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Unit P5

Electric Circuit

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The topics in this unit are:

Static Electricity

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Some materials that are **insulating** can become **electrically charged** when they are rubbed against each other.

Static builds up when **electrons** are 'rubbed off' one material onto another

The material **receiving** the electrons becomes **negatively** charged and the one **giving up** electrons becomes **positively** charged

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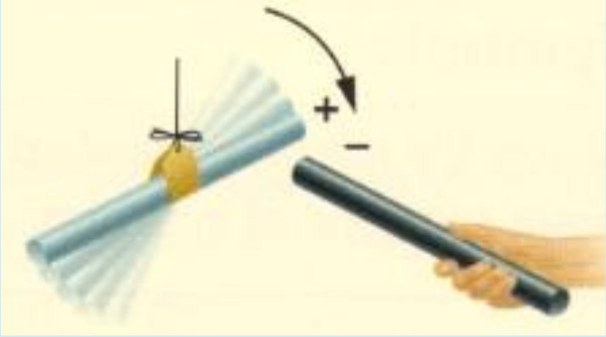
Repulsion and Attraction

When two **charged** materials are held close together they exert a **force** on each other.

If two **identical** charges are held together, they **repel** each other



If two **opposite** charges are held together, they **attract** each other

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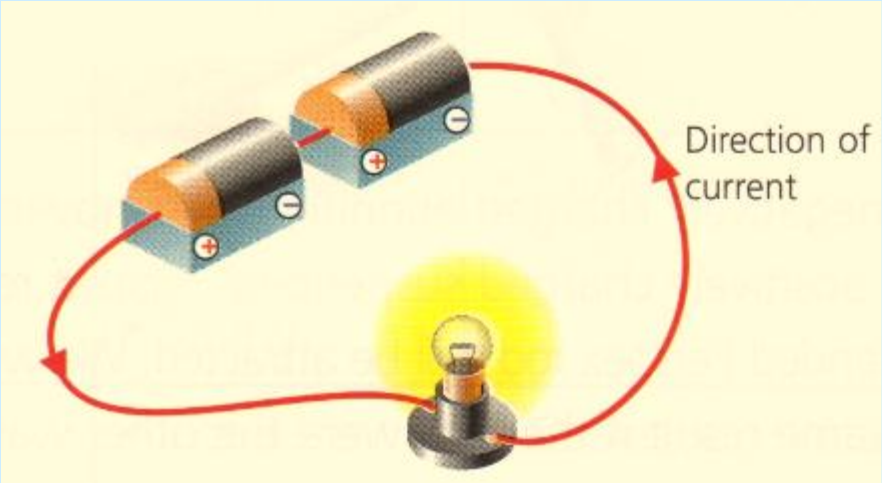
Electric Circuits

In an electric circuit, an **electric current** flows through.

A current is a **flow of charges**.

The battery causes the charges to move in a **continuous** loop around wires and components



In **metal** conductors, there are lots of charges **free** to move.

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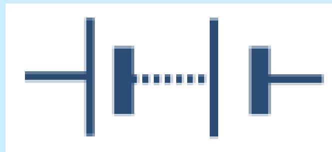
Circuit Symbols

Components can be represented using **circuit symbols**

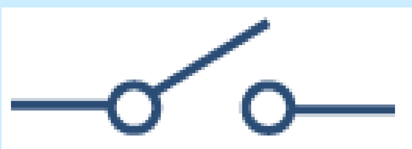
cell



battery

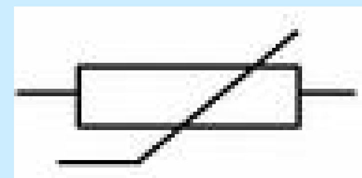
bulb

ammeter



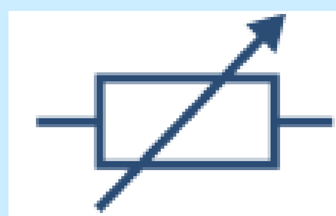
switch

voltmeter

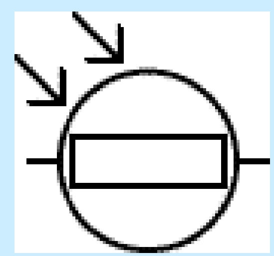


thermistor

resistor



variable resistor



light dependent resistor

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Currents

A current is the **flow of charge** around a circuit

A **direct** current (d.c.) always flows in the **same direction**

An **alternating** current (a.c.) changes the direction of **flow back and forth**

The amount of current flowing in a circuit depends on the **potential difference** across the components

The **greater** the potential difference (**voltage**), the greater the current that flows through the component.

