TOPIC 20 Magnetism

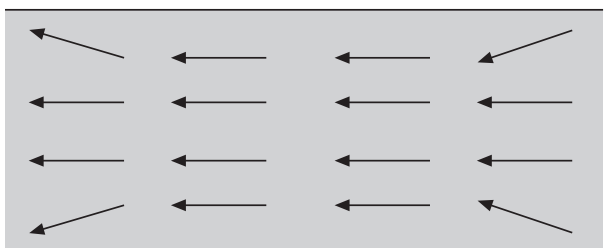
Objectives

Candidates should be able to:
(a) state the properties of magnets
(b) describe induced magnetism
(c) describe electrical methods of magnetisation and demagnetisation
(d) draw the magnetic field pattern around a bar magnet and between the poles of two bar magnets
(e) describe the plotting of magnetic field lines with a compass
(f) distinguish between the properties and uses of temporary magnets (e.g. iron) and permanent magnets (e.g. steel)

NOTES

20.1 Laws of Magnetism

1. Properties of Magnets:
   (a) A magnet has two poles where the magnetic forces are the strongest: North pole and South pole.
   (b) Magnets DO NOT exist as monopoles (unlike electric charges).
   (c) We can use arrows to indicate magnetic dipoles in a magnet. The arrowhead indicates North pole.

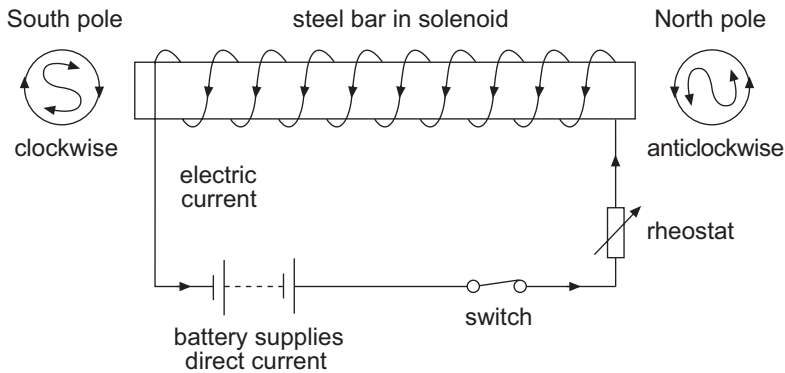


The arrows nearer to the edge are not exactly parallel due to repulsion of like poles.

   (d) The law of magnetism states that like poles repel and unlike poles attract.
   (e) Repulsion is the only way to test if an object is a magnet.

2. Induced magnetism: A magnetic material becomes an induced magnet when placed in a magnetic field, i.e. near a permanent magnet. The magnetic field from the magnet aligns the randomly arranged dipoles in the material.

3. Magnetisation using electricity:
   To magnetise a steel bar, one can place it in a solenoid connected to a d.c. source.
   (a) The magnetic field produced by the solenoid magnetises the steel bar.
   (b) The polarities of the magnetised steel bar depend on the direction of the current.
   (c) If the bar is viewed from one end and the current flows in an anticlockwise direction, then that end will be the North-pole; if clockwise, then that end will be the South-pole.



20.2 Magnetic Properties

1. Examples of magnetic materials: iron, steel, nickel and cobalt.

2. Permanent magnets are magnets that do not lose their magnetism easily. They are made from materials like steel. Steel is an alloy of carbon and iron.

3. The differences between the magnetic properties of iron and steel can be summarised in the table below:

Properties	Iron	Steel
Material	soft	hard
Magnetisation	easy	difficult
Demagnetisation	easy	difficult
Magnetic field strength in solenoid	strong	weak
Magnetism	temporary	permanent

4. Comparison between electromagnet and permanent magnet:

Electromagnet	Permanent magnet
Made of a coil of wire (often with a soft iron core).	Made of hard magnetic material like steel.
Magnetism is temporary. Requires a current through the coil to sustain the magnetic field strength.	Magnetism is permanent. Does not require any electric current to retain magnetic field strength.
Applications: telephone receivers, electric relays, electric bells, circuit breakers and loudspeakers*.	Applications: magnetic doorstops, compasses, motors, dynamos and loudspeakers*

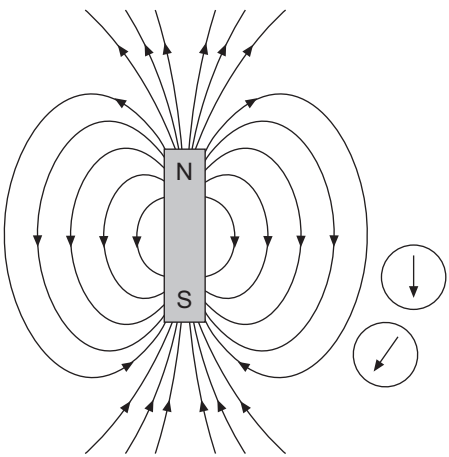
* A loudspeaker uses both an electromagnet and a permanent magnet.

20.3 Magnetic Field

1. A magnetic field is a region in space where magnetic materials experience a force.

2. Magnetic field lines: We draw magnetic field lines to help us visualise the direction of the magnetic forces.

3. A compass can be used to plot the magnetic field lines around a magnet by marking each end of the compass needle with a dot as it is moved from the North pole to the South pole and linking up the dots together to form a solid line. The arrow on the line indicates the direction the compass needle points.



Important:

1. Magnetic field lines always start from North and end at South.
2. Each line is always in a complete closed loop (no matter how big the loop is) unlike electric field lines which can point to infinity.
3. Strength of a magnetic field depends on how close the lines are spaced together. (Closer ⟶ Stronger)

4. The magnetic field lines between like poles and unlike poles are as follows: