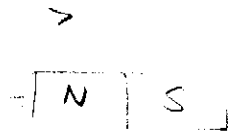


# WUNZK

①

- Magnetic Fields



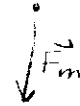
dipole

magnetic charges don't exist, always dipoles

Align with field

- Force on moving charge

$$\vec{F}_m = q\vec{v} \times \vec{B}$$



centripetal force

$$R = \frac{mv}{qB}$$

RHR #1

- Currents are source of  $\vec{B}$  field (moving charges)

Biot-Savart

$$d\vec{B} = \frac{\mu_0 I d\vec{l} \times \vec{r}}{r^2}$$

How-to

Electric  
Q

Magnetic  
moving Q

$$d\vec{E} = \frac{kQdQ}{r^2}$$

$$d\vec{B} = \mu_0 I \frac{d\vec{l} \times \vec{r}}{r^2}$$

RHR #2

Circle around wire

E from I

Gauss

$$\oint_{\text{closed surf}} \vec{E} \cdot d\vec{A} = \frac{Q_{\text{encl}}}{\epsilon_0}$$

$$\oint_{\text{closed loop}} \vec{B} \cdot d\vec{l} = \mu_0 I_{\text{encl}}$$

Ampere's Law

How-to

use RHR #2

- Changing  $\vec{B}$  fields create  $\mathcal{E}_{ind}$  (&  $I_{ind}$ )

Faraday  $\left. \mathcal{E}_{ind} = - \frac{d\Phi_B}{dt} \right\}$

Lenz: direction opposes change  
 "Loops Hate Change"

- Mutual Inductance  
                   1                  2

$$\mathcal{E}_{ind2} = -M_{12} \frac{dI_1}{dt}, \quad \mathcal{E}_{ind1} = -M_{12} \frac{dI_2}{dt}$$

→  $M_{12} = \frac{N_2 \Phi_{2,1}}{I_1}$

"sensitivity to changing current"