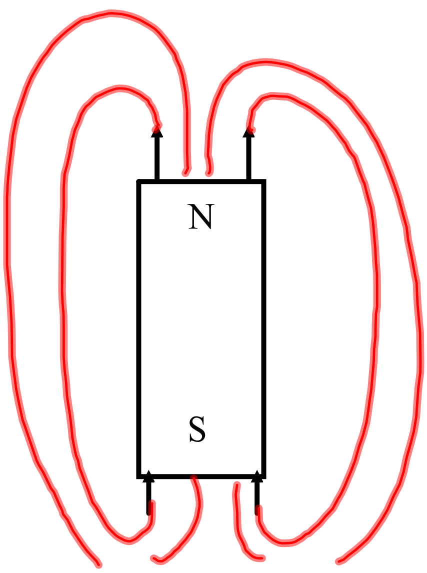
Magnetism Part 2

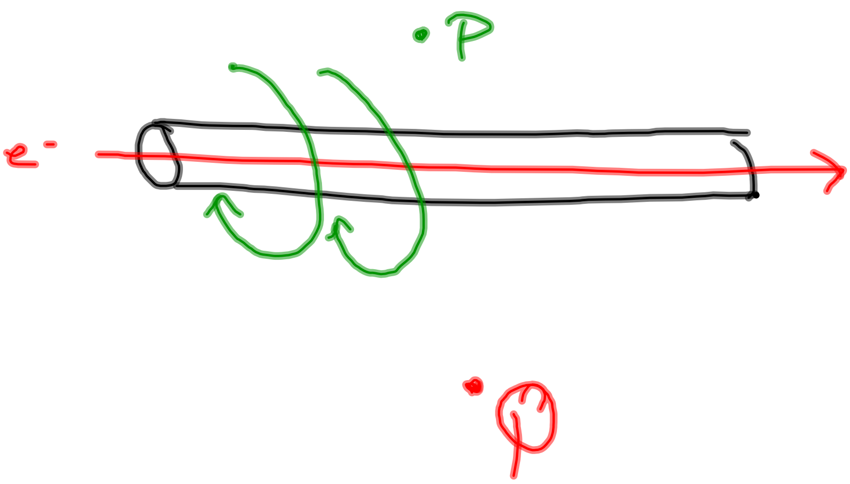
Tesla (SI) or Gauss (cgs) is the measure of magnetic field strength.

Orested first to notice that an electric current causes a compass to deflect thus infering that a moving electric charge creates a magnetic field.

What direction does that field go? use the right hand rule!

Your thumb is the direction of current flow and your fiinger curl in the direction of the magnetic field.




