Edexcel Physics IGCSE

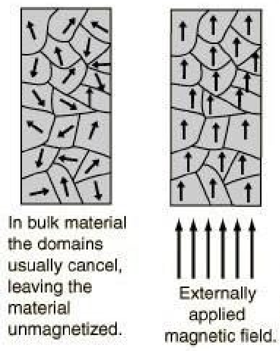
Topic 6: Magnetism and Electromagnetism

Summary Notes

(Content in **bold** is for physics only)

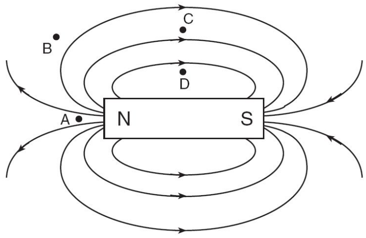
Magnetism

Magnets **repel and attract other magnets** and **attract magnetic materials.** Like poles of magnets repel and opposite poles attract.



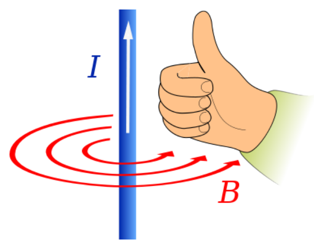
- Non-magnetic materials are materials that are not attracted to magnets and cannot be magnetised (e.g. glass, plastic)
- Magnetic materials are materials that are attracted to magnets and can be magnetised (e.g. iron, steel, cobalt, nickel)
    - Magnetism can be **induced** in magnetic materials by **placing** them in a **magnetic field.**
    - Magnetic materials that can be **permanently** magnetised are described as **magnetically hard** (e.g. **steel**). Magnetic materials that are only **temporarily** magnetised are described as **magnetically soft** (e.g. **soft iron**).

Magnetic field lines:



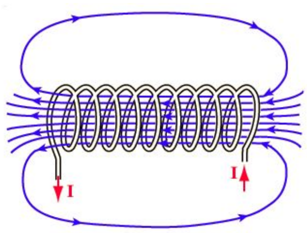
- **Magnetic field lines** represent the **magnetic force** on a **north pole** at a given point.
    - The **direction** of a magnetic field line shows the **direction** of the force.
    - How **close together** the magnetic field lines are shows the **magnitude** of the force.
- **Field lines** from magnets point **from north to south.**
    - The field lines of a bar magnet are shown in the diagram.
    - There is a **uniform** magnetic field between the opposite poles of two magnets placed close together, as the field lines move from the north pole of one straight towards the south pole of the other. The field lines are **parallel** and **evenly spaced**.

Electromagnetism

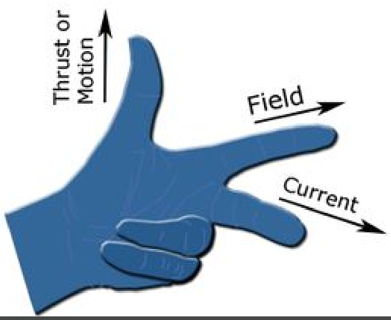


An **electric current** passing through a **conductor** produces a **magnetic field** around it.

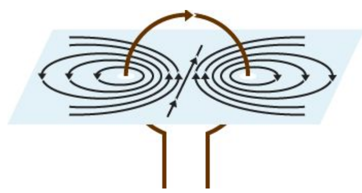
Electromagnets consist of a coil of wire wrapped around a magnetically soft core and can be turned on and off.



- **The right-hand grip rule determines the direction of the magnetic field produced by a current carrying wire, shown in the first diagram.**
- **The magnetic field created by a current carrying solenoid is like the field produced by a bar magnet, shown in the second diagram.**
- **The magnetic field created by a current carrying flat circular coil is shown in the third diagram.**



A **force** acts on a **current-carrying conductor** in a magnetic field. **Fleming's left-hand rule** shows the relative



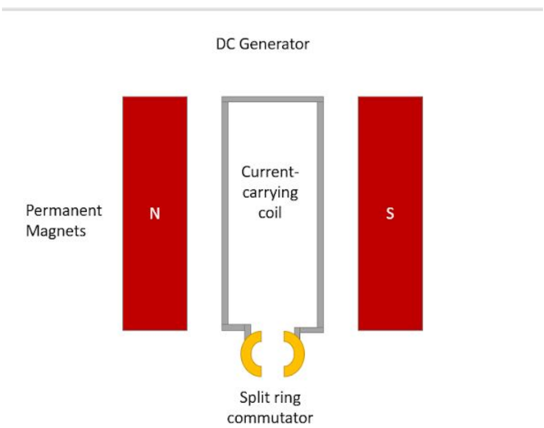
directions of the force, field, and current…
This is called the **motor effect**.

