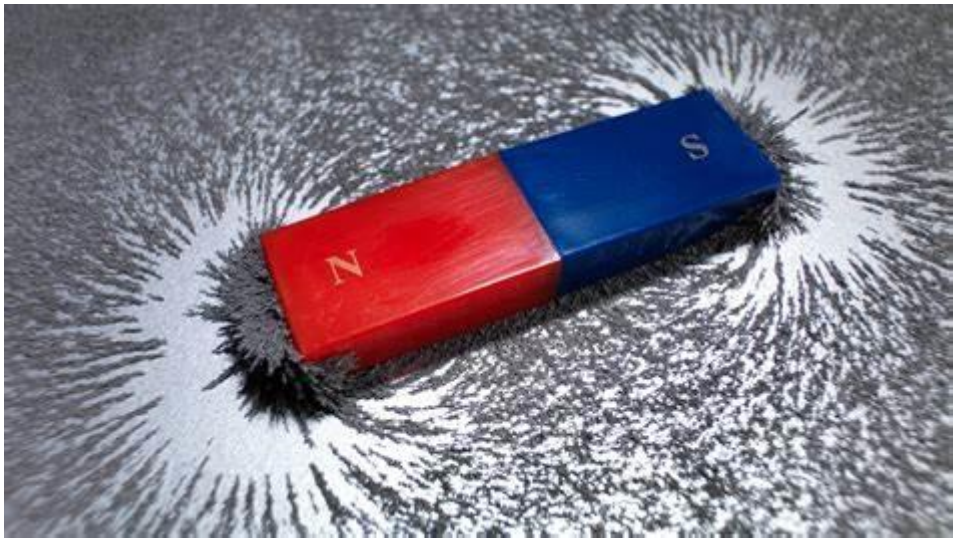


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S2 New Curriculum Physics

Theme: Magnetism

Chapter 6 – Magnets and magnetic fields



MAGNETISM

This is the ability of substances to attract and/or to repel others.

A **magnet** is a piece of metal which is able to attract another magnet or a magnetic material.

Lodestone is a naturally occurring magnet.

A magnet exerts magnetic forces on magnetic materials. The magnetic forces are:

(i) Forces of attraction.
(ii) Forces of repulsion.

Uses of magnets

- In construction of cycle dynamos, telephones, loud speaker, electric meters, current measuring instruments.
- To remove metal splinters from oil engine
- For door closures

- Electric bell
- Magnetic ink
- Computer memory cards.
- Electric motor
- Magnets are used in hospitals to remove iron pieces from the eye of patient.
- Making magnetic tapes used in audio and video recorders.

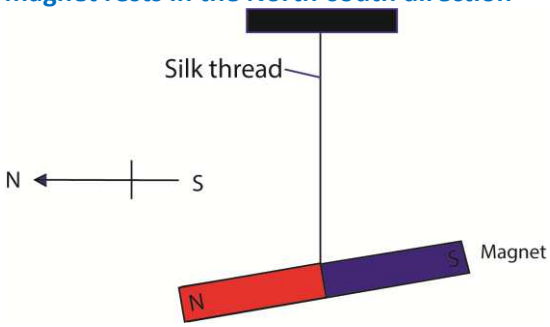
Properties of a magnet

(i) **It attracts other pieces of metals.**

- Materials attracted by magnets are called magnetic materials
- Materials strongly attracted by magnets are called ferromagnetc materials such as iron, nickel steel, cobalt.
- Materials that are not attracted by magnets are non magnetic materials, e.g. copper, brass, aluminium, wood and plastics

(ii) **It possesses magnetic poles**- theNorth Pole and South Pole at the ends of a magnet. These are places where magnetic forces appear to be concentrated.

(iii) **A freely suspended magnet rests in the North-south direction**



Explanation; This is because the earth is a magnet having its south pole in the northern hemisphere and its north pole in the southern hemisphere so there is attraction between the poles of freely suspended magnet and the earth's magnet.

