

WHAT CREATES A MAGNETIC FIELD?

- ① A MAGNET
- ② A MOVING CHARGED PARTICLE
- ③ A CURRENT

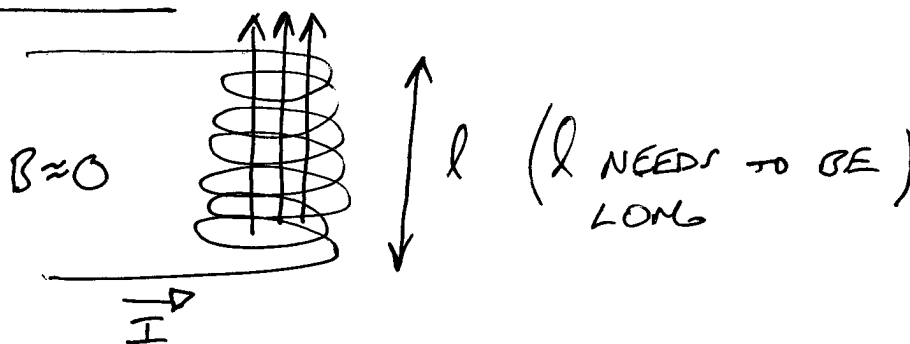
a) CURRENT IN A LONG, STRAIGHT WIRE

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

b) CURRENT IN A SOLENOID

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

SOLENOID



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

Annotations for the equation:

- An arrow points from the text "# OF TURNS OF WIRE CURRENT IN SOLENOID" to the N in the numerator.
- An arrow points from the text "LENGTH OF SOLENOID" to the l in the denominator.
- An arrow points from the text "MAGNITUDE OF MAGNETIC FIELD INSIDE SOLENOID" to the B on the left side of the equation.

MAGNETIC FIELD INSIDE A SOLENOID IS UNIFORM

(GG Ch 20 P 48)

$$\begin{aligned} B &= \frac{\mu_0 N I}{l} \\ &= \frac{(4\pi \times 10^{-7} \text{ T}\cdot\text{m/A})(420)(2 \text{ A})}{(0.12 \text{ m})} \\ &= 8.8 \times 10^{-3} \text{ T} \end{aligned}$$

WHAT FEELS A FORCE FROM A MAGNETIC FIELD?

- ① A MAGNET
- ② A MOVING CHARGED PARTICLE
- ③ A CURRENT
- ④ SOME METALS (LIKE IRON)

FORCE ON A MOVING CHARGED PARTICLE

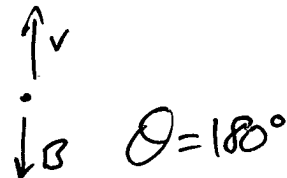
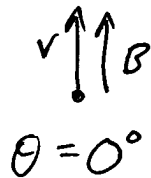
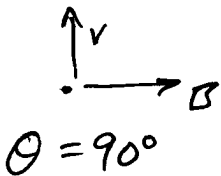
LORENTZ FORCE LAW

MAJORITY OF FORCE FELT BY q

$$F = |q|vB \sin \theta$$

SETTING: A PARTICLE WITH CHARGE q AND VELOCITY v IS MOVING IN A MAGNETIC FIELD B (B IS CREATED BY SOMETHING ELSE, NOT THE PARTICLE WITH CHARGE q).

θ IS THE ANGLE BETWEEN \vec{v} AND \vec{B} .



DIRECTION OF MAGNETIC FORCE ON A PARTICLE

- \vec{F} IS PERPENDICULAR TO BOTH \vec{v} AND \vec{B} .



- RIGHT HAND RULE #2 :

PUT FINGERS OF RIGHT HAND TOWARD \vec{v} .

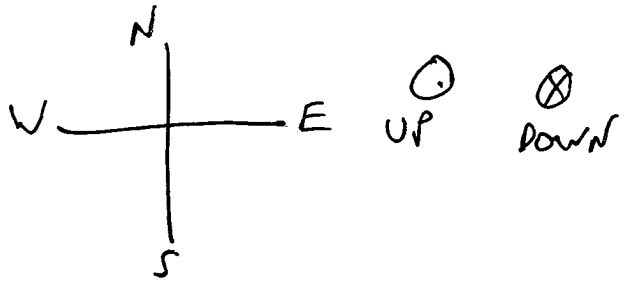
BEND FINGERS TOWARD \vec{B} .