e⁻
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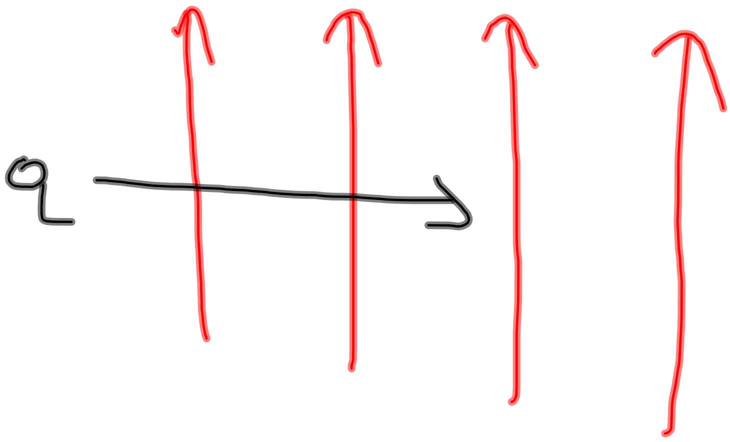
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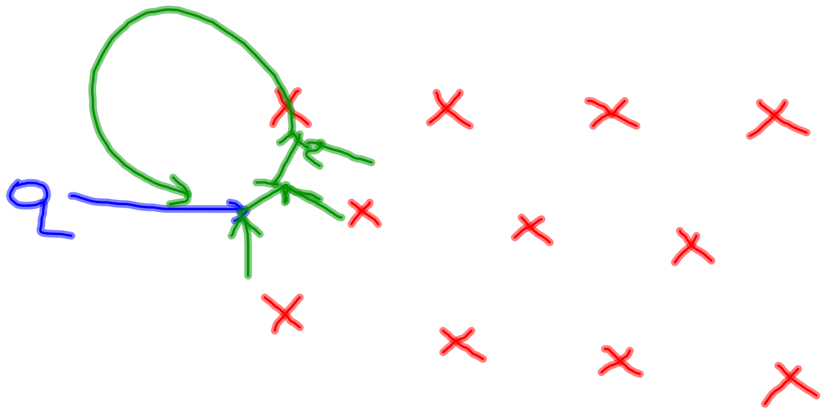
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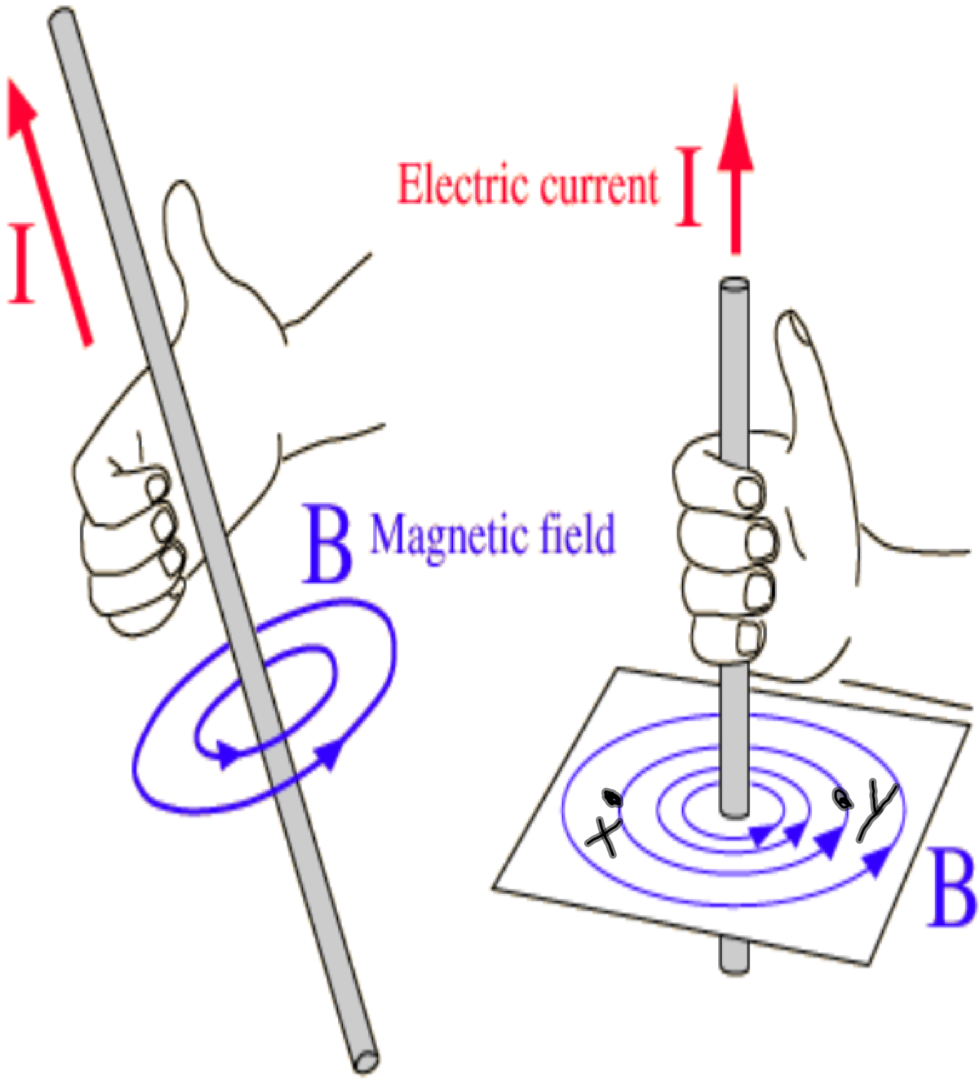
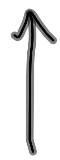
Right Hand Rule

