Flux, Gauss, and Ch. 29 – 30 Summary

Better to remain silent and be thought a fool than to speak out and remove all doubt. *Twain*

If con is the opposite of pro, then isn’t Congress the opposite of progress?

Scientist are nothing more than Big Children who view the entire universe as their playground.

If god is not a Tar Heel, why is the sky Carolina Blue?

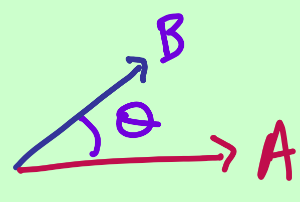
Magnetic Flux

- The magnetic flux is

  $\Phi_B \equiv \int B \bullet dA$

  $d\vec{A}$ is area vector $\perp$ to surface with magnitude dA

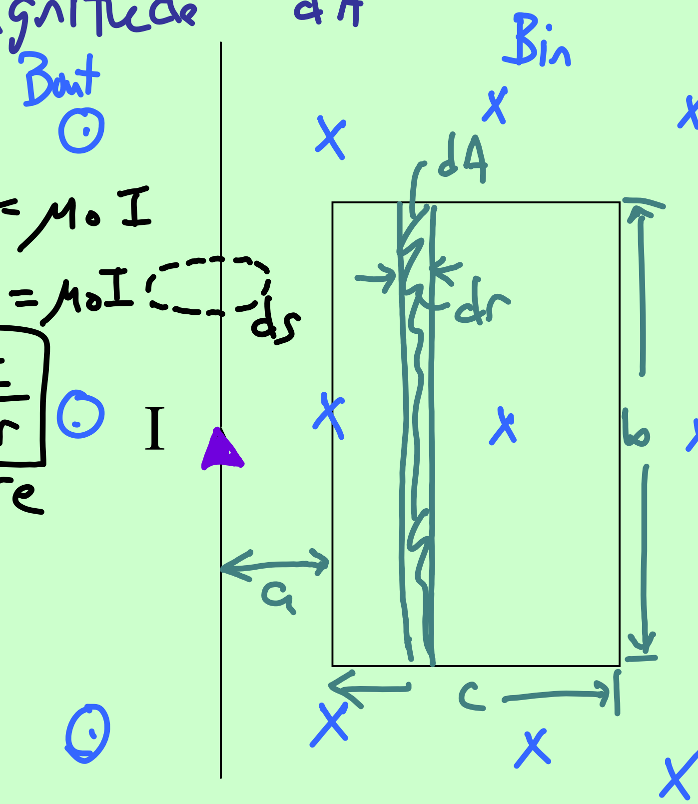
- $\Phi_B \equiv BA\cos\theta$



$\oint B \cdot ds = \mu_0 I$

$B(2\pi r) = \mu_0 I$

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



- Units of magnetic flux are

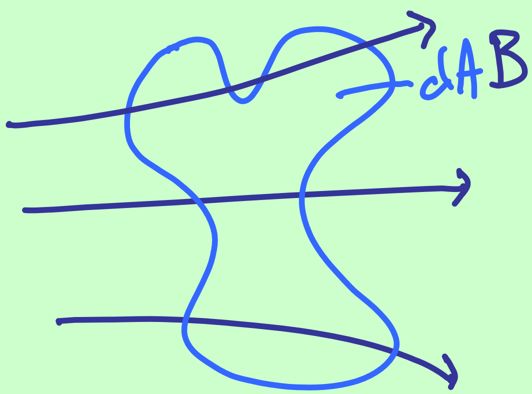
  $T \cdot m^2 = \text{Weber}, \ Wb$

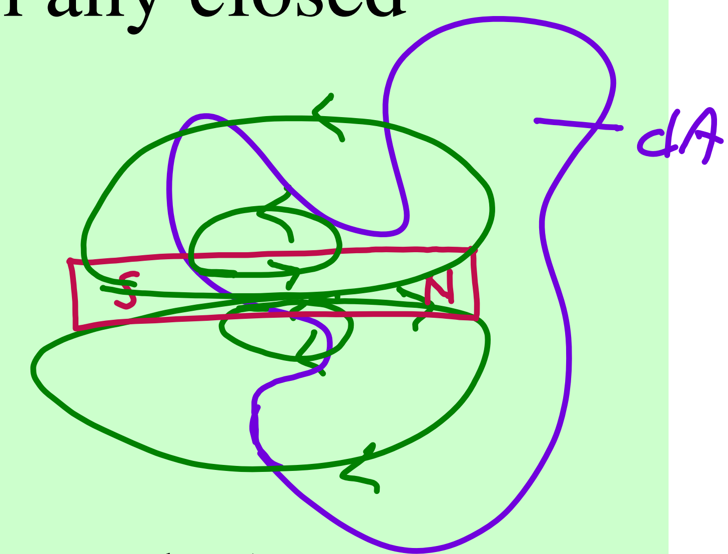
1. Use figure to find the total magnetic flux through the loop due to the current in the wire.

