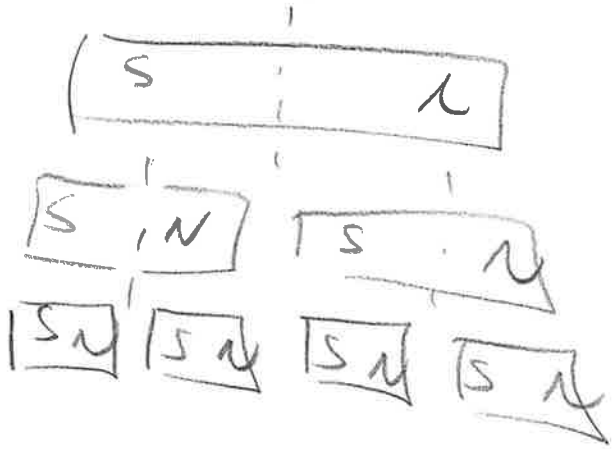
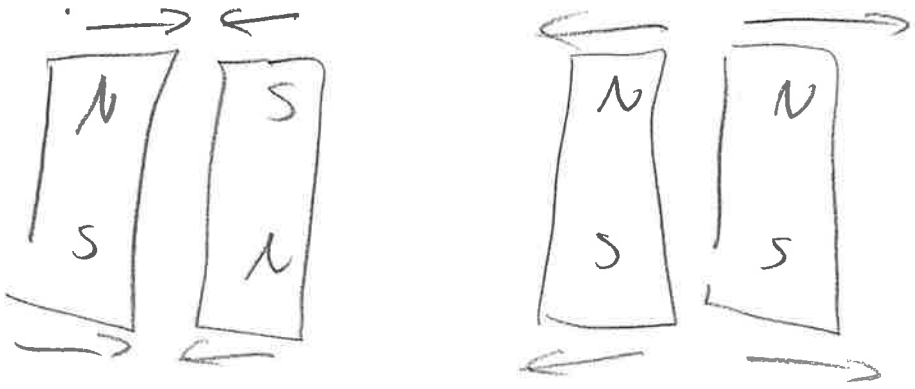
Magnets

- 2 magnetic poles: North and South
- No magnetic monopole



- opposite poles attract



Earth's Magnetic Poles

- Earth's South magnetic pole is at the geographic North pole.

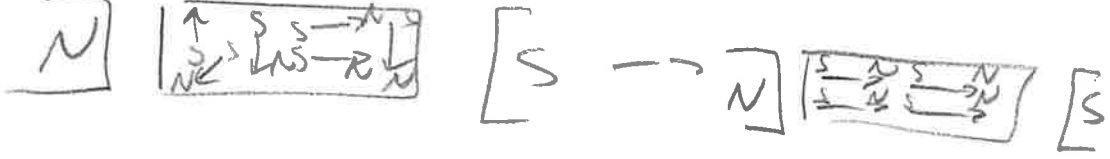
- N on compass points to Earth's South magnetic pole.

Ferromagnets

- Materials capable of exhibiting strong magnetic effects.

  e.g.) Iron, cobalt, neodymium

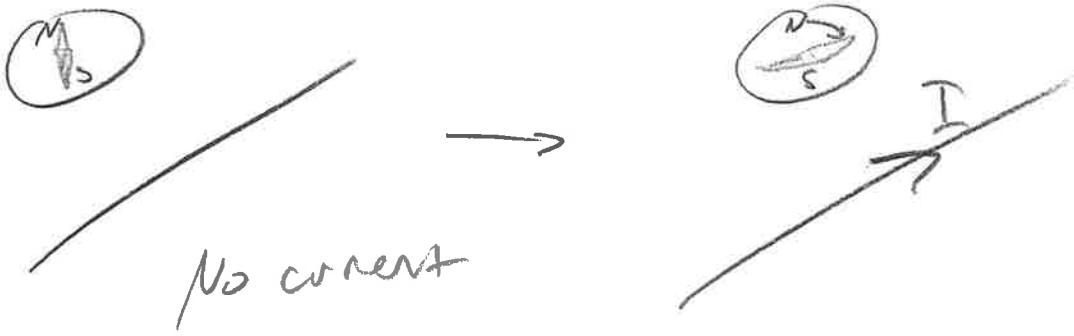
- Are capable of being magnetized.



Electromagnets

- Compasses are deflected when placed near a current-carrying wire.