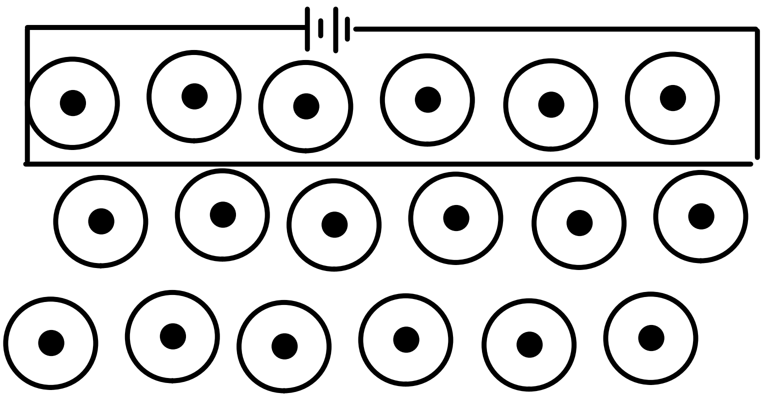


The force that current carrying wire enconters because of a magnetic field. Is caused by the interaction of the magnetic field induced by the wire and the magnetic field the wire is passing through.



$$F = BI\ell \textbf{ sin } \theta$$

Problem: A 12.0 cm long conducting wire carries a current of 30. amps is passed through a .90 Tesla magnetic field. Calculate the force on the wire.



$F = BIL \sin\theta = (.90\ T \times 30\ amp \times .12 m)$

$F = 3.24\ N$

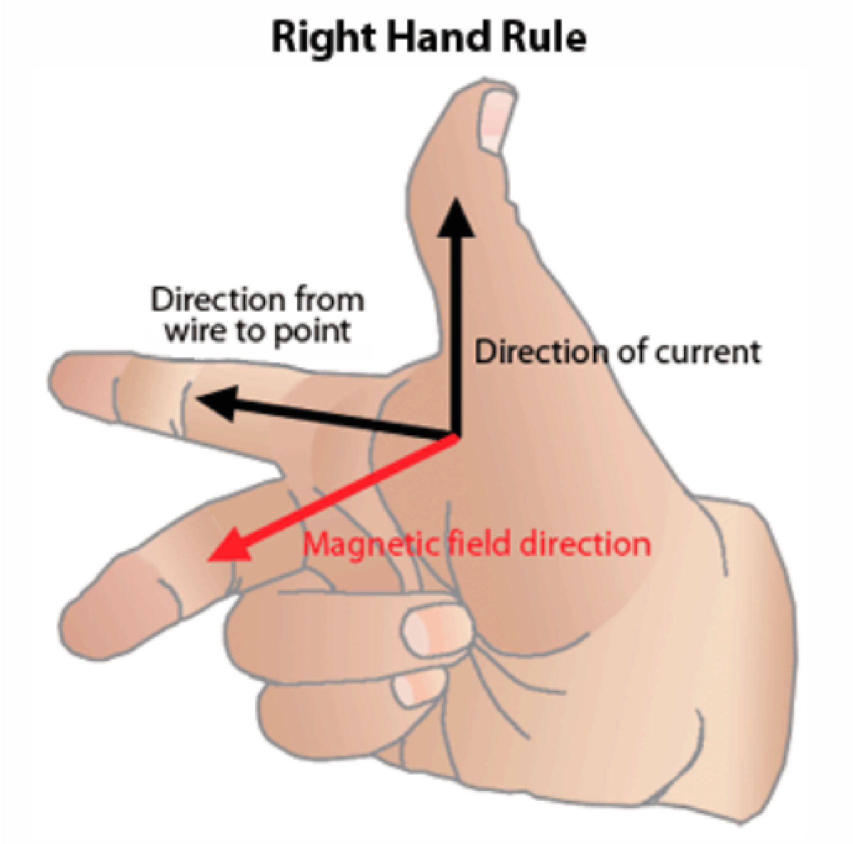
Next Page

What direction is the force on the wire?

We use a second right hand rule.

The direction of the force is perpendicular to the direction of the current and the magnetic field.

The thumb is the current, the fingers the magnetic field and the palm is the force direction.



What applies to a moving current also applies to an individual charged object.

What force would a charge passing through a magnetic field is solved by;

