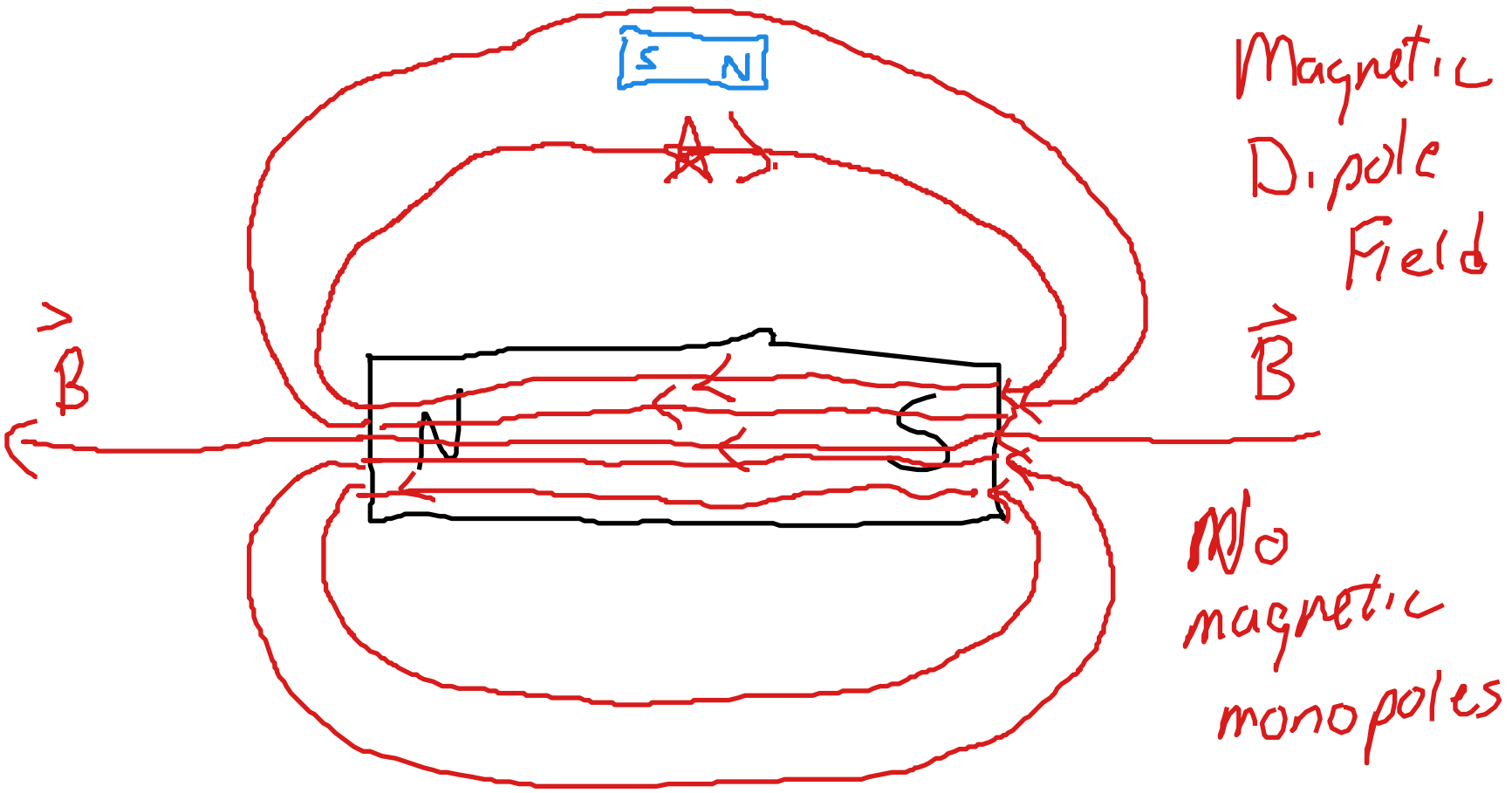