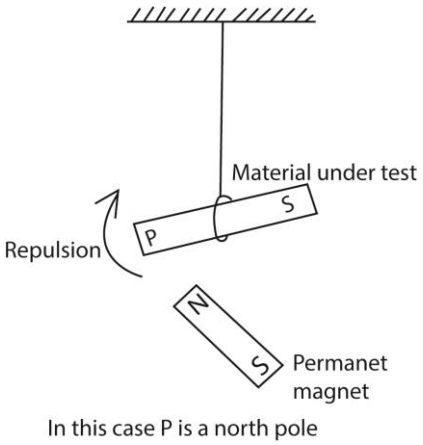
Law of magnetism

States that **like poles of magnets repel and unlike poles of magnet attract**

Testing for polarity of a pole

A known pole of magnet is brought near the ends of a material suspected to be a magnet. If repulsion occurs then that end of material is a like pole. The poles of a given magnet or magnetized material are tested by repulsion occurring between poles of a known magnet and that of the material whose polarity is to be tested.

NB: Repulsion is a sure test for polarity because repulsion only occurs due to like poles of magnets. While **attraction** is not a sure test because attraction can either result from unlike poles of magnets **or** from magnet and Ferromagnetic material which is not magnetized.

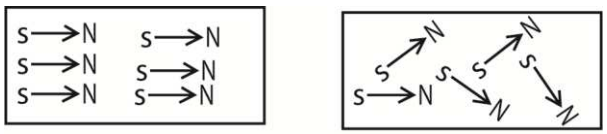


In this case P is a north pole

Magnetic domain theory

A magnet is made us of tiny molecular magnets called dipole arranged in groups called magnetic domains, lined up with their N-poles pointing in the same direction.

In nonmagnetic materials, the domains are randomly mixed and their magnetic effect cancels each out.



Magnetized material

Unmagnetized material

Magnetization

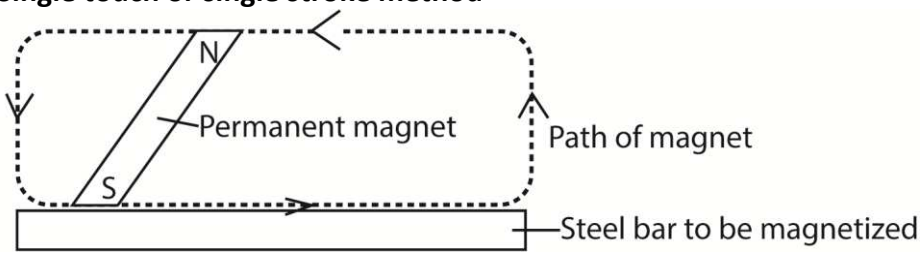
This is a process by which randomly arranged molecular magnet of a ferromagnetic material are arranged to point in one direction.

Methods of magnetization

These include:

- Single touch method.
- Double touch method.
- Electrical method using direct current (d.c.).

Single touch or single stroke method



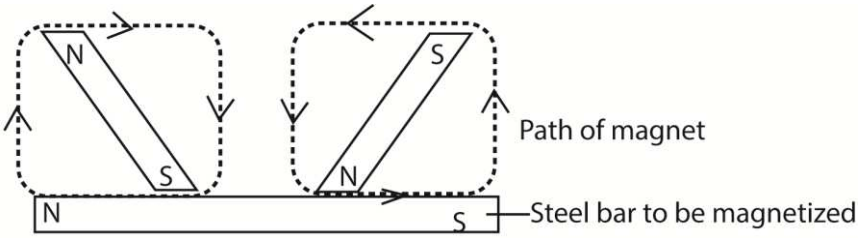
Single stoking
A steel bar (Ferromagnetic material) is stroked several times from end to end using a bar magnet. The stroking is done in the same direction and using the same pole of bar magnet.

Molecular magnets explanation
The stroking of the magnet pulls the randomly molecular magnets to face in one direction thus material becomes magnetic.

Disadvantage of single stroke method
The magnet produced has one pole nearer to the end as compared to the other pole

Identification of a pole
The pole of the bar magnet being used for stroking should be the same pole induced at the end of the steel bar from where stroking starts.

Double touch method or double stroke method

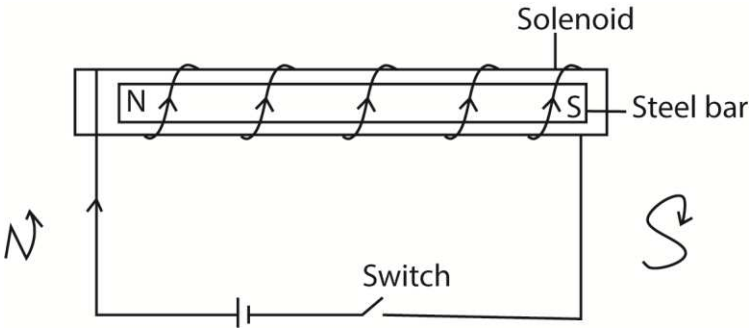


This uses two bar magnets placed at the centre of the steel bar with unlike poles as in the diagram. The stroking begins in the middle of the steel bar and ends at the opposite ends. The magnets are raised high at the end of each stroke before another one begins. This prevents reversing the acquired magnetism.

