Fundamentals of Electric Circuits

22nd Nov

Any functional electric circuit needs the following:

- A complete circuit, made from an electrical conductor
- A source of energy

Wires are often made of copper (a type of metal).

Energy sources are usually batteries or a mains plug socket (where the energy is from generators, or solar panels for example).

In a working circuit ELECTRICAL CURRENT flows through the circuit. This then transfers energy from one place to another.

Energy is transferred from the energy source (such as a battery) to the components (parts) in the circuit. Over time, the energy stored by a battery decreases.

The VOLTAGE of a battery relates to the amount of energy it can transfer when current flows.

Higher voltage means more energy transfer.

A high enough voltage could transfer current through your body. This can cause: burns, your heart to stop beating.

Electric circuits HEAT UP when current flows. A large current can make them very hot. This can cause skin burns or fires.

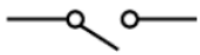
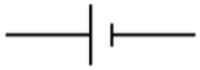
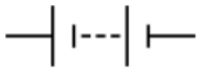
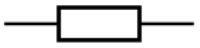
To stay safe: disconnect circuits when not in use, do not touch them when they are working, try to avoid short circuits.

A short-circuit is where a wire or other conductor connects directly from one terminal (+ or -) of a battery to the other. This causes a high current to flow.

In homes, fuses or circuit breakers disconnect circuits when too much current flows.

Making Electrical Circuits

26th Nov

Circuit Symbol	Name	Function
	Wire	D
	Switch	G
	Cell	E
	Battery	J
	Bulb	C
	Voltmeter	H
	Ammeter	B
	Resistor	A
	Diode	F

A. Resists the flow of electric current; Can be used to limit the current passing through a circuit

B. Used to measure the electric current flowing in a circuit

C. Takes energy from the electrons in a circuit and transfers it in the form of light

D. Made from a conducting material so it can carry current around the circuit

E. Provides a source of energy for an electric circuit

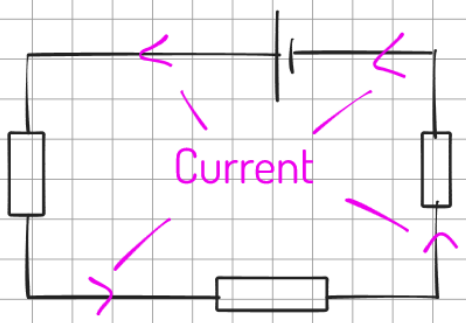
F. Allows electric current to flow through it in one direction only

G. Can be opened or closed to turn the current in a circuit on or off

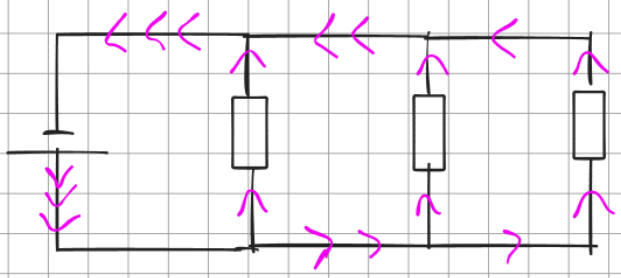
H. Used to measure the potential difference (voltage) across a component in a circuit

J. Multiple cells to provide a circuit with greater voltage

SERIES circuits have only ONE PATH for the current to flow through. The same current flows through all components in this one loop.



PARALLEL circuits have MORE THAN ONE PATH for current to flow through. The current splits down each branch in a parallel circuit.

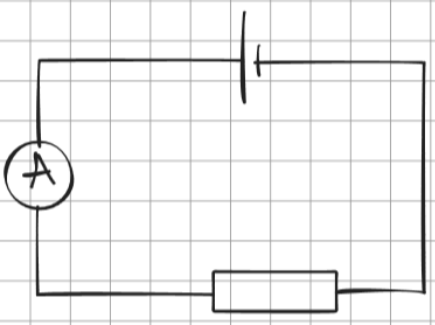


Measuring Current and Voltage

27th Nov

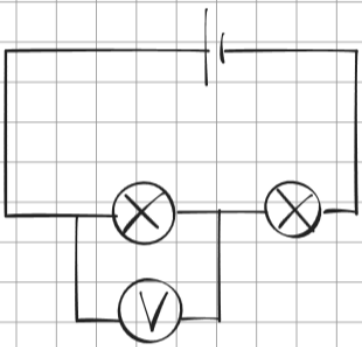
Ammeters measure the CURRENT in a circuit. To measure properly the current must flow through the ammeter, so it has to be connected in SERIES.

e.g.



This would tell us the current that flows in this loop.

Voltmeters measure the VOLTAGE in a circuit. They are connected in PARALLEL with the component we want to measure voltage across.



This would tell us the voltage across the left hand bulb.

We can represent objects or systems (such as a circuit) with SCIENTIFIC MODELS.

These models can help us to visualise how things work.