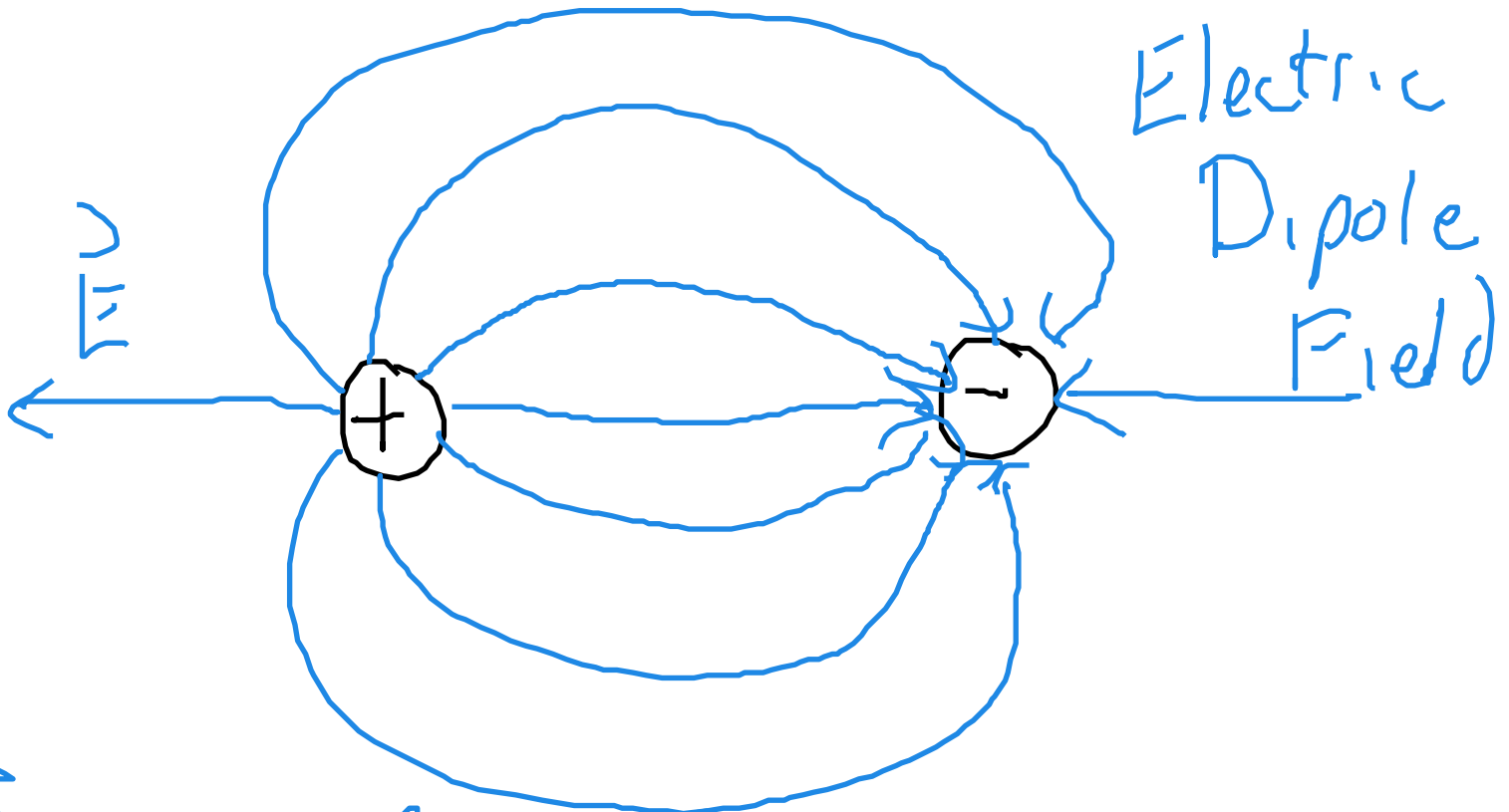