Molecular magnet
As stroking is done, the molecular magnets are pulled to face in one direction therefore creating poles at the ends of the steel bar.

Advantage of a double touch method over a single touch method
All poles are at both ends while for single touch method one pole is nearer to end than the other.
Disadvantages of double touch method over a single touch method
Double touch method is more expensive and tiresome.

Electrical method



The steel bar to be magnetized is placed inside a solenoid connected to the cells.
When direct current is switched on for some time, the bar will be magnetized

Note that with a.c. current the bar is not magnetized

Polarity of steel bar
The polarity of the steel bar depends on the direction in which the current is flowing. Current flows from positive to negative, so if on looking at the end of solenoid, current is flowing in a clock wise direction, that end will be South Pole but if it is flowing anti clockwise the end will be a north pole.

Induction method
When a magnetic material is kept close to a magnet for long time it gets magnetized.

Magnetic saturation
This is the maximum level of magnetization when the resultant magnetic axes of all domains in magnetic material are aligned with the magnetizing field.

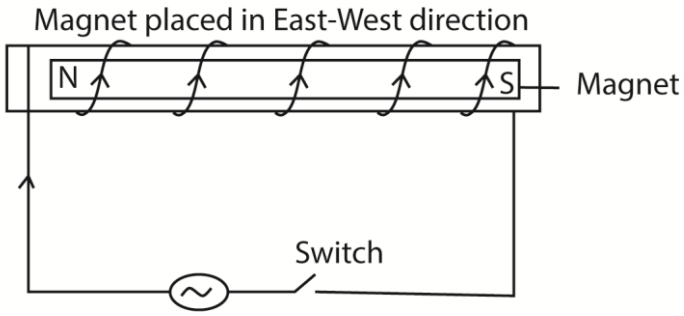
Demagnetization

Demagnetization is the process through which magnets lose their magnetism
Demagnetization result in scattering molecular magnets to face in randomly.

Methods of demagnetization
(i) By Heating:
Heating a magnetized material makes it loses its magnetism. This is because the temperature rise causes the vibrations of molecular magnets to become so great that their ordinary arrangement is destroyed.

(ii) By hammering:
Hammering a magnetized material placed in east-west direction, makes it loses most of its magnetism. This is because when a magnet is hammered, the vibrations of the molecular magnets increase which result in random arrangement.

(iii) By electrical method using alternating current

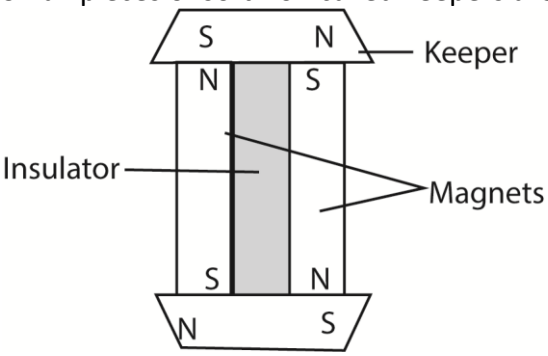


Here an alternating current is supplied to the solenoid in which the magnet is placed in east-west direction.

The alternating current (a.c.) causes the molecular magnet to change from orderly to random arrangement as current changes direction of flow every half cycle.
The demagnetized magnet should be removed from solenoid and stored along east- west direction to avoid magnetization due to earth's field.

Storing magnets

Small pieces of soft iron called keepers are placed across opposite **poles** of two bar magnets



These iron keepers become induced magnets and their poles neutralize the poles of the magnets. This ensures that there is no magnetic loss.

Soft and hard magnetic substances

Soft magnetic materials are substance that are easily magnetized and easily lose magnetism, e.g. soft iron.
Soft magnetic materials are used in making soft-iron core in transformers, dynamos, e.t.c.

Hard magnetic material are materials that are difficult to magnetize but retain their magnetism for long, e.g. steel.
Hardmagnetic materials are used in loud spears.

