Introduction to Physical Science

Magnetism

Presented by Robert Wagner

Magnets

- Magnets attract certain materials like iron
- Magnets can attract or repel other magnets
  - All magnets have two poles (two poles cannot be separated)
  - North magnetic pole
  - South magnetic pole
- Like poles repel and unlike poles attract

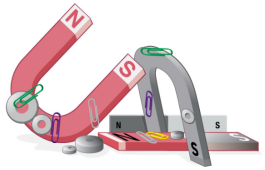

Image Credit: OpenStax College Physics - Figure 22.3 CC BY 4.0

Magnets

- Magnets attract certain materials like iron
- Magnets can attract or repel other magnets
  - All magnets have two poles (two poles cannot be separated)
  - North magnetic pole
  - South magnetic pole
- Like poles repel and unlike poles attract

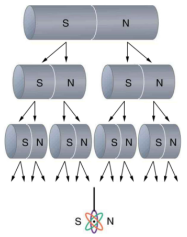

Image Credit: OpenStax College Physics - Figure 22.6 CC BY 4.0

Magnets

- Magnets attract certain materials like iron
- Magnets can attract or repel other magnets
  - All magnets have two poles (two poles cannot be separated)
  - North magnetic pole
  - South magnetic pole
- Like poles repel and unlike poles attract

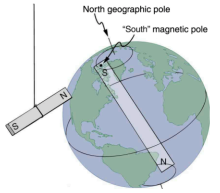

Image Credit: OpenStax College Physics - Figure 22.4 CC BY 4.0

Ferromagnets

- Materials that exhibit strong magnetic effects are called ferromagnets (ferro for iron)
- These materials are strongly attracted to magnets
- They can be made into permanent magnets through heating

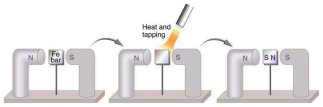

Figure 22.7 An unmagnetized piece of iron is placed between two magnets, heated, and then cooled, or simply tapped when cold. The iron becomes a permanent magnet with the poles aligned as shown: its south pole is adjacent to the north pole of the original magnet, and its north pole is adjacent to the south pole of the original magnet. Note that there are attractive forces between the magnets.

Image Credit: OpenStax College Physics - Figure 22.7 CC BY 4.0

Ferromagnets

- Materials that exhibit strong magnetic effects are called ferromagnets (ferro for iron)
- These materials are strongly attracted to magnets
- They can be made into permanent magnets through heating

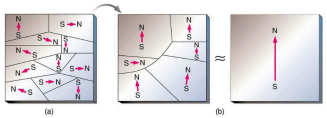

Figure 22.8 (a) An unmagnetized piece of iron (or other ferromagnetic material) has randomly oriented domains. (b) When magnetized by an external field, the domains show greater alignment, and some grow at the expense of others. Individual atoms are aligned within domains; each atom acts like a tiny bar magnet.

Image Credit: OpenStax College Physics - Figure 22.8 CC BY 4.0

Electromagnets

- Electric currents can cause magnetic effects
- Electromagnetic - Temporarily induced magnet
  - Behave like a permanent magnet
- Combination of ferromagnet and electromagnet can give very strong magnetic effects

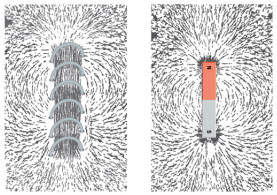

Image Credit: OpenStax College Physics - Figure 22.10 CC BY 4.0

Electromagnets

- Electric currents can cause magnetic effects
- Electromagnetic - Temporarily induced magnet
  - Behave like a permanent magnet
- Combination of ferromagnet and electromagnet can give very strong magnetic effects
- Ferromagnetic materials can be used for memory devices

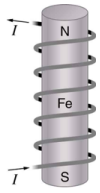

Figure 22.11

Image Credit: OpenStax College Physics - Figure 22.11 CC BY 4.0

Electromagnets

- Electric currents can cause magnetic effects
- Electromagnetic - Temporarily induced magnet
  - Behave like a permanent magnet
- Combination of ferromagnet and electromagnet can give very strong magnetic effects
- Ferromagnetic materials can be used for memory devices

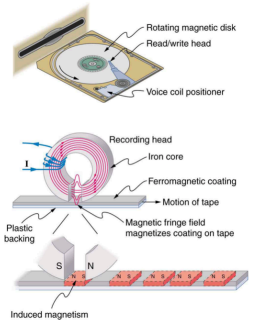

Image Credit: OpenStax College Physics - Figure 22.12 CC BY 4.0

Where Does Magnetism Come From?

- Electric currents are the source of magnetism
  - Ferromagnets - electric currents at submicroscopic level
- Current loops always produce a magnetic dipole - having a north and south magnetic pole
  - Isolated magnetic poles - magnetic monopoles have not been observed to exist

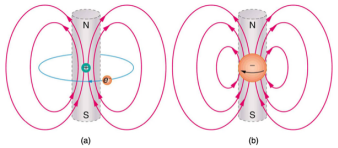

Image Credit: OpenStax College Physics - Figure 21.24 CC BY 4.0

Magnetic Field Lines

- Direction of magnetic field lines:
  - Direction to which the north end of a compass needle points
- Magnetic field (called B-field)
  - Field strength is proportional to how close the lines are
  - Magnetic field lines can never cross
  - Magnetic field lines are continuous closed loops

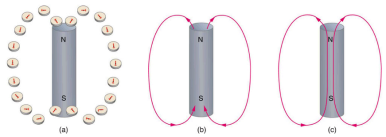

Image Credit: OpenStax College Physics - Figure 22.15 CC BY 4.0

Summary

- Magnets attract materials like iron and have north and south magnetic poles
- Ferromagnetic materials (like iron) can be made into permanent magnets through heating
- Electromagnets are temporary magnets induced by electrical currents