Magnetic Dipole Field

$\vec{B}$

$\vec{B}$

No magnetic monopoles

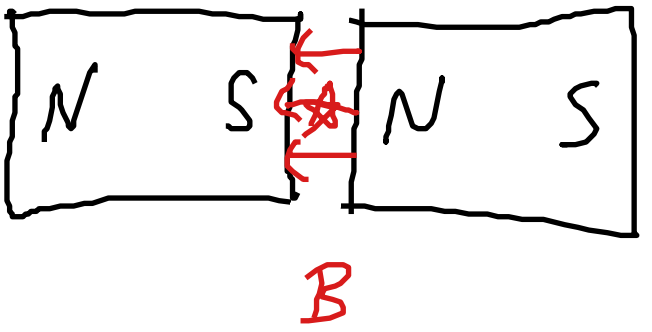


Electric Dipole Field

$\vec{E}$

$\vec{E}$ emerge from (+) sources

& stop at (-) sources



B

No magnetic monopoles → magnetic field lines never end

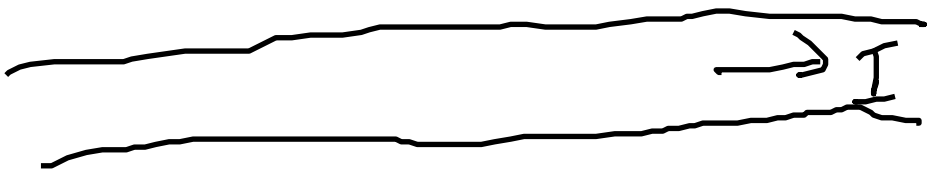
- loops
- start and end at ∞

Magnetic Fields are created by

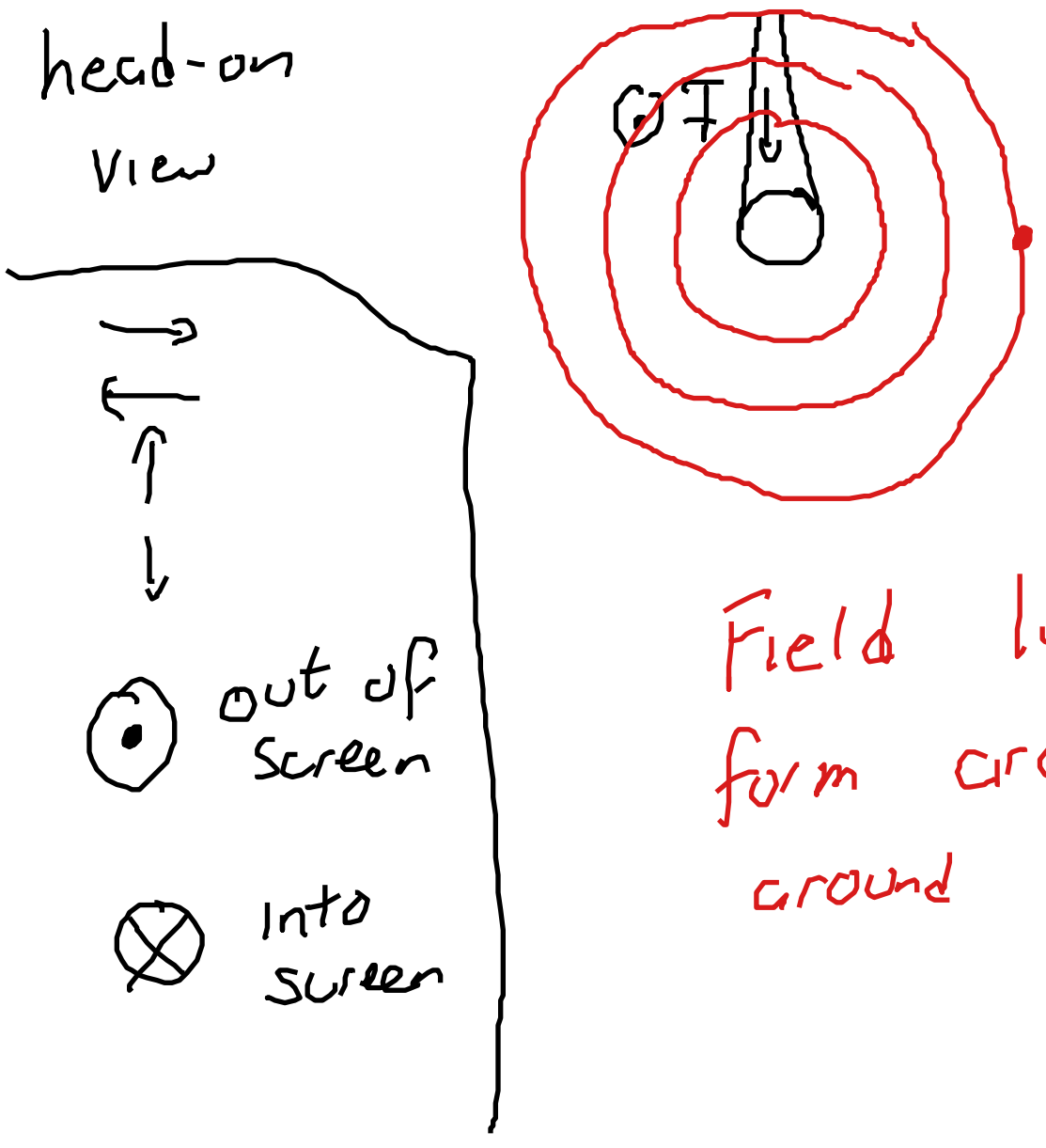
- "spin" of electrons & other subatomic particles
  (built in magnetic field — source of bar magnet's field)
- electric current