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Resistance

Components, such as lamps, resist the flow of charge through them. They have **resistance**.

The **greater** the resistance of a component, the **smaller** the current that flows.

Resistance (**ohms,** Ω) measures how hard it is to get a current through.

It can be calculated by

$$\text{Resistance } (\Omega) = \frac{\text{voltage (V)}}{\text{current (A)}}$$

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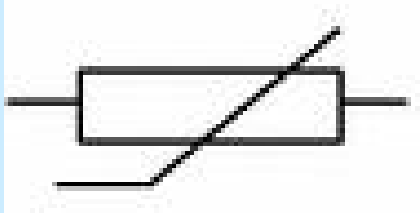
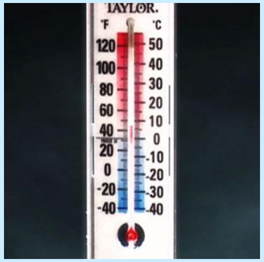
Thermistors and Light Dependent Resistors

The resistance of some materials depends on other **conditions**

Thermistors



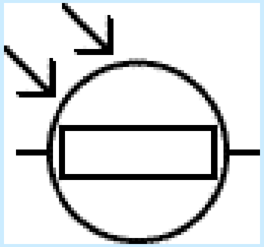
The resistance of a **thermistor** depends on its **temperature**.



As the temperature **increases**, the resistance **decreases** allowing more current to flow.

Light Dependent Resistor

The resistance of an LDR depends on the **light intensity**.



As the amount of light **increases**, the resistance **decreases** allowing more current to flow

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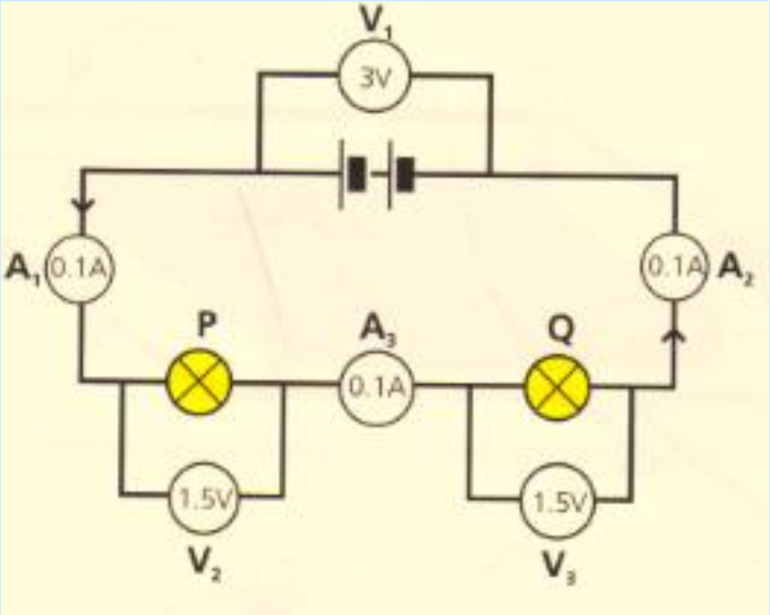
Series Circuits

In a **series circuit** all the components are connected in **one loop**.

The current flowing through each component is the same

$$A_1 = A_2 = A_3$$



The potential difference (voltage) across the components is the same as the potential difference across the battery

$$V_1 = V_2 + V_3$$

If a circuit has 2 **identical** components they will have the **same** voltage across them.

If the components are **different** the one with the **greatest resistance** will have the **greatest voltage**

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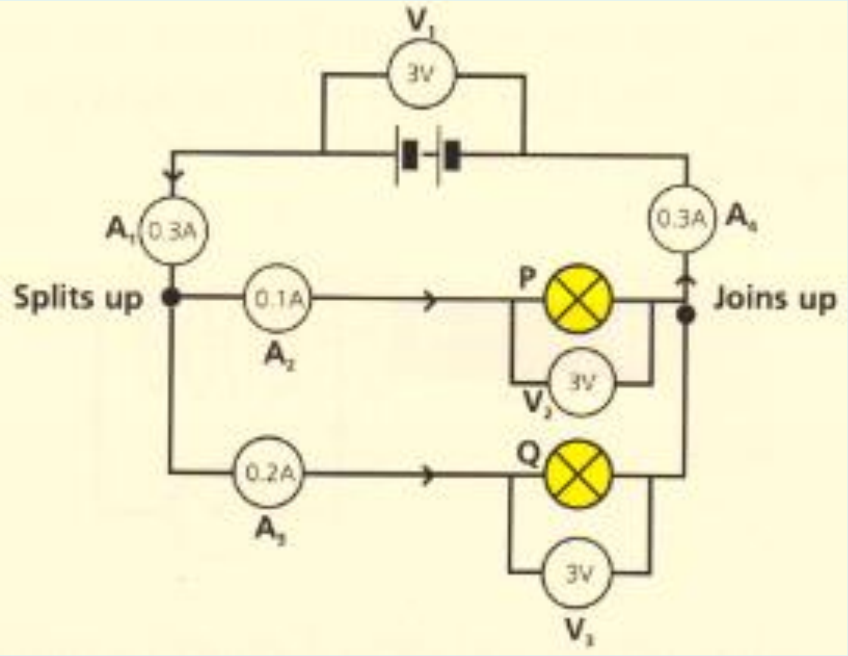
Parallel Circuits

