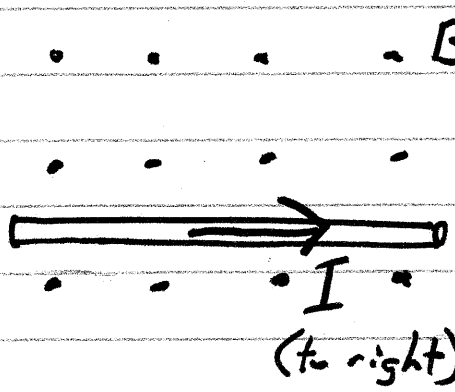
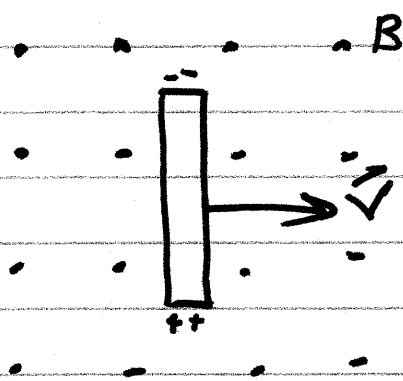
 Phys 2426 2014-10-13

Results of the Magnetic Force



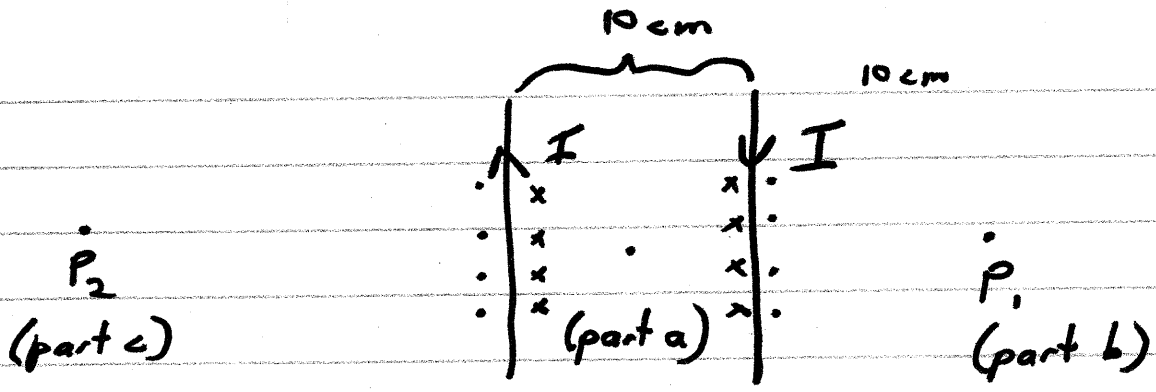
Current in a wire causes a physical force.



Physical motion separates charges. This means there is a generated voltage.

⊕ parts pushed down.
⊖ parts pushed up

(2)



Due to one wire:

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

For two wires: Find B_1 and B_2, then add as vectors.

(a) Midway in between

B_1 due to left wire = into page

B_2 = into page

$B = B_1 + B_2$ use $d = 5$ cm in each

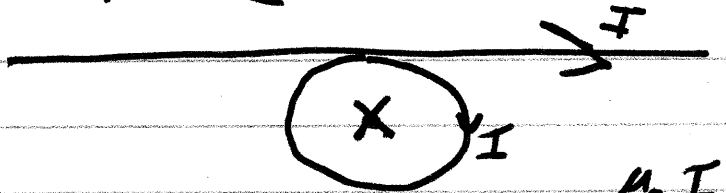
(b) To the right of both

B_1 = inward use $d_1 = 20$ cm

B_2 = outward $d_2 = 10$ cm

$B = B_1 - B_2$

#14



@ middle, $B_1 = B_{wire} = \frac{\mu_0 I}{2\pi r}$ (in)

$B_2 = B_{loop} = \frac{\mu_0 N I}{2r}$ (in)

$N = 1$

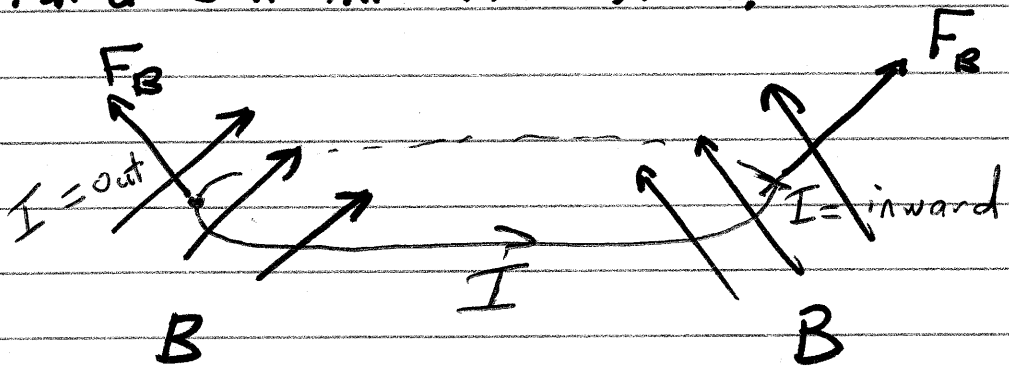
(3)

Why are magnets attracted to each other?

