



1

**Permanent magnets** always have a **magnetic field**, an area around them that can attract magnetic materials.

2

**Induced magnets** occur when a piece of magnetic material becomes a magnets when placed in a magnetic field.

3

There are three **magnetic** elements **Iron, Nickel** and **Cobalt**. Steel (~98% iron ~2% carbon) is magnetic .

4

Magnetic fields can be shown using **iron filings** and **plotting compasses** (also show field line direction). The ends of a magnets are called **Poles**. Magnetic field lines travel from **North pole to South pole**. Like poles **repel**, opposite poles **attract**.

5

Earth's magnetic field is produced by the **movement of charged particles** in the core. It shields us from **cosmic rays** and enables us to **navigate** using **compasses**.

6

A **compass** is a **bar magnet** that orientates itself in **Earth's magnetic field** pointing towards geographic north.

7

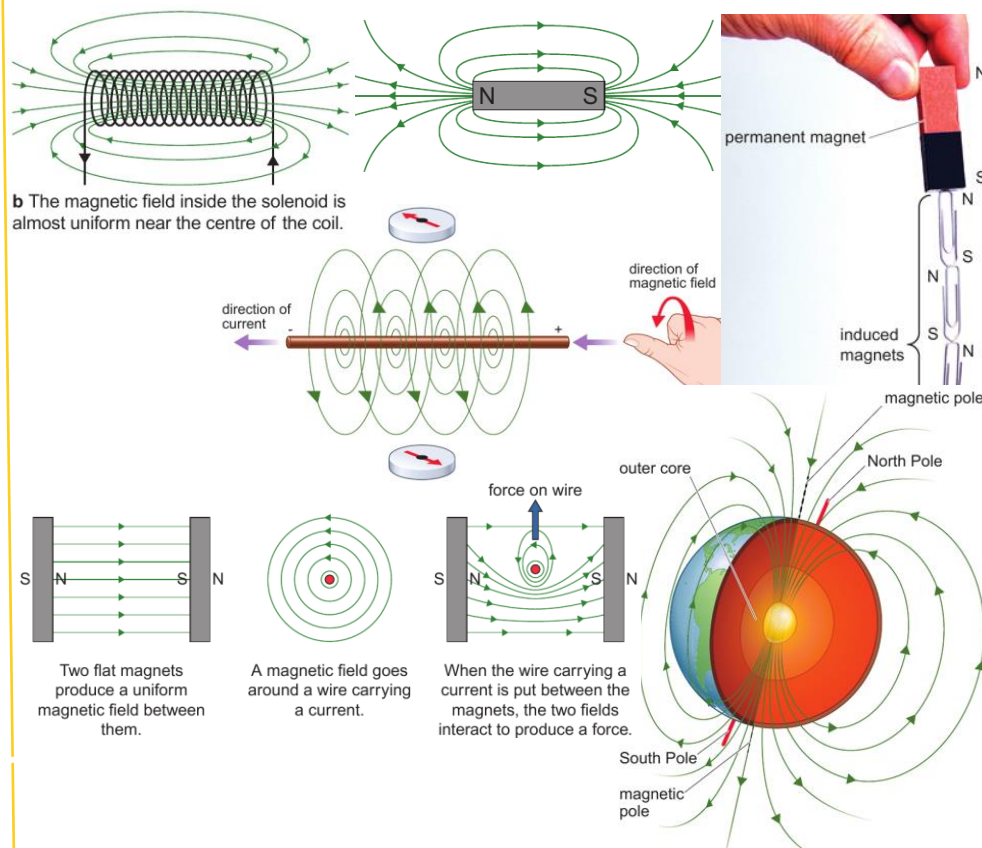
A **current** moving in a wire creates an **magnetic field**. The **higher the current the stronger the magnetic field**. The direction of the magnetic field can be found using the corkscrew rule (see below).

8

A **solenoid** is a coil of wire that produces a magnetic field like a bar magnet with poles at each end. A coil of wire with a current flowing through it is called an **electromagnet**. Electromagnets are strengthened by adding more **coils of wire**, increasing the **current** flowing through the wire or adding a **core**. (higher tier only)

9

A **core** is a magnetic material such as iron and which is placed in the centre of a coil of wire. It increases the strength of the electromagnet becoming a temporary magnet (induced magnet).



