Magnetism

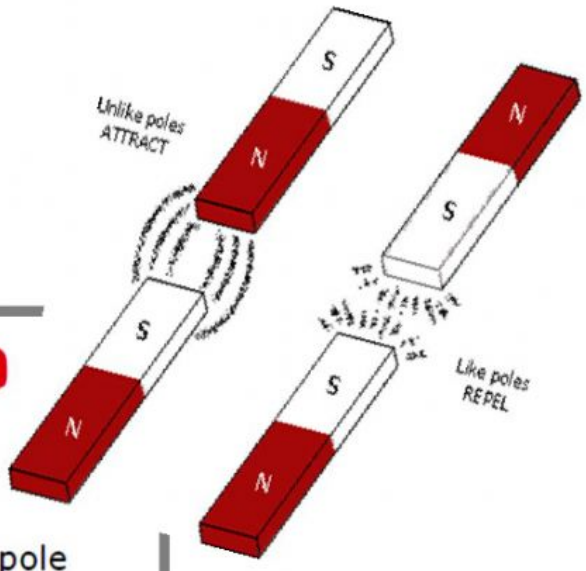
Grade 9 Revision:

TYPES OF FORCES

- **Contact force** E.g. friction, tension, compression
- **Non-contact force** (field force) E.g. gravitational, magnetic, electrostatic

- Magnetic materials are:
  - Iron
  - Cobalt
  - Nickel
  - Steel (man-made substance containing iron)

This doesn't mean these substances are magnets. It means they are naturally ATTRACTED to magnets.



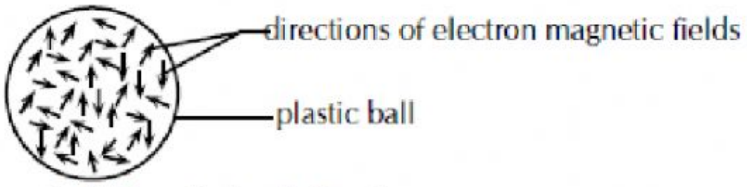
WHAT ARE MAGNETS?

- Magnets have a and a pole
- **Like** poles (S and S / N and N) (push)
- **Unlike** poles (S and N) : (pull)

Magnetic fields

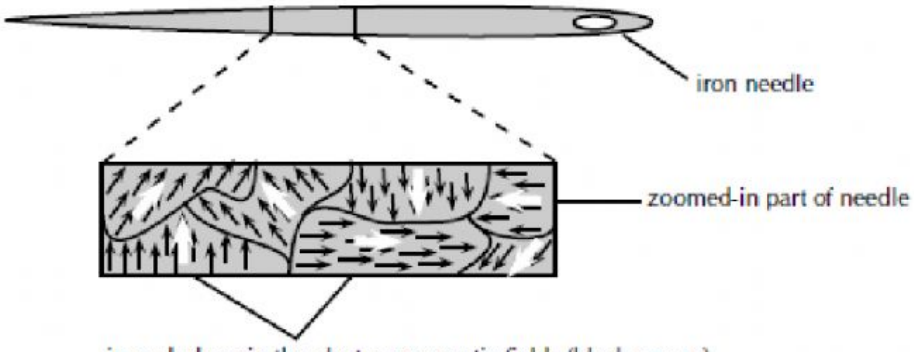
A magnetic field is a region in space where a magnet or object made of magnetic material will experience a non-contact, magnetic force.

So electrons inside any object are moving and have magnetic fields associated with them. In most materials these fields point in various directions, so the net magnetic field is zero. For example, in the plastic ball below, the directions of the magnetic fields of the electrons (shown by the arrows) are pointing in different directions and cancel each other out. Therefore the plastic ball is not magnetic and has no magnetic field.

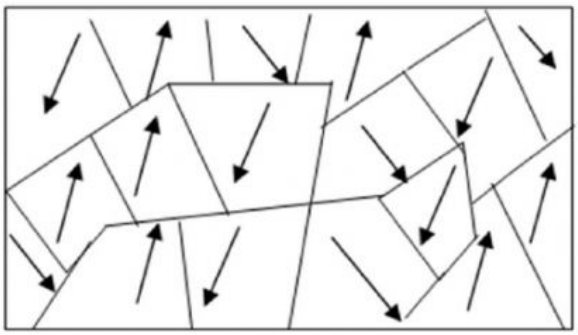


The electron magnetic fields point in all directions
and so there is no net (total) magnetic field for the whole ball