$F=qvB \sin \theta$

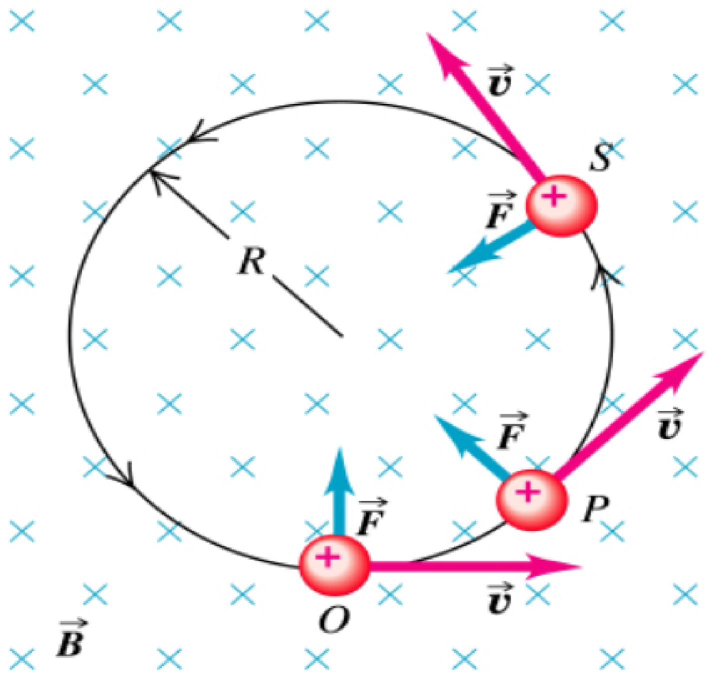
Force = charge x velocity of charge x Magnetic field

Calculate the force needed to accelerate a proton, that is injected into a collider ring with a magnetic field strength of 10.0 T, to 10.0% the speed of light.

$$F = (+1.6 \times 10^{-19}\,C)(3 \times 10^{7}\,m/s)(10\,T)$$

$$F = 4.8 \times 10^{-11}\,N$$

$$(5.9 \times 10^{-26}\,N)$$



(a)

What path would a charged object take when it enters a magnetic field?

(Use information from the last problem.)

F=qvB and F=ma

Derive an equation to find the radius of the path the proton takes. Then use the equation to calculate the radius.

$$F_c = ma_c = \frac{mv^2}{r} \qquad F = qvB$$

$$\frac{mv^2}{r} = qvB$$

$$r = \frac{mv^2}{qvB} \qquad r = \frac{mv}{qB}$$

$p^+ \rightarrow 10\% c \rightarrow 1T$

$$r = \frac{mv}{qB} = \frac{(1.67\times10^{-27}\,kg)(3\times10^{7}\,m/s)}{(1.602\times10^{-19}\,C)(1T)}$$

$$r = .313\ \frac{kg\ \frac{m}{s}}{C \cdot \frac{kg}{Cs}}$$

p^+ 10% c 1.0 T

$$r = \frac{mv}{qB} = \frac{(1.67\times10^{-27}\,kg)(3\times10^{7}\,\frac{m}{s})}{(1.602\times10^{-19}\,C)(1\,T)}$$

$$r = .313\ \frac{kg\cdot\frac{m}{s}}{C\cdot T} = \frac{\cancel{kg}\ \cancel{\frac{m}{s}}}{\cancel{C}\ \frac{\cancel{kg}}{\cancel{C}\cdot\cancel{s}}}$$

$$r = .313\ m$$

Caclulate the magnetic field created by a long straight wire carrying a current of 10. amps at a distance of 10.0 cm.

$\frac{\mu_0}{2\pi} = 2 \times 10^{-7} \frac{T \cdot m}{A}$

We use the equation:

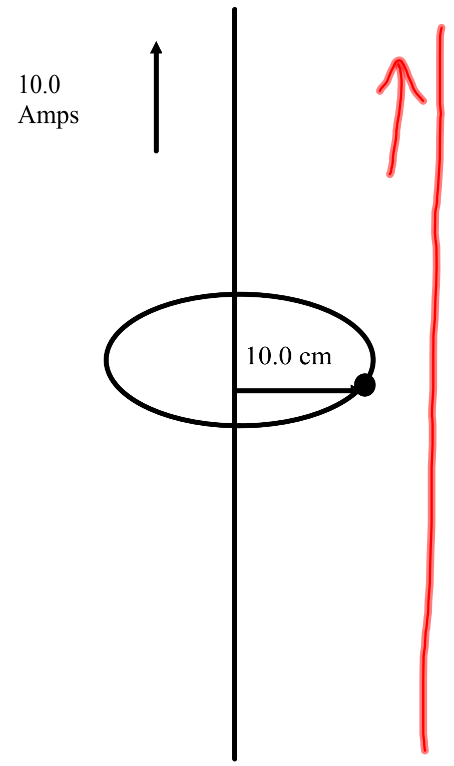
B =(μ_o/ 2π)I/r or B = 2x10^{-7} Tm/A (I/r))