The componetns in a **parallel circuit** are connected in **separate loops.**

The total current going **from** and **back to** the battery is the same

$$A_1 = A_2 + A_3 = A_4$$



The **amount of current** going through each component depends on the **resistance**.

The **greater** the resistance the **smaller** the current.

The current is smallest through the component with the **largest resistance**

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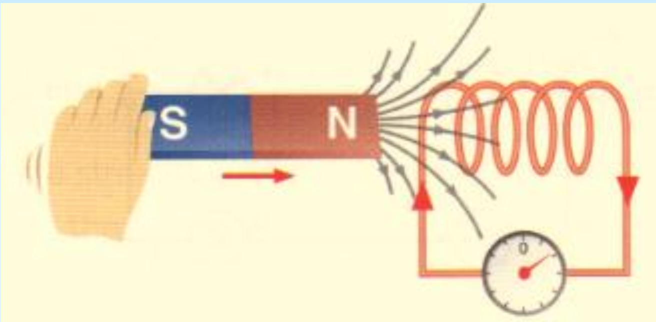
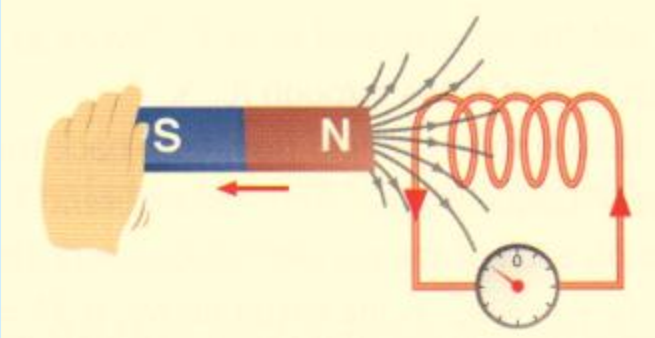
Electromagnetic Induction

In electromagnetic induction, **movement** produces current.

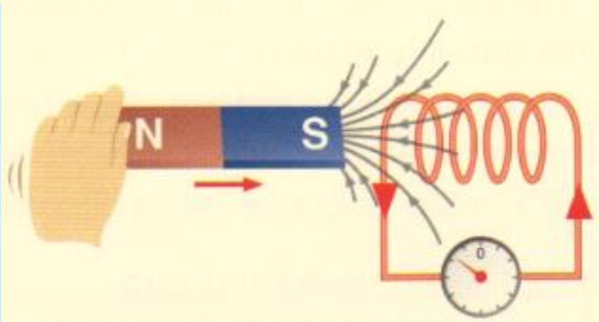


If a wire cuts through the magnetic field, then a **voltage** is induced.

Moving the magnet into the coil **induces** a current in one direction



We can make a current in the **opposite** direction by moving the magnet **out of the coil** or moving the other **pole** of the magnet into the coil



