Mains electricity 1

- Mains electricity in the UK is an **AC** supply.
- It has a frequency of **50 Hz** and a potential difference of **230 V.**

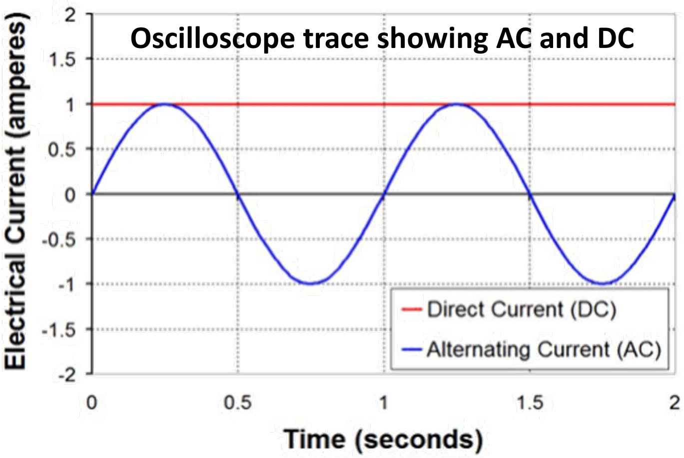
1. AC versus DC

There are two types of current:

1. **Direct current (DC):** the current travels in **one direction only.**
   Examples: batteries, cells
2. **Alternating current (AC):** the charge moves **backwards and forwards** at a certain **frequency** (rate).
   Examples: mains electricity, generators

The current is produced from two types of potential difference:

1. **Direct potential difference:** the potential difference always stays the same
2. **Alternating potential difference:** the potential of the live wire changes from a positive value to a negative value, while the neutral wire remains at 0 V. This causes a change in the direction of the potential difference.



- We can use **transformers** to increase the potential difference and decrease the current.
- Reducing the current reduces any **heat loss** through the wires, making the energy transfer **more efficient.**

2. 3-pin plug

- Plugs connect devices to the mains supply.
- The cable contains **3 copper wires coated in plastic**:

Live Wire

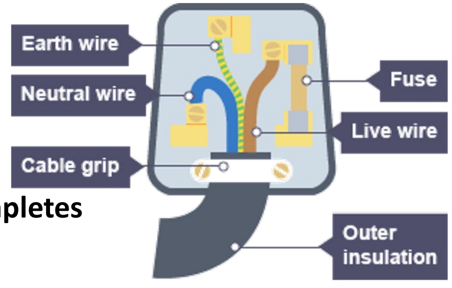
- Copper wire coated with **brown** plastic
- **Carries the AC current** to the device

Neutral Wire

- Copper wire coated with **blue** plastic
- Connects to the mains supply and **completes the circuit**

Earth Wire

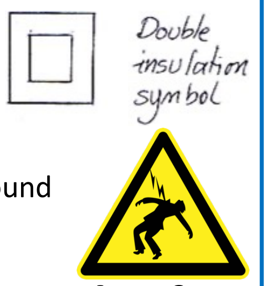
- Copper wire coated with **green/yellow striped** plastic
- **Safety wire** – provides a path to the ground in case of a fault



3. Electrical safety

Sometimes a **fault** can cause the current to get **too high**. There are 2 ways in which the circuit can be **disconnected** to stop danger:

1. **Fuse**: appliances and plugs have glass/ceramic containers that have a **thin wire** inside. This melts if the current is too high. The fuse is placed between the live pin and the live wire.
2. **Earthing:** most appliances with **metal cases** are earthed. This means when a fault occurs a large current flows from the live wire to the earth and **melts the fuse**. Some appliances are double insulated, and therefore have no earth connection. A double insulated appliance has a casing made of an insulating material.



Electric shocks

The live has a potential of **230 V**, but the ground (earth) has a potential of **0 V**. This creates a **potential difference** and current flows.

The live, neutral and earth pins are made of brass as this is stronger than pure copper, but has good conductivity.