e.g. long straight wire with current I

side view



head-on view



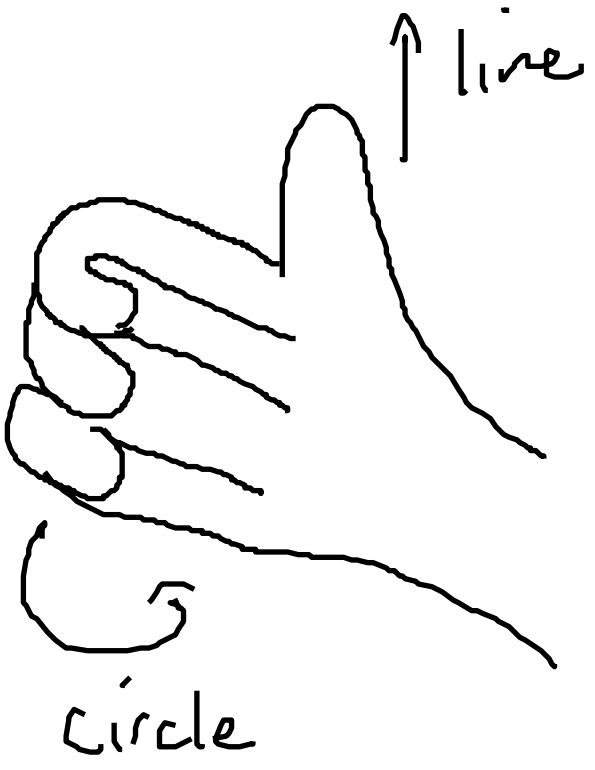
$\vec{B}$ (as a vector) is tangent to this circle