Magnetic field

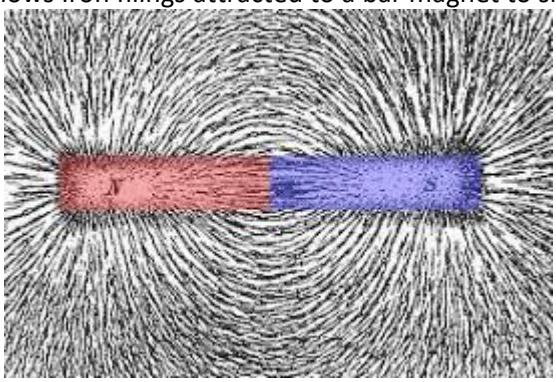
A mgnetic field is a region around a magnet in which magnetic force is experienced.

An experiment to determine the magnetic field pattern of bar magnet using iron fillings

- A cardboard is placed on a magnet and iron fillings sprinkled on the cardboard

- On tapping slightly on the cardboard, the fillings arrange themselves along the magnetic lines.
- The figure below shows Iron filings attracted to a bar magnet to show the magnetic field.

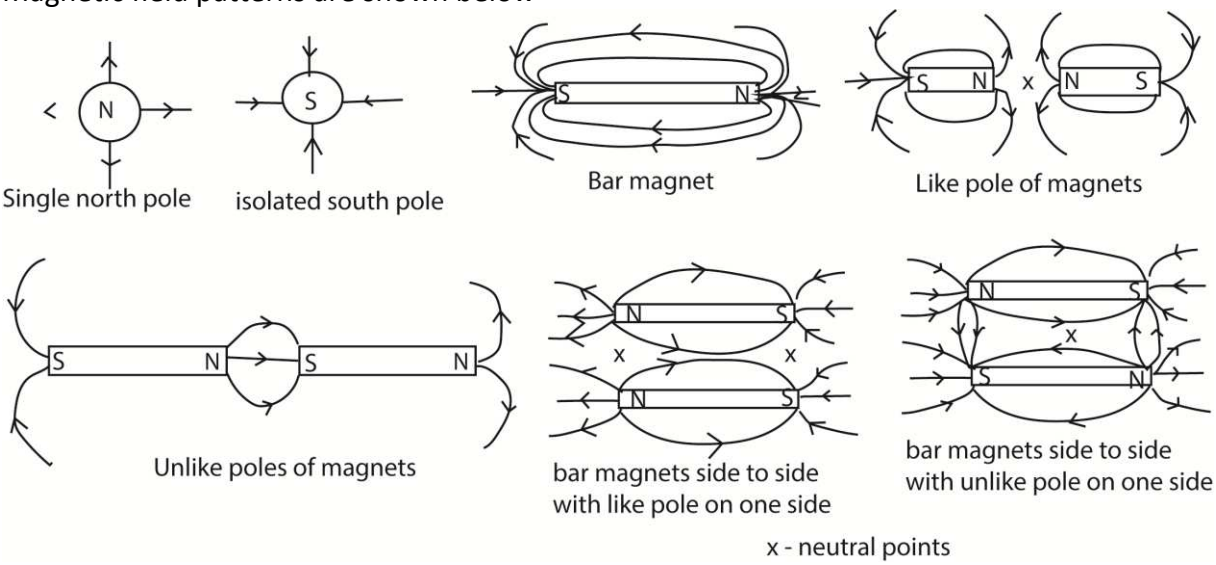
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Magnetic field lines

They are lines of forces in magnetic field running from North to south poles of a magnet. The direction of these lines can be shown using a plotting compass.

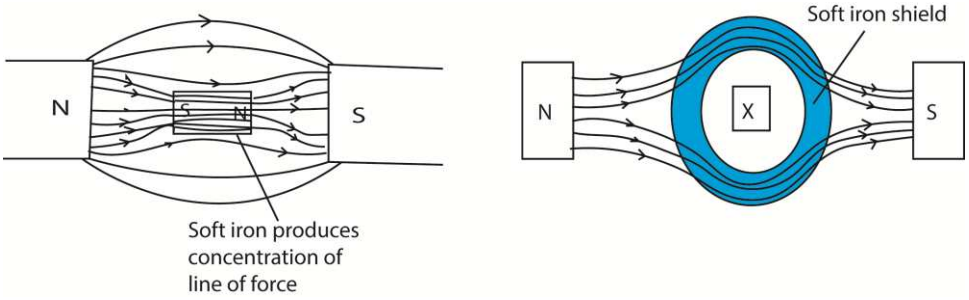
Magnetic field patterns are shown below



NB: (i) Neutral point are places around magnets where the magnetic field flux is zero; i.e. no magnetic line pass through neutral point

