L 28 Electricity & Magnetism [5]

Magnetism
- Magnets
  - permanent magnets
  - electromagnets
- magnetic forces
- applications

Magnetism
- two sources of magnetism
  - permanent magnets
  - electromagnets
- the earth’s magnetic field
  - how does a compass work
  - the north pole is really a south pole!
  - Van Allen radiation belts

Permanent magnetism
- certain minerals (magnetite, Fe₃O₄) are naturally magnetic
- a piece of loadstone will attract bits of iron
- a magnet produces a magnetic field in the space around it, just like the Sun has a gravitational field that holds the planets in their orbits
- the magnetic field can be visualized with iron filings

Earth’s magnetic and Gravitational fields

Permanent magnets
- Are made from alloys of some of the rare earth elements like neodymium and samarium and cobalt.
- Always have a north and a south pole
- like poles repel and unlike poles attract
- if you break a magnet in half you get 2 magnets → cannot have just a north or just a south pole

Bar Magnet
- If you pass current through a loop of wire you get a magnet Oersted discovered this
- Ampere figured out the formula relating currents to magnetic fields (Ampere’s Law)

Electromagnet
Homemade magnets

You can think of the nail as a collection of little magnets that are randomly aligned. The magnetic field of the coil aligns these little magnets giving a larger field than that of the coil alone. We say that the nail becomes "magnetized", but the effect is not permanent.

Magnetic materials

- some materials are naturally magnetic or can be magnetized and retain their magnetism → ferromagnetic materials
- other materials (iron) can be magnetized temporarily by placing them near magnets
- some materials have essentially no magnetic properties → copper, aluminum, plastics...
- heat can destroy magnetism (Curie effect)

The earth is a big magnet

- The earth’s north geographic pole is the south pole of a big magnet.
- A compass needle is attracted to the earth’s north geographic pole
- The earth’s magnetism is due to currents flowing in its molten core (not entirely understood!)

CNN Report Dec. 12, 2003
Earth’s magnetic field fading
Slight chance of flipping magnetic poles

The strength of the earth’s magnetic field decreased 10% over the last 150 years. At this rate, the field will disappear altogether in 1,500 to 2,000 years.

Sun – Earth Connection:
space weather

Space weather can have a large effect on communications, and it can cause damage to orbiting satellites.

Northern Lights

SUN
Particles stay on the magnetic field lines

- electron that originated on the sun → part of the solar wind.
- The earth’s magnetic field traps charged particles.
- During periods of intense solar activity, satellites can be at risk.

Van Allen Radiation Belts

Magnetic forces

- magnetic fields can cause charges to turn around.

Magnetic forces on wires

- Wire pushed OUT
- Wire pulled IN
Forces on parallel wires

Opposites repel
Likes attract

Applications

Magnets are not just for holding things on the refrigerator!

The electric motor

When a current is present in a coil, it experiences a torque and rotates.

Magnets make speakers work

The force between the permanent magnet and the voice coil moves the speaker cone

MAGLEV Trains

Magnetic tape recording