Magnetism

ELEC 105
ELEC 106

Magnetic Materials

Magnetite consists of an iron oxide.
A natural magnet attracts certain materials:

- cobalt
- nickel
- iron
- steel
- alloys of any of the above

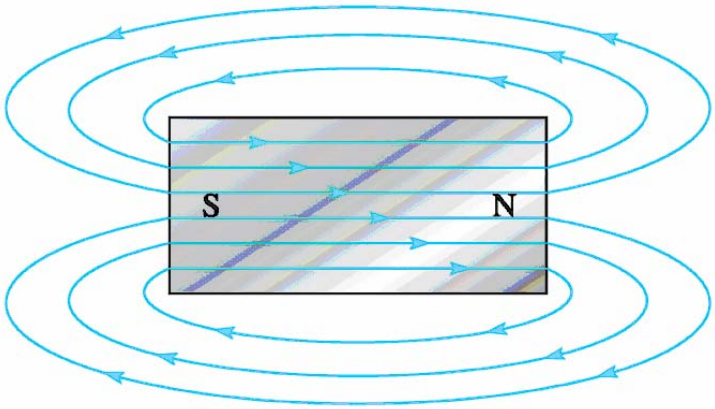
These materials are called **Magnetic** materials.

Properties of Magnets

Magnets exhibit the following properties:

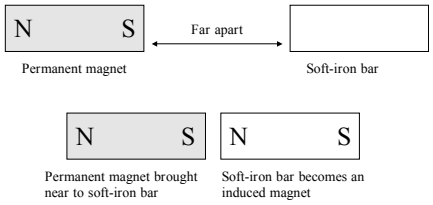
1. They attract magnetic materials
2. They have **2 magnetic poles**;
   a. the North and South seeking poles
   b. These are the strongest parts of the magnets
   c. The poles are found very near (but not at) the ends of the magnet
3. If allowed to swing freely a magnet will come to **rest** with one end pointing towards the Earth's **North** pole, the other end pointing towards the Earth's **South** pole
4. **Like poles repel, Unlike poles attract**

Magnetic Lines of Flux



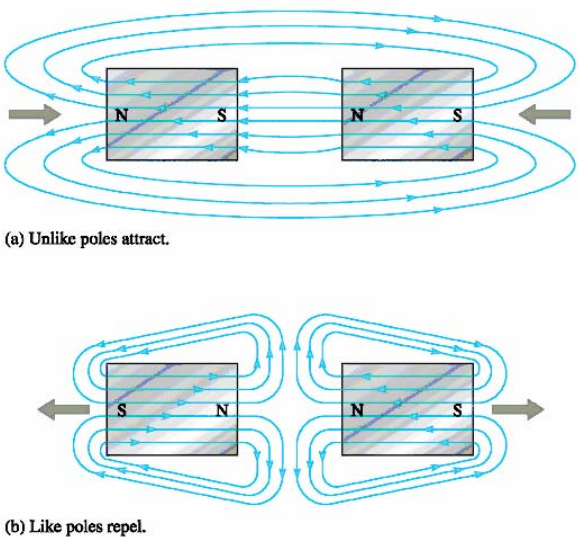
Blue lines represent only a few of the many magnetic lines of force in the magnetic field.

Induced Magnetism



- When a non-magnetized magnetic material is brought near to (or touches) a magnet, the material itself will become a weak magnet
- This is called induced magnetism
  - this means the material has magnetism induced in it
- Induced magnetism in magnetic materials is the reason that these non-magnetized objects are able to be attracted to magnets
- Notice that magnetic induction, an opposite pole is always induced
  - 2 unlike poles facing each other is observed during magnetic induction
- If placed sufficiently near to each other, attraction occurs between the permanent & induced magnets

Laws of Magnetism



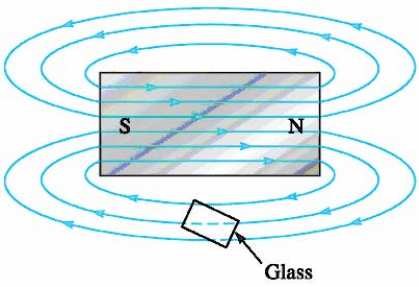
Non-Magnetic Materials

Natural magnet cannot attract other materials.
These include:

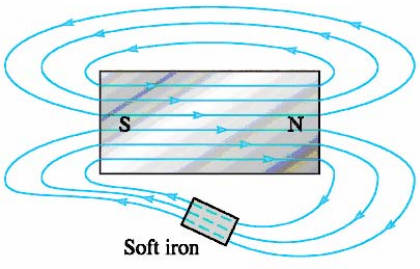
- copper
- brass
- wood
- plastics
- materials other than iron, steel, cobalt, nickel

These materials are called **Non-Magnetic** materials.

