

# Magnetism

- **Review:**

- \_\_\_\_\_ : inverse square law, depends on two bodies, has constant,  $f \sim m_1 m_2 / d_2$ .
- \_\_\_\_\_ : inverse square law, depends on two *charges*, has constant,  $f \sim q_1 q_2 / d_2$ .

- **Magnetic Force:** inverse square law, depends on two \_\_\_\_\_ *poles*, has constant,  $f \sim q_1 q_2 / d_2$ .

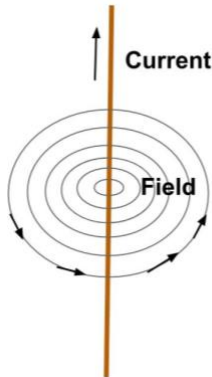
- Historically, from Greeks around 0, found lodestones in \_\_\_\_\_ – now called magnetite.
- Separate from electricity until Oersted and \_\_\_\_\_ saw relationship. [OERSTED 1820]
- \_\_\_\_\_ seem to always have a North and South pole (refrigerator magnets alternate poles).
- Like poles \_\_\_\_\_, unlike poles \_\_\_\_\_.

- **Magnetic Fields**

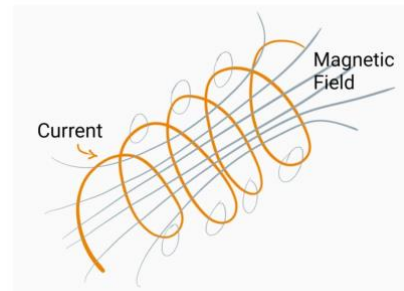
- \_\_\_\_\_ have lines that go from north pole to south pole. Even cans of food are magnetized a little.
- Magnetic Fields are related to moving \_\_\_\_\_ charges; still charges produce no magnetic field.
- Magnetic fields are \_\_\_\_\_ (Einstein: Special Theory of Relativity, 1905).
- Every atom therefore produces \_\_\_\_\_.
- *Magnetic* \_\_\_\_\_ are clusters of aligned atoms. Iron allows temporary and permanent alignment quite well – that is why it is attracted to a magnet. [TEMP MAGNET: HIT & HEAT]

- **Electromagnetic Fields**

- Actually all \_\_\_\_\_ or \_\_\_\_\_ fields are electromagnetic fields.
- Use \_\_\_\_\_ hand rule on either and you'll see that a spinning field of either causes the other.
- *This is how to form Electromagnets, Meters, Solenoids, Microphones, Speakers, TV, and the GENERATOR, MOTOR, & TRANSFORMER!* [SOLENOID, SPEAKER, MICROPHONE]
- In a \_\_\_\_\_, electric fields accelerate particles that are steered into spirals by magnetic fields.



If the current is straight – the magnetic field is circular straight



If the current is circular – the inner magnetic field is straight

- **Earth's Magnetic Field**

- We think formed by molten, moving \_\_\_\_\_ from convection currents causing electric current.
- Magnetic \_\_\_\_\_ pole is about 1800km from geographic North Pole (in Hudson Bay, Canada). Magnetic \_\_\_\_\_ pole is south of Australia. This difference is the *magnetic declination* and it changes *over time* (right now at about 40 km/yr) and *by position* (see the map at the site: [http://geology.isu.edu/geostac/Field\\_Exercise/topomaps/mag\\_dec.htm](http://geology.isu.edu/geostac/Field_Exercise/topomaps/mag_dec.htm)).
- We think poles have shifted 700,000, 870,000 and 950,000 years ago.

- **Cosmic Rays** (great website: <http://helios.gsfc.nasa.gov/cosmic.html> )

- \_\_\_\_\_, other atomic nuclei (mostly from Sun) – at mid-latitudes about 5 particles/cm<sup>2</sup> minute.
- \_\_\_\_\_ field catches most in Van Allen belts; they fluoresce as Aurora Borealis and Australis.

- **Biomagnetic Fields**

- We increasingly are learning that we have a sense of magnetic fields – don't know uses, yet.
- Magnetic Resonance Imaging (MRI) hits hydrogen protons with radio, then watches EM waves.

## Magnetism Worksheet

- **Review:**

- Gravity: inverse square law, depends on two bodies, has constant,  $f \sim (1)$ \_\_\_\_\_.
- Electricity: inverse square law, depends on two *charges*, has constant,  $f \sim (2)$ \_\_\_\_\_.

- **Magnetic Force:** inverse square law, depends on two *magnetic poles*.

- Separate from electricity until Oersted and (3)\_\_\_\_\_ saw relationship. [OERSTED 1820]

- **Magnetic Fields**

- Fields have lines that go from (4)\_\_\_\_\_ to (5)\_\_\_\_\_
- Magnetic Fields are related to moving electric charges; still charges produce (6)\_\_\_\_\_.
- Every atom therefore produces (7)\_\_\_\_\_.

- **Electromagnetic Fields**

- Actually all electric or magnetic fields are (8)\_\_\_\_\_ fields.
- Use right hand rule on either and you'll see that a spinning field of either causes the other.
- This is how to form Electromagnets, (9)\_\_\_\_\_ (10)\_\_\_\_\_ (11)\_\_\_\_\_
- In a Cyclotron, (12)\_\_\_\_\_ fields accelerate particles that are steered into spirals by (13)\_\_\_\_\_ fields.

- **Earth's Magnetic Field**

- We think formed by molten, moving iron from (14)\_\_\_\_\_ currents causing electric current.

- **Cosmic Rays**

- Protons, other atomic nuclei (mostly from (15) \_\_\_\_\_ – at mid-latitudes about 5 particles/cm<sup>2</sup> minute.
- Magnetic field catches most in Van Allen belts; they fluoresce as Aurora Borealis and Australis.

- **Biomagnetic Fields**

- We increasingly are learning that we have a sense of (16) \_\_\_\_\_ fields – don't know uses, yet.