Mains Electricity 2

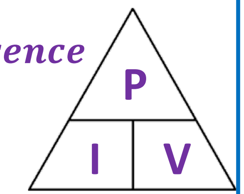
4. Power

- Power is the **rate at which energy is transferred** in circuits.
- It's measured in **watts (W)**.
- It can be calculated using:

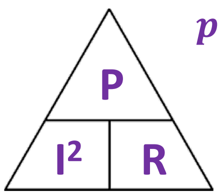
$$power = current \times potential\ difference$$

(W) (A) (V)

Learn



If you don't know the potential difference, you can substitute the $V = I \times R$ equation to get $P = I \times I \times R$. This can be simplified to:



$$power = current^2 \times resistance$$

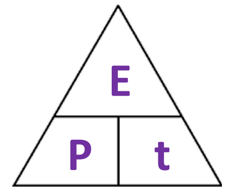
(W) (A) (Ω)

Learn

- If you double the current, the **power quadruples**.
- This shows how important it is to **keep current low** in appliances.

5. Electrical appliances

- Energy is usually measured in Joules (J), but in the home we can also measure it in **kilowatt hours (kWh)**.
- You can calculate the energy of an appliance using:



$$energy = power \times time$$

(J) (W) (s)

OR (kWh) OR (kW) OR (h)

Learn

- Appliances' energy rating is usually labelled in **kilowatt hours**.
- The higher the energy rating, the **more powerful** the appliance is.
- Appliances that have a **heating** element (e.g. kettles and ovens) usually use the most energy.

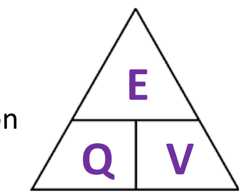
If you are working with **small amounts of energy** (e.g. electrostatics), you can use the following equation:

$$energy = charge\ flow \times potential\ difference$$

(J) (C) (V)

Learn

This also helps define potential difference (see section 3(a))



6. The National Grid

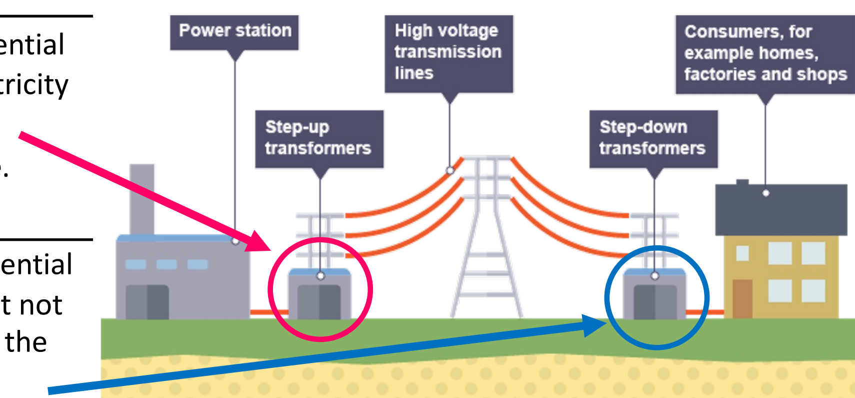
- The electricity generated in power stations is transported to the home through the **National Grid** via the use of **cables** and **transformers**.
- The National Grid is very **efficient,** because it uses **low current** to transport the electricity (remember – high current causes energy to be lost as **heat**!).

Step-Up Transformers

- These are used to **increase** the potential difference to **275 000 V** as the electricity leaves the power station.
- This causes the current to **decrease**.

Step-Down Transformers

- These are used to **decrease** the potential difference back down to a saf<u>er</u> (but not safe) **230 V** as the electricity leaves the National Grid and enters the home.
- This causes the current to **increase**.