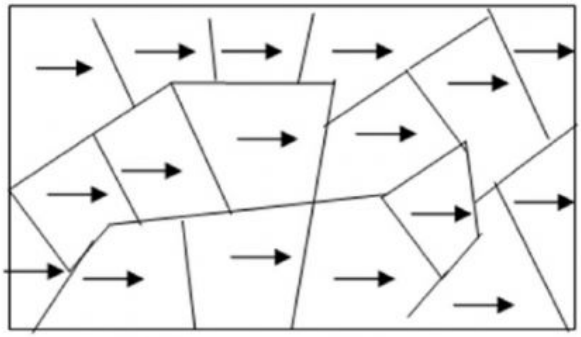
In some materials (e.g. iron), called **ferromagnetic** materials, there are regions called *domains*, where the electrons' magnetic fields line up with each other. All the atoms in each domain are grouped together so that the magnetic fields from their electrons point the same way. The picture shows a piece of an iron needle zoomed in to show the domains with the electric fields lined up inside them.



in each domain the electron magnetic fields (black arrows)
are pointing in the same direction, causing a net
magnetic field (big white arrows) in each domain



A. Random domain orientation



B. After magnetization

In permanent magnets, many domains are lined up, resulting in a *net magnetic field*. Objects made from ferromagnetic materials can be magnetised, for example by rubbing a magnet along the object in one direction. This causes the magnetic fields of most, or all, of the domains to line up in one direction. As a result the object as a whole will have a net magnetic field. It is *magnetic*. Once a ferromagnetic object has been magnetised, it can stay magnetic without another magnet being nearby (i.e. without being in another magnetic field). In the picture below, the needle has been magnetised because the magnetic fields in all the domains are pointing in the same direction.

(identical) poles of magnets one another whilst (opposite) poles

This means that two N poles or two S poles will push away from each other while a N pole and a S pole will be drawn towards each other.

Do you think the following magnets will repel or be attracted to each other?

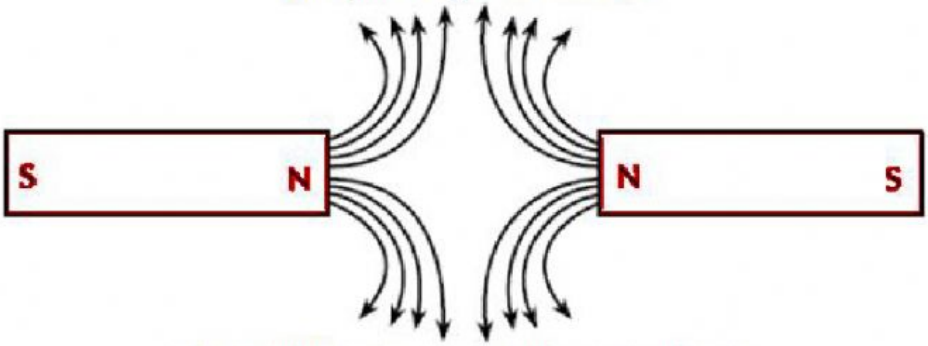
We are given two magnets with the N pole of one approaching the N pole of the other. Since both poles are the same, the magnets will each other.

We are given two magnets with the N pole of one approaching the S pole of the other. Since both poles are the different, the magnets will each other.

Drawing Magnetic Fields:

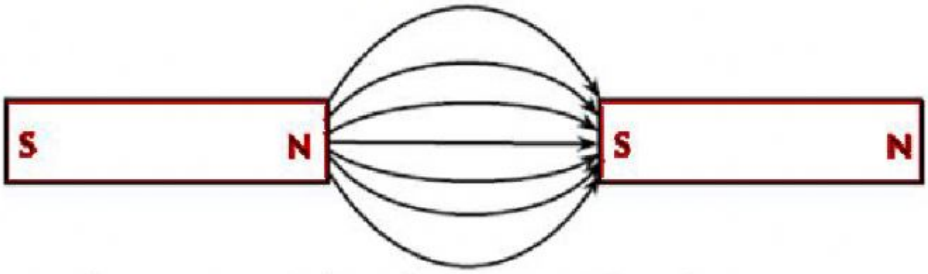
- Magnetic fields are represented by **field lines**
- Field lines are **imaginary**
- Field lines run from North → South
- High concentration of lines indicates a strong magnetic field
- Field lines do not cross each other

Like poles repel each other



The field lines between 2 like poles diverge

Unlike poles attract each other



The magnetic field lines between 2 unlike poles converge

Note the direction of the field is shown by arrows which always go away from towards