- Electric currents produce magnetic fields



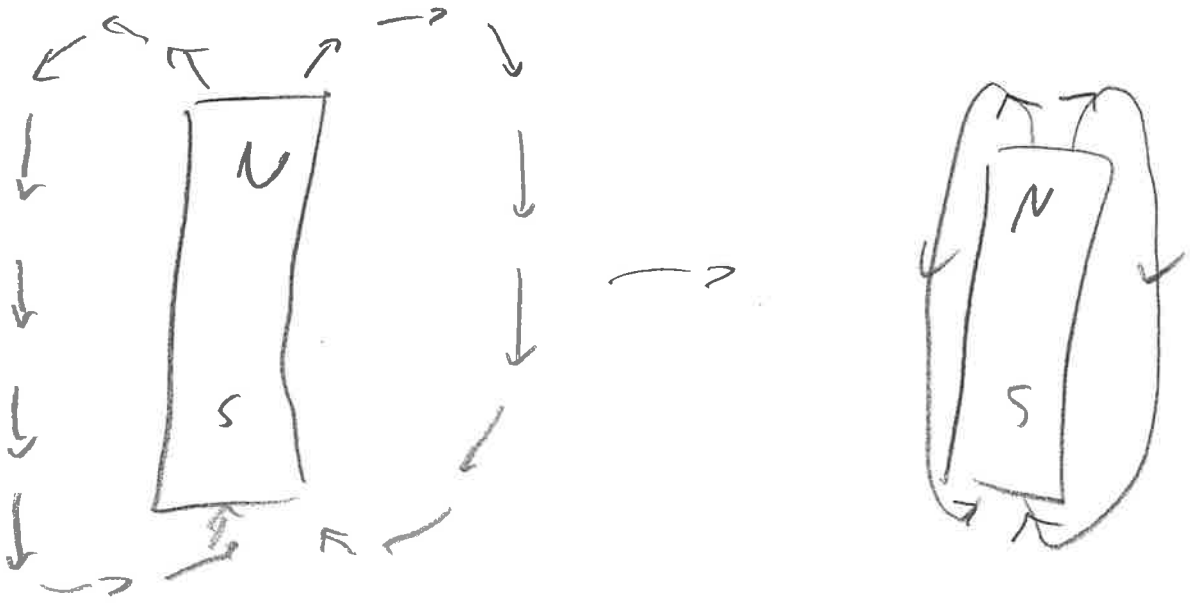
Coil

- filings align with magnetic field

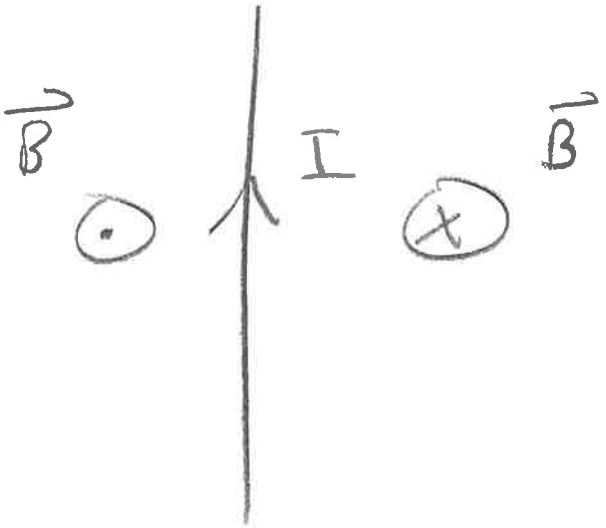
- Electric current is the source of all magnetism

Magnetic Field Lines

- where the N end of a compass points.

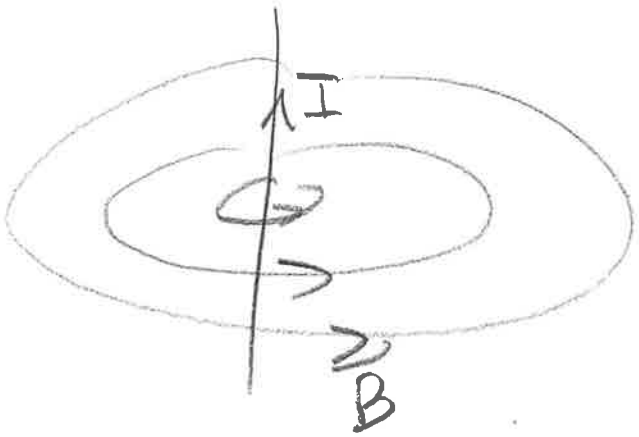


Magnetic Field from a wire



⊙ - out of the page

⊗ - into the page.