Field lines form circles around wire

clockwise

counter clockwise

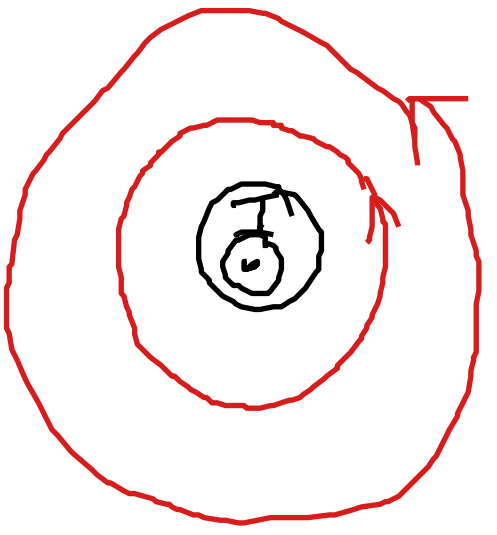
Circle – Line Right Hand Rule

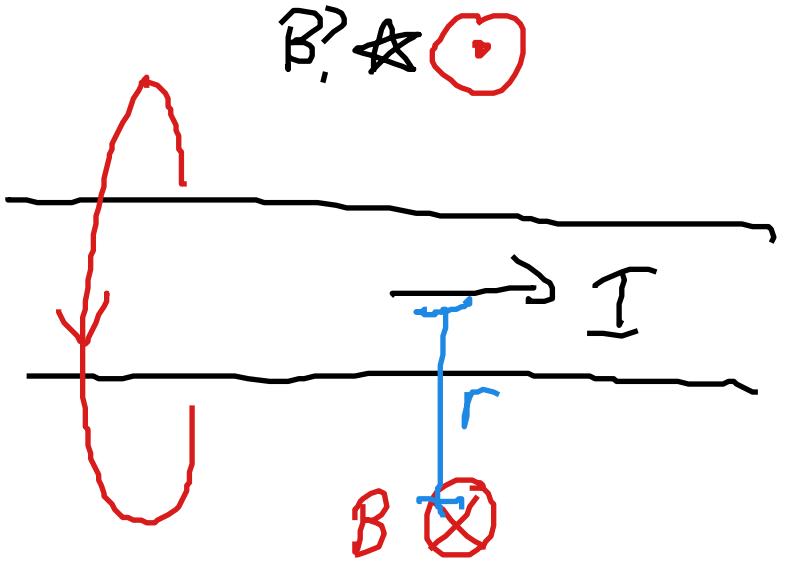


Current of a Long Straight Wire

line: current

circle: field





strength of magnetic field

$$B = \frac{\mu_0}{2\pi}\frac{I}{r}$$

I ← current in A

r ← distance from wire in meters

$$\mu_0 = 4\pi \times 10^{-7}\ \frac{Tm}{A}$$

$$= 1.26 \times 10^{-6}\ \frac{Tm}{A}$$

$$= 1.26\ \frac{\mu T\, m}{A}$$

$$\frac{\mu_0}{2\pi} = 0.2\ \frac{\mu T\, m}{A}$$

SI Units of Magnetic Field

Tesla (T)

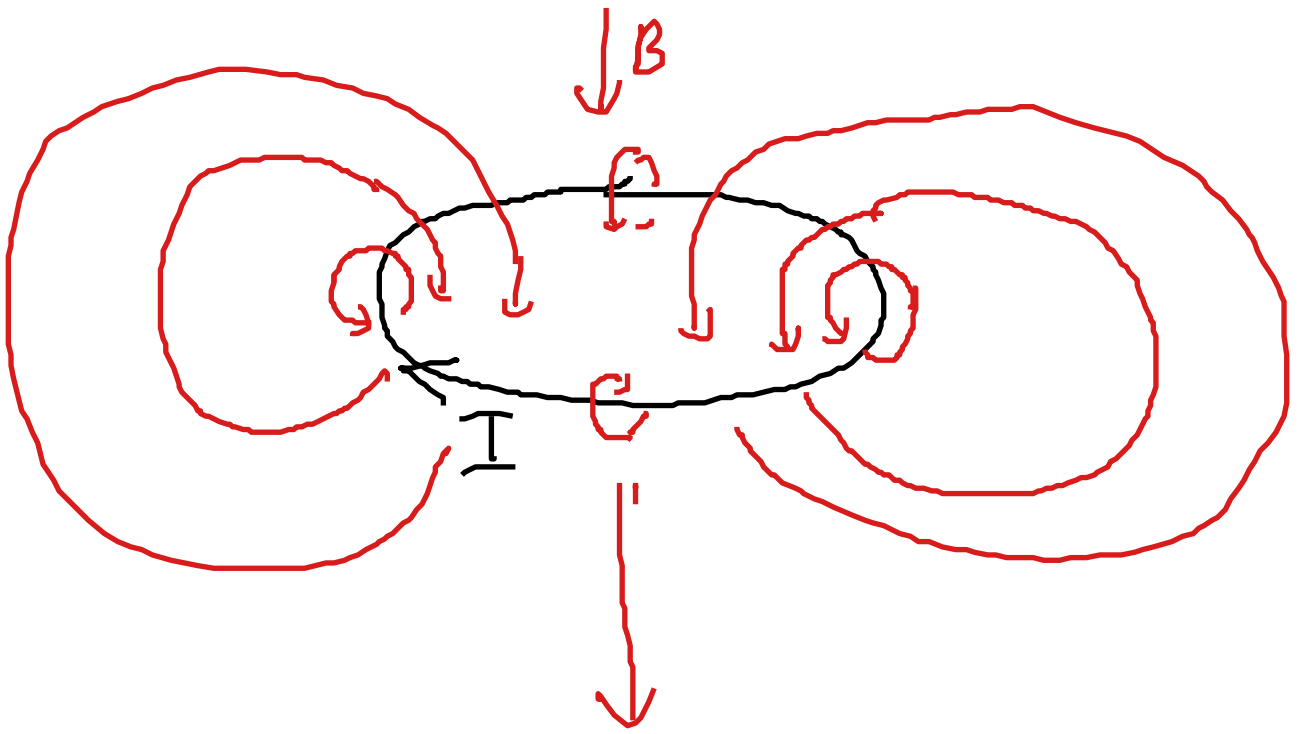
1T fairly strong field
(close to a
neodymium magnet)