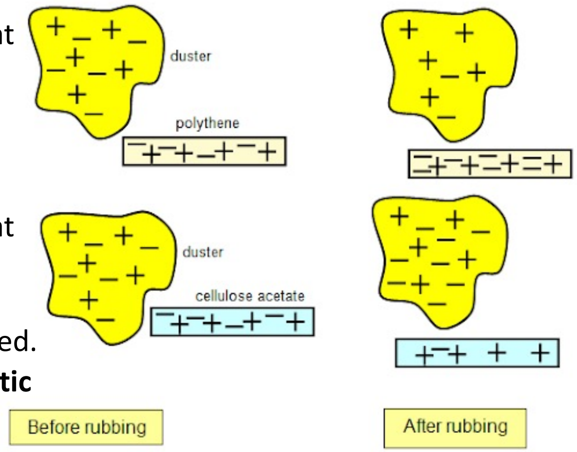


Static Electricity

(separate Physics only)

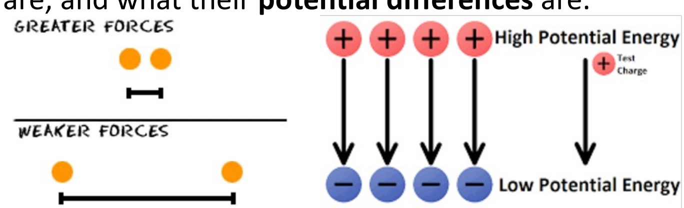
7. Static charge

- When certain materials are **rubbed together**, they become **electrically charged**.
- Negatively charged **electrons** are rubbed off one material and onto the other.
- The material that **gains** electrons becomes **negatively** charged.
- The material that **loses** electrons becomes **positively** charged.
- This is called **static electricity.**



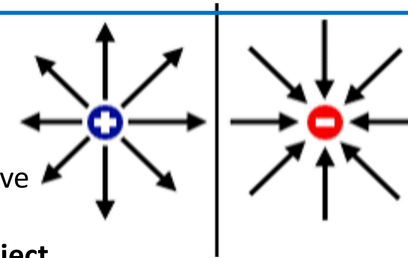
8 (b). Static shocks

- When two charged objects get close to each other, **sparking** can occur.
- **Sparking** is the sudden flow of electric current **across the gap between the objects**. This heats the air enough to cause it to **glow**. This can be very dangerous in industry.
- The size of the spark depends on **how far away** the objects are, and what their **potential differences** are.

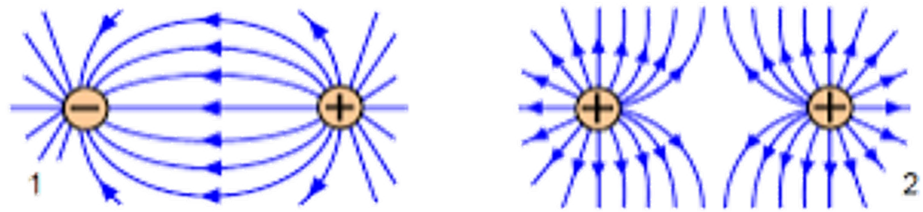


- Too close a distance or too great a potential difference leads to a **static shock**!

8 (a). Electric fields



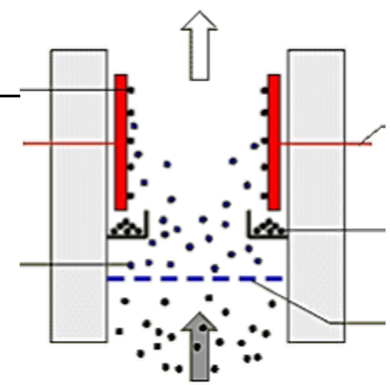
- When an object is electrically charged, it creates an **electric field** around itself.
- The field **direction** goes **away** from a positive charge and **towards** a negative one.
- Electric fields are **strongest close to the object.**
- When two electrically charged objects are brought together, they **exert a force** on each other. This is an example of a **non-contact force.**
- Like charges **repel,** and opposite charges **attract**.
- This is because of the **electric fields** around the objects (see below).



Static electricity uses

Factories

- Used to **reduce pollution** (smoke) coming out of factories.
- The smoke particles are given a charge, and sticks to electrodes with the **opposite** charge in the chimneys instead of leaving out the top.



Spray Paint

- Used to **evenly cover surfaces** without wasting paint or missing spots (e.g. cars).
- The object is given a **positive charge**. The spray paint is **negatively charged**. So, the paint is **attracted** to the object and sticks to it evenly.