Right hand rule (2)

- thumb in direction of the current
- fingers curl in the direction of $\vec{B}$ field.

Lorentz force

- Moving charges in a magnetic field feel a magnetic force called the Lorentz force.

$$|\vec{F}| = q|\vec{v}||\vec{B}|\sin\theta$$

$|\vec{F}|$ – magnetic force (N)

q – charge (C)

$\vec{v}$ – velocity vector (m/s)

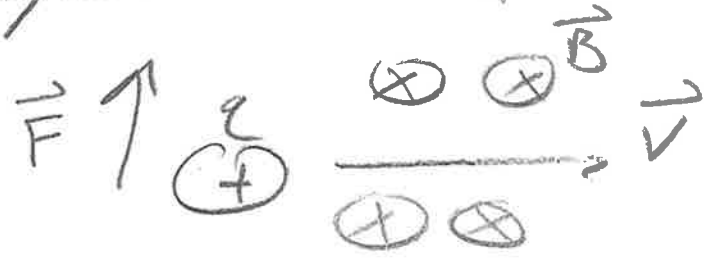
$\vec{B}$ – magnetic field vector (T)

$$1\,T = \frac{1\,N}{C \cdot m/s} = \frac{1\,N}{A\,m}$$

- strongest magnets on the order of 1T
- Earth's magnetic field is $\sim 5 \times 10^{-5}$ T

Right-hand Rule (1)

Determine the direction of the magnetic force.



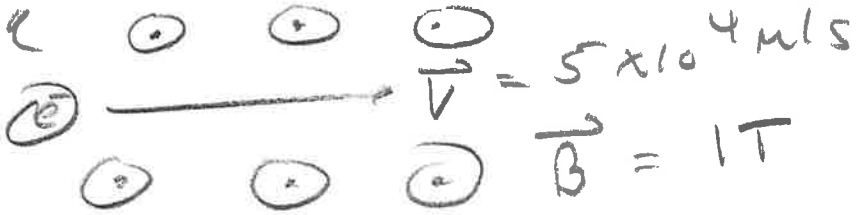
- flip Force for negative charges.

Lorentz Force Problem 1

An electron moves in the presence of an external magnetic field. Find!

a) The direction of the Lorentz force

b) The magnitude of the force



a) up

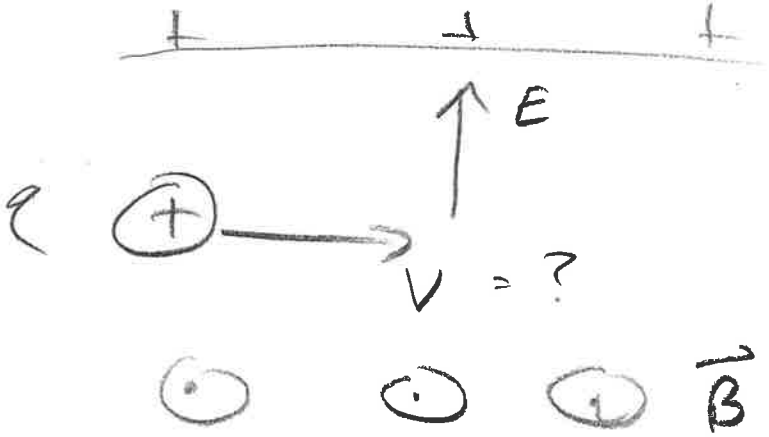
b) $F = qvB$

$F = (1.6 \times 10^{-19})(5 \times 10^4)(1\text{T})$

$$F = 8 \times 10^{-15} \text{ N}$$

Lorentz Force Problem 2

A beam of protons ($q = 1.6 \times 10^{-19} C$) enter a region with a uniform electric field $\vec{E} = 100\ N/C$ directed upwards and magnetic field $\vec{B} = 2T$ out of the page. Find the velocity $\vec{v}$ that allows the protons to move undeflected.



$$\Sigma F = 0$$

$$F_e = F_B$$

$$qE = qvB$$

$$v = \frac{E}{B}$$

$$\boxed{v = 50\ m/s}$$