$B = 2 \times 10^{-7} \frac{I}{r}$

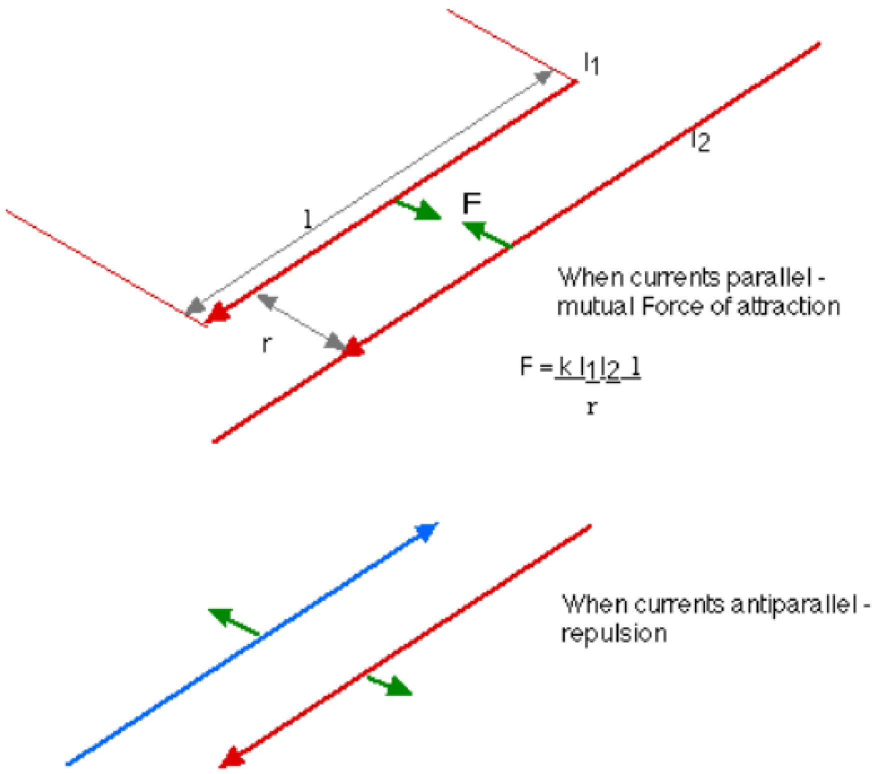
So the magnetic field would be 2x10^{-5} T,

This about the same as the earths magnetic field of roughly .5 Gauss (.00005 T).

What direction is the field?



A horizontal wire carries a current of 80.0 Amps.
A second wire 20. cm below the first must carry current I_2 so it does not fall due to gravity.
What minimum value is I_2 to allow it to stay suspended? (The mass per unit length of wire 2 is .12 g/m.)



$F = mg$ so;

$F = (.0012 \text{ kg})\, g / 1.0 \text{ m} = 1.18\text{x}10^{-3}$ N/m

$F = (2\text{x}10^{-7}$ Tm/A) I_1I_2/L use unit length of 1.0 m.

$I_2 = 15$ Amps.

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

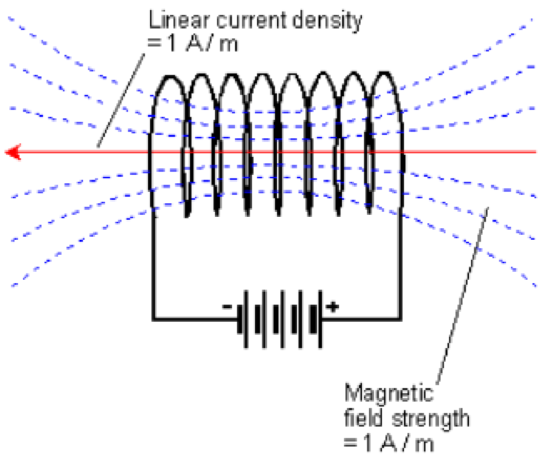
$F = \mu_0 \frac{I_1 I_2}{2\pi L} = (2\times10^{-7}) \frac{I_1 I_2}{L}$

500N

Ampere

$$\int B \cdot dA = 0$$

The previous equation leads to a definition of the amp. It is; the current flowing in each of 2 parallel conductors 1.0 m apart that results in a force of exactly 2.0×10^{-7} N/m. This, in turn, leads to the definition of a coloumb as exactly 1 A-s and it also gives us coloumbs constant.



Ampere's Law; if we sum the components of a magnetic field around a closed path of length ℓ the value is about equal to μ_o times ℓ. Or;

$B=\mu_o I/2\pi r$

In other words the magnetic field around a long straight wire forms a circle.