IF $q > 0$, THUMB GIVES DIRECTION OF \vec{F} .

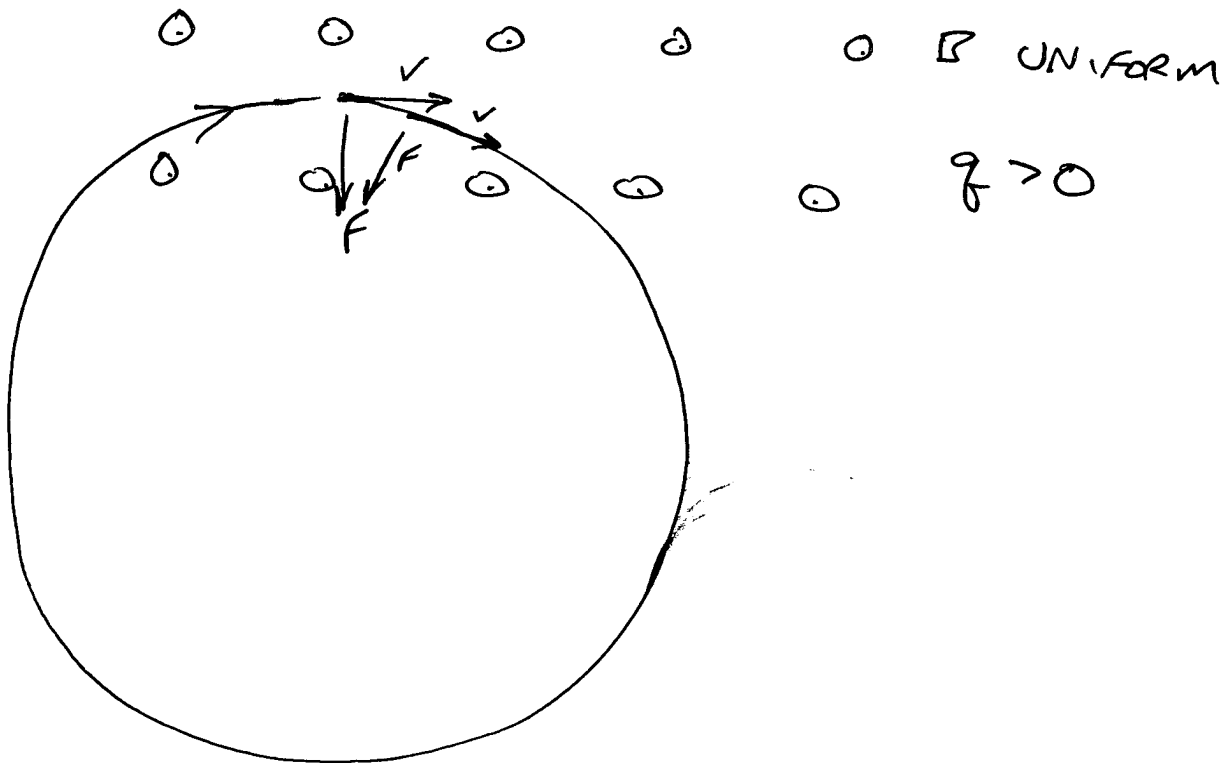
IF $q < 0$, \vec{F} IS OPPOSITE THUMB.

(66 ch 20 P10)

$$\begin{aligned}
 F &= |q| v B \sin \theta \\
 &= (1.602 \times 10^{-19} \text{ C}) (8.75 \times 10^5 \text{ m/s}) (0.75 \text{ T}) \sin 90^\circ \\
 &= 1.05 \times 10^{-13} \text{ N NORTH}
 \end{aligned}$$



THUMB POINTS SOUTH
 BUT ELECTRON IS NEGATIVE CHARGE
 SO FORCE IS NORTH.



A CHARGED PARTICLE MOVING IN A UNIFORM MAGNETIC FIELD WILL GO IN A CIRCLE (OR A SPIRAL.)