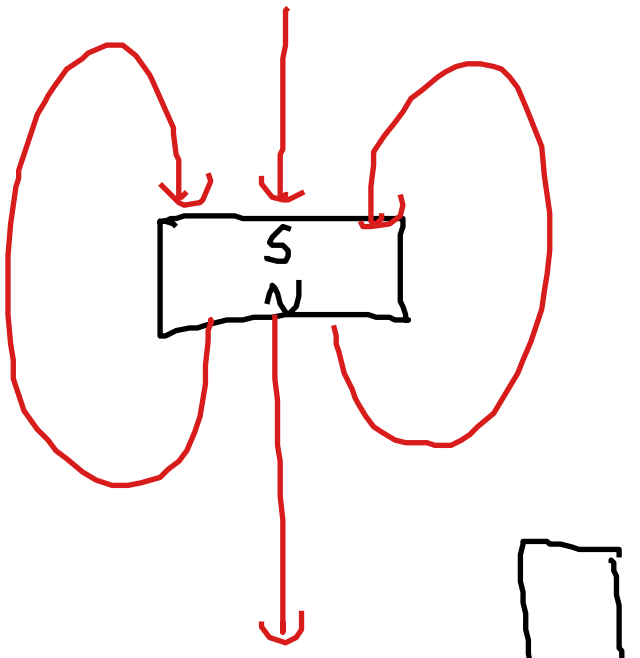
Earth's field at surface

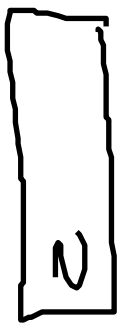
$$B = 5 \times 10^{-5} T$$

$$= 50 \mu T$$

Circular Loop of Current
(as seen from slightly above)

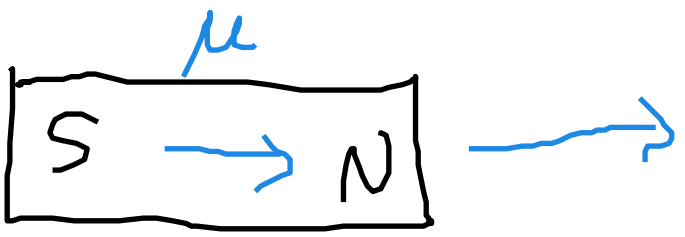




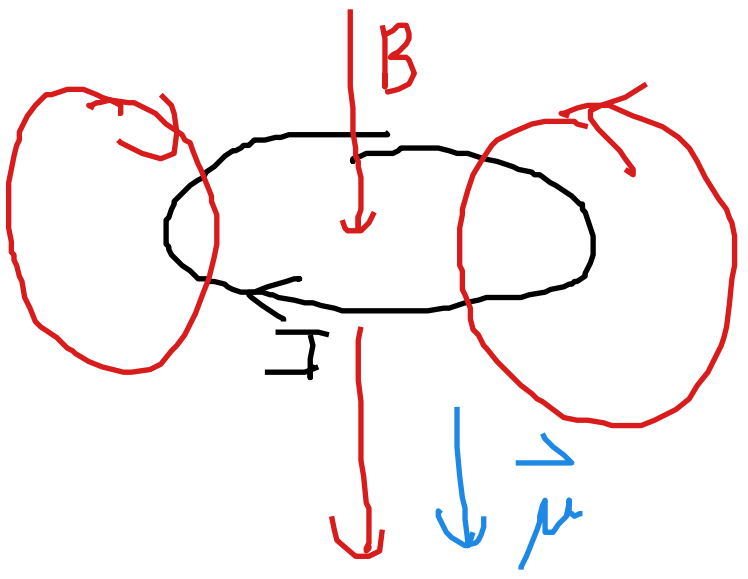


Circular loops are magnetic dipoles

Magnetic Dipole Moment $\vec{\mu}$



$\vec{\mu}$ of a magnet points from S to N, & points in direction of $\vec{B}$ field along its axis



C-L RHR

thumb: $\vec{\mu}$

fingers: I