10

**If you place a current carrying wire into a magnetic field then it will experience a force due to the interaction between with the two fields**

11

**Force on wire (at right angles to the magnetic field) = magnetic flux density x current x length (of wire)  $F = B \times I \times L$**

12

Magnetic flux density is a measure of the strength of the magnet measured in Newtons per Ampere metre (N/Am) also called tesla T. Current is measured in Amperes (A) and length of the wire in metres (m)



1

A **changing magnetic field** can **induce** a **voltage** or potential difference (p.d.) in a wire. A p.d. can also be **induced** if a **wire is moved in a magnetic field** this effect is called **electromagnetic induction**.

2

**Generators** are coils of wire moving in a magnetic field, power stations use them to make mains (**a.c.**) electricity. Generators use a slip ring to get an **a.c.—alternating current**.

3

A **Dynamo** is a coil of wire that moves in a magnetic field, it works in the same way as a generator but uses a **commutator** rather than **slip rings** so that the current only moves in one direction (**d.c.** electricity)

4

**Microphones** turns variations in **air pressure** from sound waves into to a varying **current**. Loud speakers turns variations in electrical **current** into **sound** by making a diaphragm move backwards and forwards.

5

**Transformers** are used to **change** the **potential difference (voltage)** of a supply. Transformers are made up of **two coils of wire wrapped** around a shared **iron core**. They only work with an alternating current.

6

In a transformer **current** flowing in the primary coil **induces** a **magnetic field** in the **iron core** which then **induces** an electric **current** in the secondary coil. By increasing or decreasing the number of turns in the primary coil we can decrease or increase the voltage of the current induced in the secondary coil.

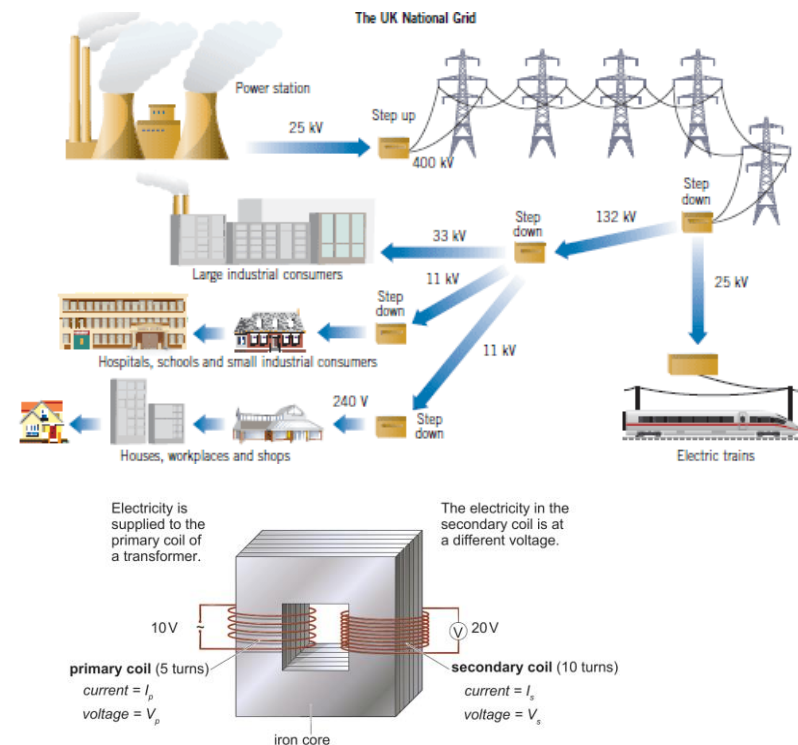
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Assuming the transformer is 100% efficient, power supplied equals the power that leaves. **Electrical power = current x potential difference**

$$P = I \times V$$

$$\frac{\text{potential difference across primary coil (V)}}{\text{current in primary coil (A)}} = \frac{\text{potential difference across secondary coil (V)}}{\text{current in secondary coil (A)}}$$

**$V_p \times I_p = V_s \times I_s$**  allows us to work out the change in voltage.



8

The national grid is a network of wires which deliver electricity safely from power stations. **Step up transformer increase the voltage to reduce energy loss due to heat when moving large distances by transmission lines. Step down transformers decrease the voltage to safer levels.**

9

Using higher voltage increases the efficiency of power transmission as less energy is lost as **heat**. The three **power** equations are used to prove this:

$$\text{power (W)} = \frac{\text{energy transferred (J)}}{\text{time taken (s)}}, P = \frac{E}{t}$$

$$\text{electrical power (W)} = \text{current (A)} \times \text{potential difference (V)}, P = I \times V$$

$$\text{electrical power (W)} = \text{current squared (A)}^2 \times \text{resistance (}\Omega\text{)}, P = I^2 \times R$$