Fixed magnet

B ↗ ↖ B B funnels toward S of magnet.

Put a coil into this field:

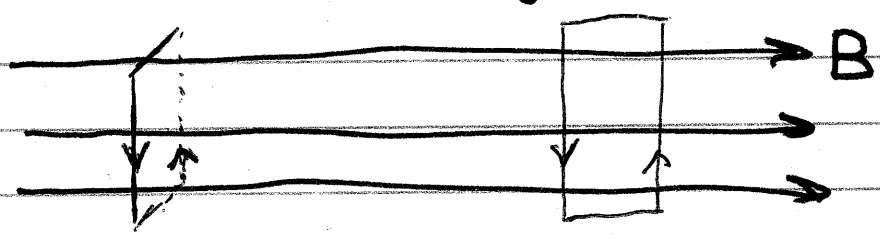


Forces add to produce net upward force. This pulls the coil toward the strong magnetic field.

$$\vec{F}_B = q\,\vec{v} \otimes \vec{B}$$

Thumb — Index — Middle

Coil in a Uniform magnetic Field



Rect. coil w/ current down front and up back.

On Front: I=(down) B=(right) F=(out)
On Back: I=(up) B=(right) F=(in)
Equal & opposite forces exert a torque.

Coil w/ current down left & up right.
On left F = out } strong torque
On right F = in }

Max Torque $\tau_{max} = \underbrace{NBA}I$

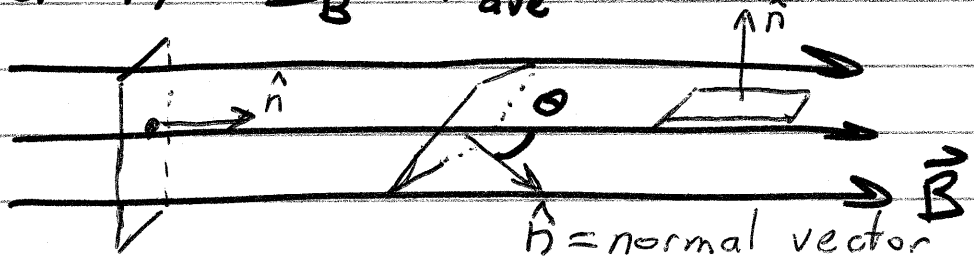
Φ_B = magnetic flux

Sec. 29.5 in book.

Magnetic Flux Φ_B measured in weber (Wb).

Formally $\Phi_B = \iint \vec{B} \cdot d\vec{A}$

Practically $\Phi_B = B_{ave} A \cos\theta$



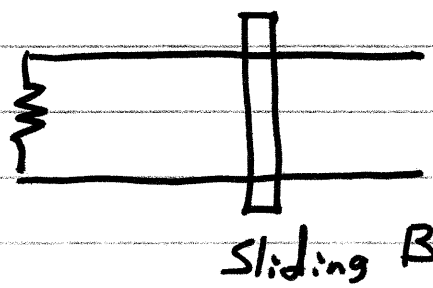
Lots of Flux $\Phi_B = BA$

In Between Zero Flux $\Phi_B = 0$

$$\Phi_B = BA\cos\theta$$

Any change in Φ_B generates voltage.

- Change B (Current or Location of B)
- Change A



- Change θ
  - Rotate coil
  - Rotate B

Generator: Coil in mag Field

$$\Phi_{max} = NBA$$

Rotation speed is $\omega = \frac{\Delta\theta}{\Delta t}$ in rad/s

$$\Phi_B = NBA\cos\theta$$
$$= NBA\cos(\omega t)$$

$$\frac{d}{dt}\Phi_B = NBA(-\sin(\omega t))\,\omega$$

$$\mathcal{E} = -\frac{d\Phi}{dt} = NBA\omega\sin(\omega t)$$

$\mathcal{E}$ = EMF = voltage

$\mathcal{E}_{max} = NBA\omega$ Physical spin generates elec.

$\tau_{max} = NBAI$ Elec current causes τ.

In a motor, $\mathcal{E}$ opposes the current.

① Low ω, Lots of I

② Fast ω, Little I