$$\Phi_B = \int B \cdot dA = \int_a^{a+c} \left(\frac{\mu_0 I}{2\pi r}\right) b\,dr = \frac{\mu_0 I b}{2\pi} \ln\left(\frac{a+c}{c}\right)$$

Gauss's Law of Magnetism

- The net magnetic flux through any closed surface is zero. $\oint B \cdot dA = 0$





⇒ Isolated magnetic poles (monopoles) have never been found.

Section 30.7

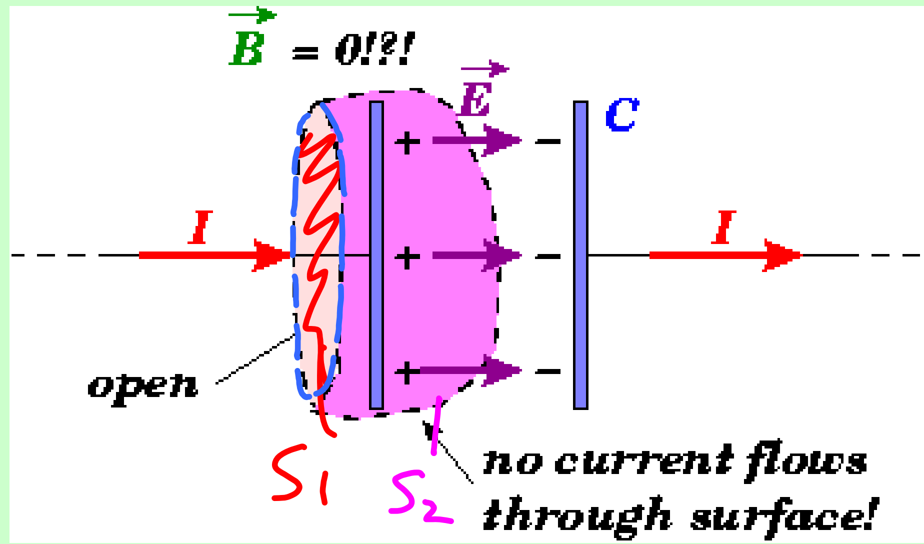
- Ampere's Law in our old form is only valid if any electric fields present are constant over time.

$$\oint_{S_1} B \cdot ds = \mu_0 I$$

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

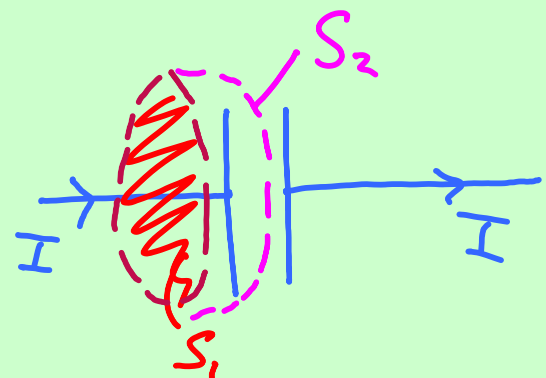
$$\oint_{S_2} B \cdot ds = \mu_0 (0)$$

$$B = 0 \quad ?$$



Ampere-Maxwell's Law

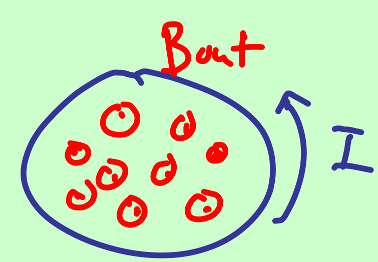
$$\oint B \cdot ds = \mu_0 I + \mu_0 \underbrace{\epsilon_0 \frac{d\Phi_E}{dt}}_{\text{displacement current}}$$



B-fields are generated by a current of changing electric flux.

