Edexcel GCSE Physics

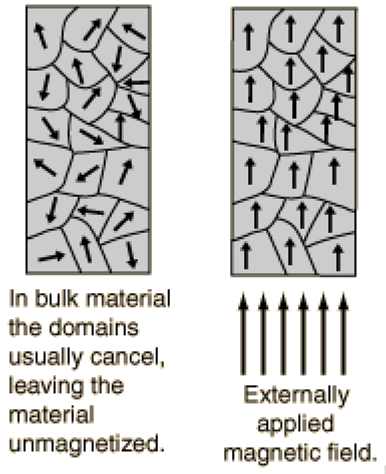
Topic 12: Magnetism and the motor effect

Notes

(Content in bold is for Higher Tier only)

Magnetism

- Like poles repel (North-North, South-South).
- Opposite poles attract.
- Magnetic materials are typically Cobalt, Steel, Iron, and Nickel.



1. www.hyperphysics.phy-astr.gsu.edu

Permanent Magnets

- Always magnetic, always have poles.
  - o Used in speakers, compasses, and electric generators.

Induced Magnets

- Materials that are "magnetic" but do not have fixed poles, ie. Magnetism must be induced.
- These can be made into temporary magnets by 'stroking' them with a permanent magnet
  - o This aligns all domains in the material in the same direction, creating a temporary magnet
  - o Electromagnets use temporary magnetic material in their core
- After time, or after a knock, the domains move into random positions, so magnetism will be lost.

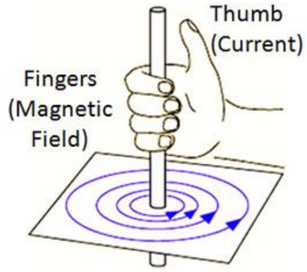
Magnetic Fields

- Field Lines point from North to South
- Field strength decreases with distance from the magnet
- Direction always points to south pole and away from north pole, at any point
- Plotting Compasses are small compasses which show the direction and shape of a magnetic field at a given point.

Earth's Core

- The core is magnetic, and creates a large magnetic field around the Earth
- We know this because a freely suspended magnetic compass will align itself with the earth's field lines and point North.
- A compass is effectively a suspended Bar Magnet, with its own north pole lining up with Earth's North pole
  - o This cannot be right - like poles repel
  - o So in fact, Earth's magnetic pole in the north is a magnetic South Pole and the geographic south pole is close to the magnetic North Pole

Current



http://www.excelatphysics.com

- Current produces a magnetic field around a wire
- The direction is dictated by the "right hand rule"
- Plotting compasses on a piece of paper through which a wire is pierced shows this
- Current direction is perpendicular to the magnetic field direction

Strength of Magnetic Field

- Magnetic field strength depends on current size; Greater current, stronger magnetic field
- Strength also varies with distance from the conductor; Greater distance from wire, weaker field

Solenoids

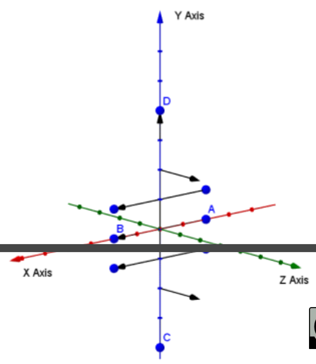
- Magnetic Field Shape is similar to a bar magnet
- Coiling the wire causes the field to align and form a giant single, almost uniform field along the centre of the Solenoid.
- Having an iron core in the centre increases its strength as it is easier for magnetic field lines to pass through than air
- The fields from individual coils cancel inside to produce a weaker field outside the solenoid
- Factors that affect strength of field:
  - Size of current
  - Length
  - Cross sectional area
  - Number of turns (coils)
  - Using a soft iron core

Current Carrying Wires and Magnets

- **Wire with a current near a magnet?**
  - **The current produces a magnetic field, which interacts with the magnet's field**
  - **The force experienced on the conductor is equal and opposite to the force felt on the magnet**
- **Magnetic forces are felt due to interaction between any two magnetic fields**

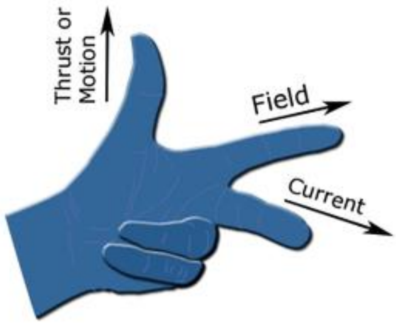
Force

- **Two magnets will interact, feeling a magnetic force of attraction/repulsion**
- **A magnet and a wire will also exert a force, as the two magnetic fields (generated by the magnet and the current in the wire) will interact**
  - **The magnetic field around a wire is circular, but the magnetic field between two magnets is straight**
  - **When the two interact, the wire will be pushed away from the field between the poles (at right angles to the wire direction and the field direction)**
- **To visualise this:**
  - **Fixed permanent magnets have field lines along the x axis, as the magnets are at A and B and the field lines are shown**



- Wire is along the y axis, where current is moving up from C to D
- The Force felt on the wire is at right angles to both the direction of the current and magnetic field lines along the z axis

Fleming's Left Hand Rule



www.wikipedia.org

- Each component is at 90^o to the others
- Use this to work out the unknown factor out of the three (usually the direction of the force felt)
- Remember current is conventional current (motion of positive charge), which moves in opposite direction to electron flow.

$$\boldsymbol{Force} = (\boldsymbol{magnetic\ flux\ density}) \times (\boldsymbol{current}) \times (\boldsymbol{length})$$

$$\boldsymbol{F = BIL}$$

- Where Magnetic Flux Density is measured in Tesla [T]
  - The number of flux lines per metre squared

Motors

- A coil of wire in between two permanent magnets
- Current flows through the wire, and the magnetic field it produces interacts with the magnets
- One side of the coil gets forced down, the other side gets forced up
  - This causes the coil to rotate
  - Use the Left Hand Rule to verify which side moves up or down