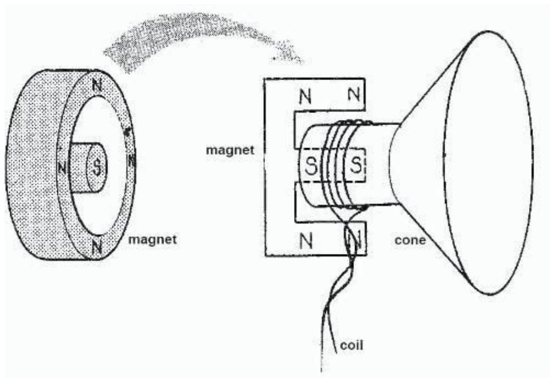
- If the **current** is **reversed** or the **magnetic field** is **reversed,** the **force** will be **reversed.**
- If the **magnitude** of the **current** or of the **magnetic field** is **increased,** the **magnitude** of the **force** will **increase.**

DC motors consist of a coil of wire in between two permanent magnets. **Direct current** flows through the wire and it experiences a **turning effect** due to the forces exerted on it in the magnetic field. As the current flows in opposite directions on each side of the coil, the forces on each side are in opposite directions - making it turn. The turning effect can be increased by:

- increasing the current
- using a stronger magnetic field
- increasing the number of turns on the coil.

A **split ring commutator** is used to ensure that the **direction** that the **current** flows in the coil reverses every half turn.





Loud speakers consist of a coil attached to a cone in a magnetic field. When **alternating current** flows through the coil, the cone is continuously pushed away and pulled back, making a **sound.** The **frequency** (and therefore pitch) of the sound can be altered by changing the frequency of the alternating current used.

A force is also exerted on charged particles moving in a magnetic field (because moving charged particles are current) as long as they are not moving parallel to the field.

Electromagnetic induction

- When there is relative movement between a conducting wire & a magnetic field, a voltage will be induced. For example, if conducting wire **moves across a magnetic field,** a voltage is induced in it. If it is part of a complete circuit, this causes a current to flow.

This is called the **generator effect**.

- The induced voltage can be increased by:
  - moving the wire **more quickly,**
  - using a **stronger magnetic** field,
  - or **increasing the length** of the wire inside the magnetic field (eg. by making it more coiled).
- A voltage is also induced in a coil with a **changing magnetic field** through it. For example, when a magnet is moved into a coil, a voltage is induced in it.
  - The **more quickly** the magnetic **field changes,** the **greater** the **voltage.**

Electricity can be generated by **rotating a magnet** within a **coil** or by **rotating a coil** in a **magnetic field.** As they rotate, the magnetic field through the coil **changes,** which induces a **voltage** and therefore a **current** in the coil. The voltage can be increased by:

- **increasing the length of wire inside the magnetic field** (eg. by using a larger area, more turns or a longer wire)
- using a **stronger magnet**
- **increasing the speed** of rotation.

A transformer consists of two coils wrapped around a soft iron core and is used to change the size of a voltage.

They are used to:

- **step up the voltage (to a greater value) for transmission in power lines which reduces power loss (because lower current causes less power loss due to the resistance of the cables)**
- **then step down the voltage for usage in homes (to keep us safe)**

- **An alternating voltage produces an alternating current in the primary coil. This creates a changing magnetic field which links with the secondary coil and induces an alternating voltage in it.**
- **A step-up transformer has more turns on the secondary than the primary which means the voltage of the secondary is greater than that of the primary. A step-down transformer has fewer turns on the secondary than the primary which means the voltage of the secondary is less than that of the primary.**
- $\frac{primary\ voltage}{secondary\ voltage} = \frac{primary\ turns}{secondary\ turns}$
- **For a 100% efficient transformer, because the power used is constant,** $V_pI_p = V_sI_s$