Magnetic Properties of Materials

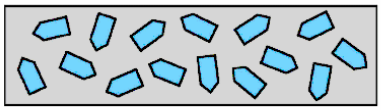


Non-Magnetic Materials are not affected by a magnetic field

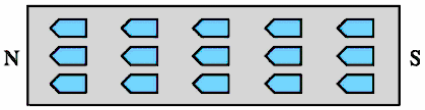


Unmagnetized ferromagnetic materials may become weak magnets in the presence of a magnetic field

Ferromagnetic Domains in Materials



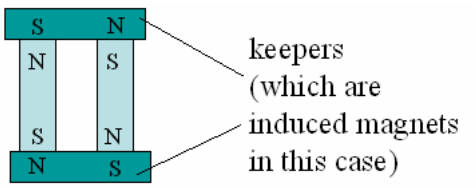
(a) The magnetic domains (N ◁ S) are randomly oriented in the unmagnetized material.



(b) The magnetic domains become aligned when the material is magnetized.

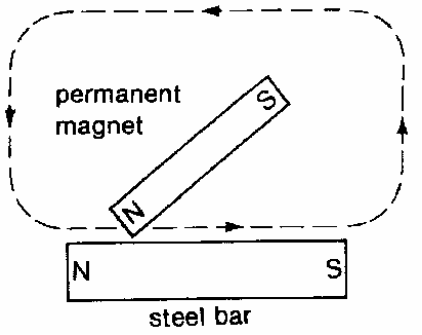
Storage of Magnets - Using Keepers

- The "free poles" near the end of magnets repel each other.
- As time passes, the magnet becomes weaker
- To prevent this weakening, bar magnets are stored in pairs by using keepers
  - 2 pieces of soft iron across the ends of the bar magnets.



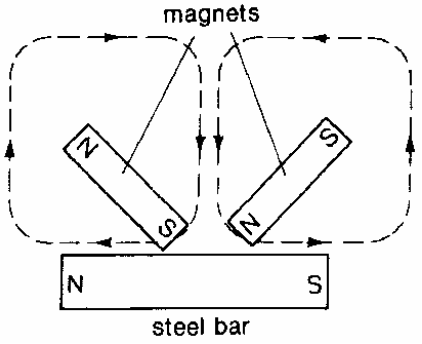
Magnetization

- Making a material permanently magnetic is called **magnetization**.
- There are several ways to magnetise materials
- **Magnetization by Stroking (Single-Touch)**
- This method is derived from applying the processes of
- Magnetic induction
  - Note the polarities of both the permanent magnet & steel bar that is to be magnetized
  - This form of magnetism gained is weak but permanent



Magnetization by Stroking (Double-Touch)

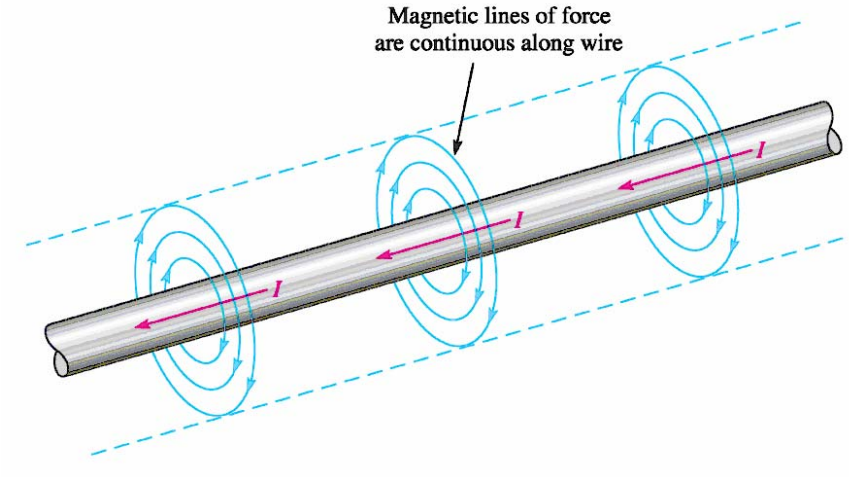
- Two permanent magnets are used in this method as compared to one being used in the single-touch stroking method.
- Note the polarities of both permanent magnets.
  - Note of the polarities of the permanent magnets & their induced ends of the steel bar
  - This form of magnetism gained is also weak but permanent



Magnetization by Heating & Hammering

- A magnet can be made by first placing a steel bar in a magnetic field
- Heat it to a high temperature
- Finally hammer it as it cools
  - This can be done by laying the magnet in a North-South direction in the Earth's magnetic field.
  - However, the magnet produced is not very strong but permanent