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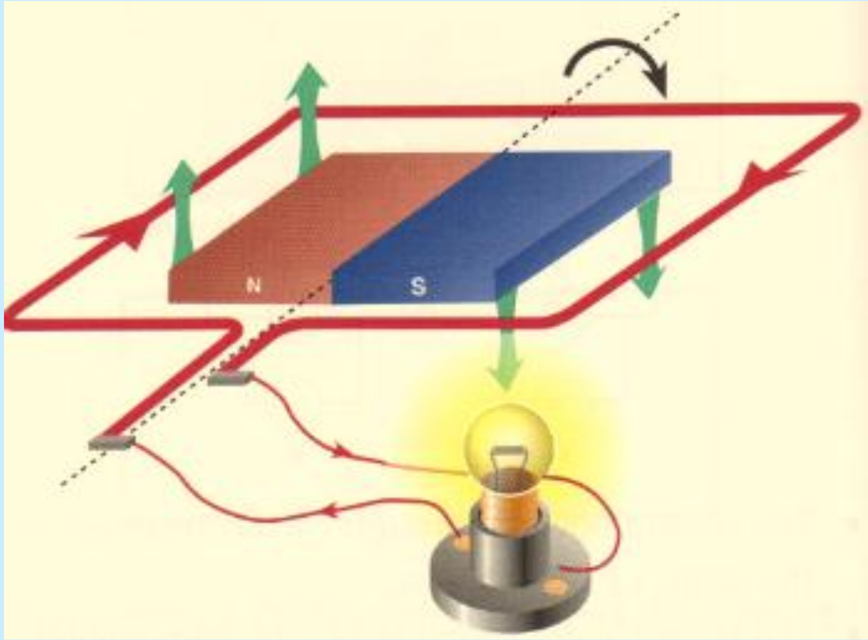
Electric Generators

Generators use **electromagnetic induction** to **generate** electricity by **rotating** a magnet inside a coil.



The size of the voltage can be increased by:

1. Increasing the **speed of rotation**
2. Increasing the **strength** of the magnetic field
3. Increasing the number of **turns**
4. Putting an **iron core** inside the coils

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Power

Power, measured in **Watts**, is a measure of how much **energy** is transferred every **second**

power (W) = potential difference (V) x current (A)

Example

An electric motor works at a current of 3A and a potential difference of 24V. What is the power of the motor?

Power = 24V x 3A

= 72 W

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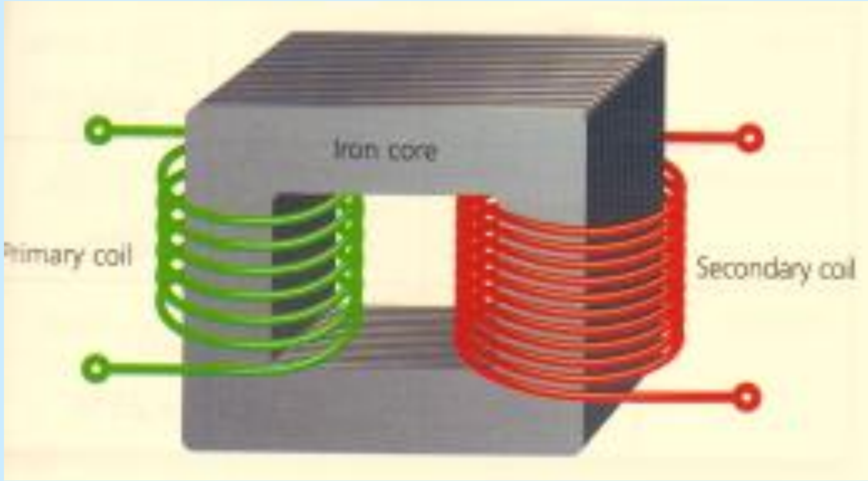
Transformers

Transformers are used to change the **voltage** of an **alternating** current.

A transformer consists of **2 coils**, called **primary** and **secondary** coils wrapped around an **iron core**.



When two coils are close together a changing magnetic field in one coil can generate a **voltage** in the other current.

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Energy

Energy is measured in **Joules (J)**.

Domestic electricity is measured in **kilowatt hours (kWh)**

The amount of energy transferred can be calculated by:

energy transferred (J) = power (W) x time (s)

energy transferred (kWh) = power (kW) x time (h)

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Cost of Electricity

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If we know the **power**, **time** and **cost per kilowatt hour**, we can calculate the **cost of energy**.

total cost = number of units (kWh) x cost per unit

Example

A 2000W electric fire is switched on for 30 minutes. How much does it cost if electricity is 8p per unit?

energy = 2kW x 0.5 h

= 1kWh

cost = 1kWh x 8p

= 8p

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Efficiency of Appliances

The greater the amount of energy that is usefully transferred, the more efficient the appliance is.

It is calcualted by:

$$\text{Efficiency (\%)} = \frac{\text{energy usefully transferred}}{\text{total energy}} \times 100$$

Appliance	Energy in	Useful energy out	Efficiency
Light bulb	100 J/s	Light: 20 J/s	20/100 X 100 = 20%
Kettle	2000 J/s	Heat: 1800 J/s	1800/2000 X 100 = 90%
Electric motor	500 J/s	Kinetic: 300 J/s	300/500 X 100 = 60%
Television	200 J/s	Light: 20 J/s Sound: 30 J/s	50/200 X 100 = 25%

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