(iii) The more crowded the field lines, the stronger the magnetic force

(iv) Magnetic shielding/screening is the protection of the object against external magnetic fields by enclosing it with soft – iron ring or box



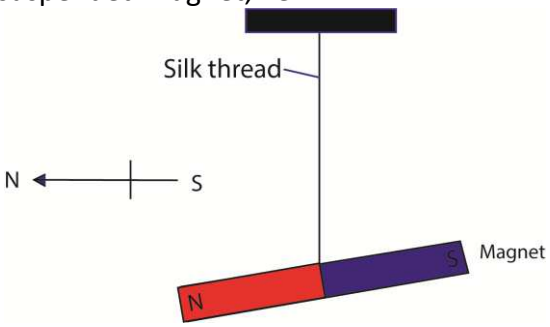
The magnetic field lines are attracted to soft iron ring shielding the region enclosed by the ring or box from magnetic field

Thick-walled soft-iron boxes are used to shield delicate and sensitive electrical instruments from external magnetic fields

The earth as a magnet

Suspending a bar magnet

When a bar magnet is freely suspended, it always come to rest in a north-south direction. This is because the earth is a magnet having its north pole in the southern hemisphere and South Pole in the northern hemisphere and these poles attract the poles of the freely suspended magnet, i.e.



Revision questions

1. (a) What is a magnet?
   (b) State the difference between magnetic materials and non-magnetic materials. Give three examples of each.
2. (a) Stat the law of magnetism
   (b) Describe with illustrations how to magnetize an iron bar.
   (c) State ways of demagnetizing a bar magnet.
3. Explain how you can test whether a substance is a magnets
4. Draw magnetic field around the following sets of magnets

(a) N S S N

(b) N S

S N

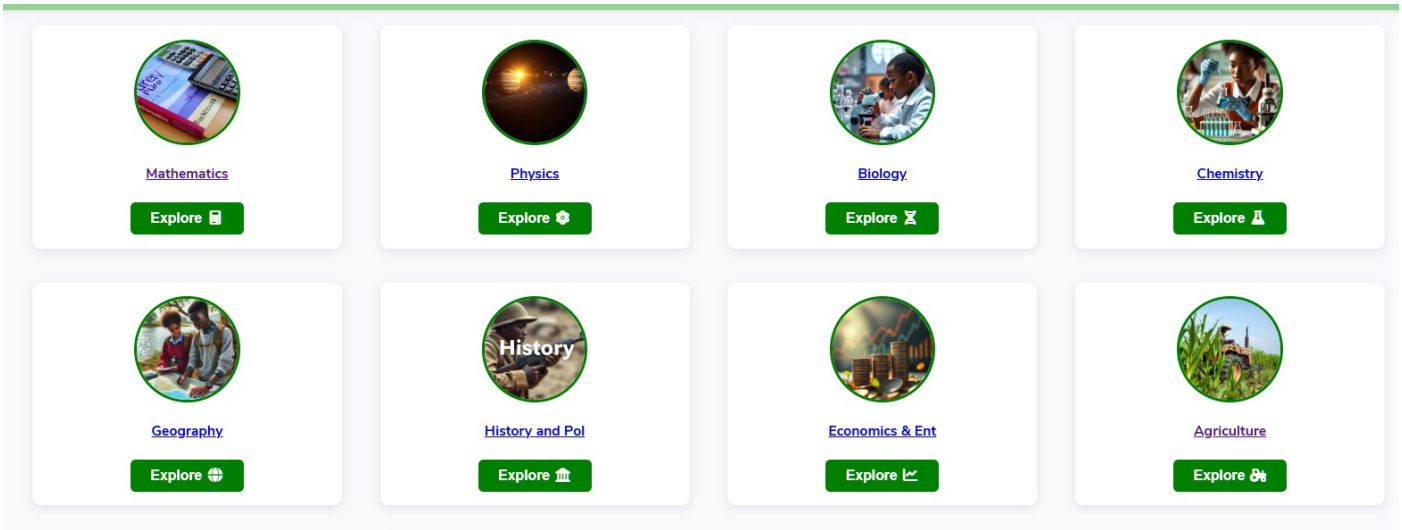
(c) S N S N

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