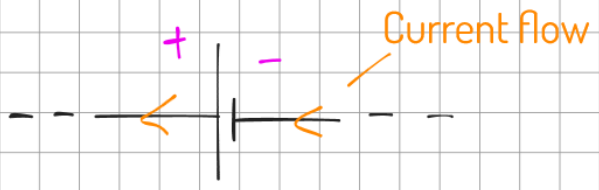
Most models have limitations. Sometimes they can be oversimplified.

Charge and Current

29th Nov

Inside conductors, there is ELECTRIC CHARGE that is free to move.

In a functional circuit charge flows from the POSITIVE TERMINAL of a battery to the NEGATIVE TERMINAL



CURRENT is the amount of CHARGE that flows past a point EVERY SECOND.

$$\text{Current} = \frac{\text{Charge}}{\text{time}}$$

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

I represents CURRENT, which has the unit of Amperes, often shortened to 'A'

Q represents CHARGE, which has the unit of Coulombs, often shortened to 'C'

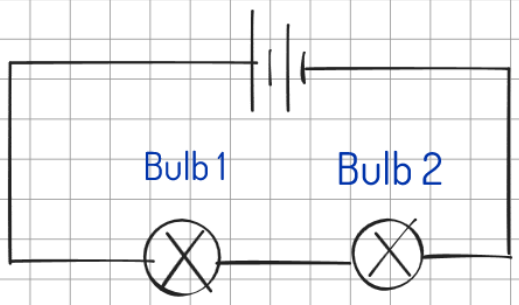
t represents TIME, which has the unit of Seconds, often shortened to 's'.

To calculate the total charged that has flowed we would use:

$$Q = I \times t \qquad (Q = It)$$

Potential Difference and Energy

4th Dec



Component	Potential difference (V)
Battery	1.5
Bulb 1	0.9
Bulb 2	0.6

A circuit's energy source provides energy to the charges in the circuit. The flowing charge then transfers this energy to circuit components.

The POTENTIAL DIFFERENCE across a component tells us the amount of ENERGY transferred by EACH COULOMB of charge.

Note: p.d. is also called VOLTAGE.

A VOLTMETER measures the potential difference ACROSS a component. It must be connected in PARALLEL with the component.

$$\text{Potential difference} = \frac{\text{energy transferred}}{\text{charge}}$$

$$V = \frac{E}{Q}$$

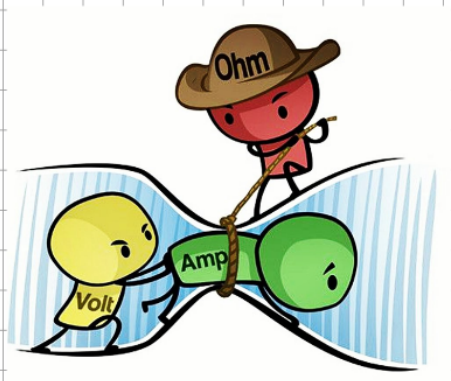
- V is the symbol that represents potential difference, which has the unit of volts, shortened to V i.e. 12 V.
- E is the symbol for energy transferred, which has the unit of joules, shortened to J i.e. 15 J.
- Q is the symbol for charge, which has the unit of coulombs, shortened to C i.e. 0.5 C.

$$\text{Energy transferred} = \text{charge} \times \text{potential difference}$$

$$E = QV$$

Resistance

9th Dec



RESISTANCE is the opposition to the flow of charge (current).

Resistance has the symbol R and the unit ohms, Ω.

The resistance of a component or circuit can be measured by finding the voltage (potential difference) and the current.

Where there is more than one path for current to flow the size of the current that flows down each path depends on its resistance.

More current flows down the path with less resistance.

If the paths have equal resistance, the current splits evenly down each path.

$$\text{Resistance} = \frac{\text{potential difference (voltage)}}{\text{current}}$$

$$R = \frac{V}{I}$$

R: in ohms, Ω

V: in volts, V

I: in amps, A

Number of bulbs in series	Potential difference [V]	Current [A]	Resistance [ohms]
1	1.37	0.17	8.05
2	1.46	0.11	14.50
3	1.54	0.05	30.80

Number of bulbs in parallel	Potential difference [V]	Current [A]	Resistance [ohms]
1	1.36	0.19	7.15
2	1.23	0.37	3.32
3	1.13	0.54	2.09

As we add more components in SERIES we INCREASE THE RESISTANCE of the circuit. For the same potential difference, we get a lower current.

As we add more components in PARALLEL we DECREASE THE RESISTANCE. There are more paths for the current to flow through, so for the same potential difference we get a lower current.

p.d., current and resistance 11th Dec

In any circuit if we increase the resistance, but keep the potential difference (voltage) the same we would DECREASE the current.

potential difference = current x resistance

$$V = I R$$

We often choose the design and structure of a circuit based on what we plan to use it for.

In the home we are likely to have our lighting in a parallel circuit. This means each bulb can be switched on and off separately, depending on how we connect the switches.

If all of the bulbs were in series, then any bulb breaking (or any switch) would break the circuit and no current can flow.