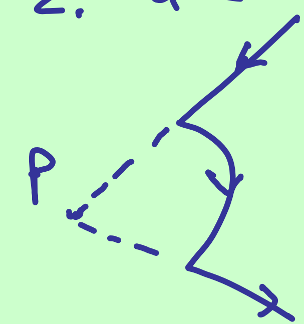
Summary of Ch. 29

- Field lines go from N to S outside magnet
- Force on a charge moving in a B-field = $q v \times B$
- Force on a current-carrying wire in a B-field = $I \ell \times B$
- Torque = $I A \times B$
- RHR
  1. Force on charge (Ch. 29)
  2. B due to I (Ch. 30)
     - A. wire
     - B. coil / solenoid



Summary of Chapter 30

1. finite wire.
2. arc



- Biot-Savart law $B = \frac{\mu_0 I}{4\pi} \int \frac{d\vec{s} \times \hat{r}}{r^2}$
- B around wire = $B = \frac{\mu_0 I}{2\pi r}$
- Force per length between 2 wires $\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\pi a}$
- Ampere's Law $\oint B \cdot ds = \mu_0 I$
  - Toroid
  - Solenoid
  - wire
  - coaxial cable

Summary of Ch. 30

- Magnetic Flux $\Phi_B = \int B \cdot dA$
- Gauss's law of magnetism $\oint B \cdot dA = 0$
- Ampere-Maxwell Law

$$\oint B \cdot ds = \mu_0 I + \mu_0 \epsilon_0 \frac{d\Phi_E}{dt}$$

Quiz

5 M.C.

RHR for F & B

$F = qv \times B$, $E = \frac{F}{q}$

Solenoid

1 F.R.

Ampere (4)

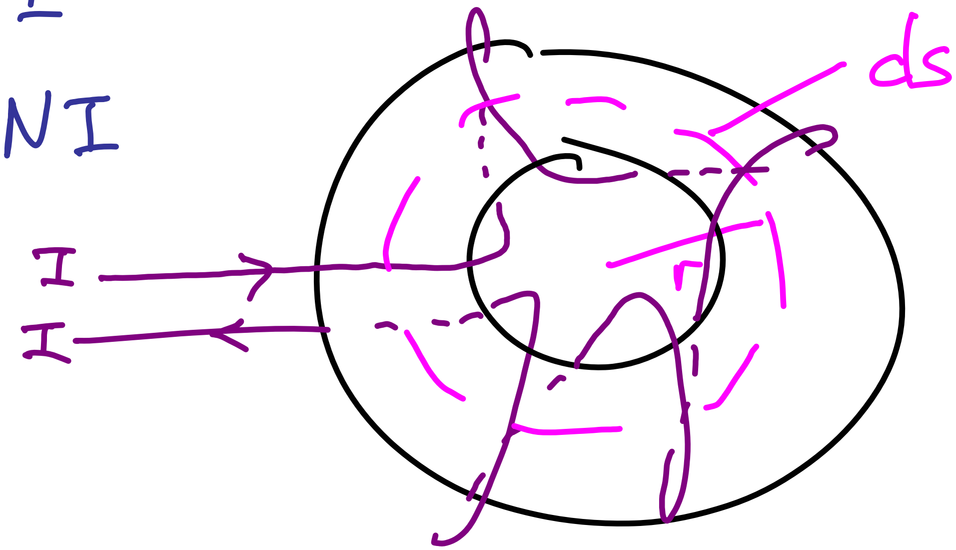
$F = qv \times B$

Ampere's Law

$$\oint B \cdot ds = \mu_0 I$$

$$B(2\pi r) = \mu_0 N I$$

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



$$\oint B \cdot ds = \mu_0 I$$

$$B l = \mu_0 N I$$

$$B = \mu_0 \frac{N}{l} I$$

$$\boxed{B = \mu_0 n I}$$