** around a circuit.



Alternating

What does alternate or alternative mean?



The electricity in your home (from the mains) **changes direction** 100 times per second.
This is called Alternating current (AC).
Some appliances need to have a Direct current only. e.g. your television set.
So it has a **rectifier** to change the AC to DC.

Summary

What I should know

- An electric current is a flow of electric charge.
- Electrical conductors allow current to flow through them freely. Insulators do not normally allow current to flow through them.
- Electricity is a very convenient form of energy. It can easily be changed into many other forms of energy.
- Circuits must be complete. A potential difference or voltage or source of energy must also exist across the circuit to move the electrons.
- A switch is a device which either completes or breaks a circuit, allowing current to flow or not.
- Voltage is a measure of the 'push' or 'force' that a power supply has to drive a current. Voltage is measured with a voltmeter. It is measured in volts (V).
- Current is measured in amperes (A). Current is measured with an ammeter.
- The resistance of a material is a measure of its opposition to the flow of current through it. It is measured in ohms (Ω). Resistance is measured with an ohmmeter.
- A rheostat is a variable resistor, whose resistance can be changed.
- A variable resistor can control the current flowing in a circuit. When the resistance is high, the current is low and when the resistance is low, the current is high.
- Ohm's law states that the current flowing through a metallic conductor is proportional to the voltage across it, provided the temperature remains constant.
- Resistance (at constant temperature) = Voltage ÷ Current **or** $R = V / I$.
- With two bulbs in series, the same current flows through each bulb. If one bulb blows or is switched off, the other will also go off.
- With two bulbs in parallel, if one bulb blows or is switched off, the other bulb will remain lighting as there is still a complete path for the current.

Summary

What I should know

- Three major effects of an electric current are (i) the heating effect, (ii) the magnetic effect, and (iii) the chemical effect.
- Everyday electric heating appliances are based on the heating effect of an electric current.
- A fuse is a safety device. It is an enclosed thin length of wire. This wire melts when a current greater than its stated value passes through. Thus, it switches off the current in a circuit.
- The magnetic effect of a current is used in electric motors, electric bells, loudspeakers, ammeters, circuit breakers, etc.
- The chemical effect of a current is seen in the electrolysis of water and in electroplating.
- Current that travels in one direction only is called direct current (or d.c.). Current which is constantly changing direction is called alternating current (a.c.).

Attachments

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Simple Circuit

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