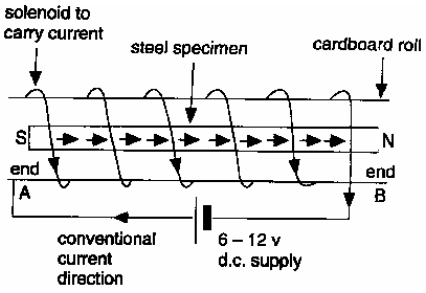
Electromagnetism



The current direction in the graphic is for electron flow

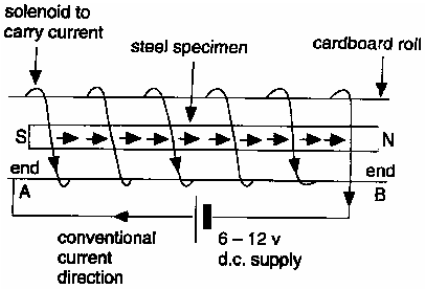
Electromagnetism

- Place the steel object inside a coil of wire (a **solenoid**).
- Pass a **direct current through the solenoid**
- A magnetic field is produced on the solenoid.
- As such, the steel rod is now placed inside a magnetic field.
- When the current is turned off the steel rod is found to be magnetized

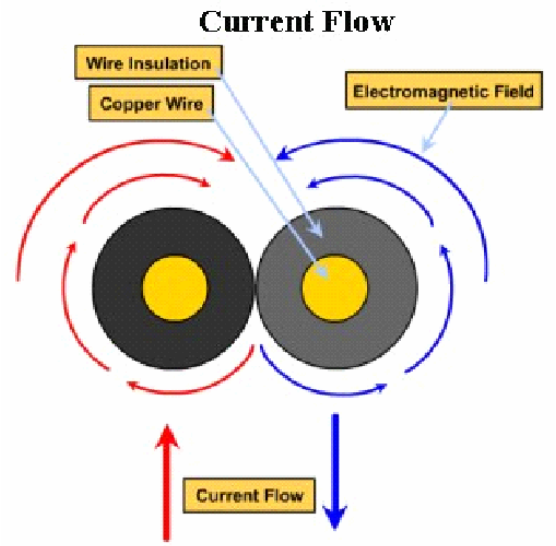


Electromagnetism

- Magnetization by the use of an electrically-generated magnetic field in a Solenoid
- The polarity of the newly-formed magnet for conventional current flow can be determined using the **Right-hand Rule**.
  - Wrap the fingers around the coil form in the direction of the current flow in the solenoid
  - the thumb will point in a direction indicating the end which becomes the N-pole



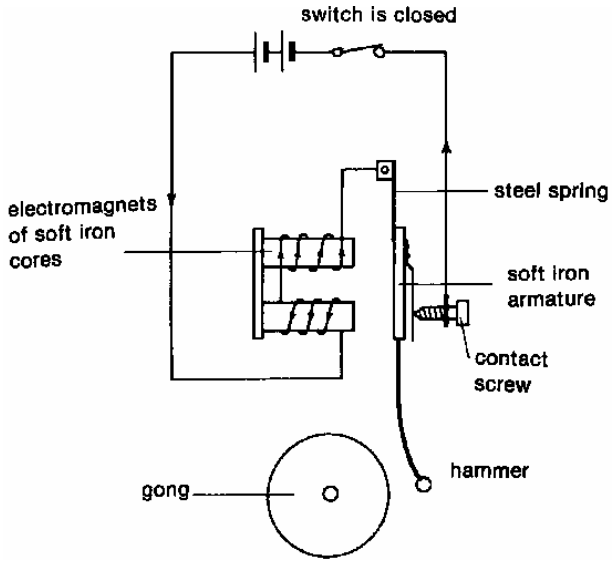
Current Flow in Twisted Pair



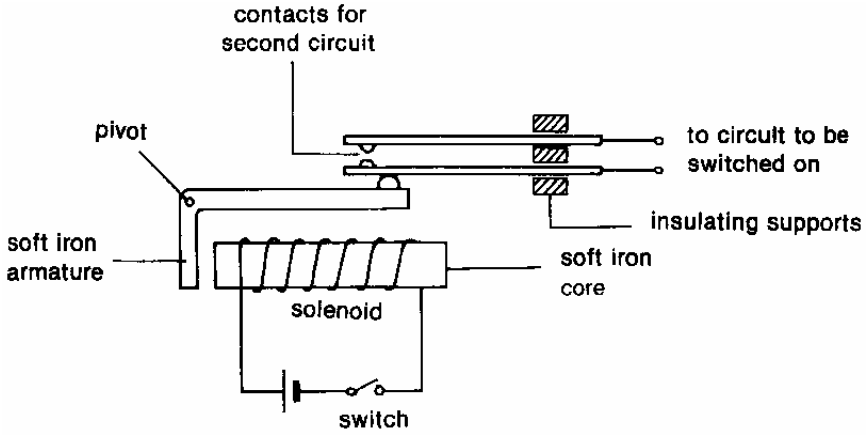
DeMagnetization by Heating & Hammering

Heat a magnet
Then hammer it as it is allowed to cool in the absence of a magnetic field i.e. facing East-West

Example of Electromagnetism – Door Bell



Example of Electromagnetism – Relay



Example of Electromagnetism – Speaker