

Physics 135B Activity 8: Magnetism

Sources of Magnetic Field

- 1- Naturally occurring rocks called magnets
- 2- Charges in motion, i.e., electric current

Recall that electric field is created by charges at rest.

Like electric field, magnetic field is a vector quantity.

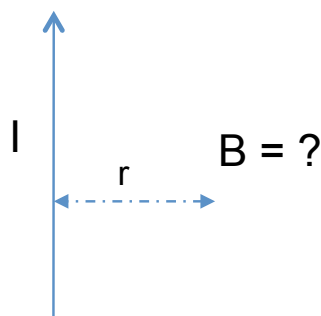
Magnetic field due to an infinitely long current-carrying wire:

Magnetic field created by a wire carrying a current I at a distance r :

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

where $\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$.

The direction is also found from the right-hand rule.

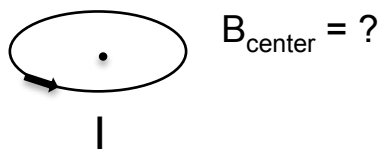


Magnetic field of a circular current-carrying wire at the center:

Magnetic field created by a wire carrying a current I at a distance r :

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

The direction is also found from the right-hand rule.

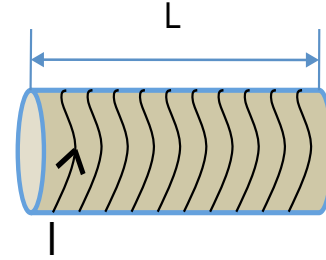


Magnetic field of a solenoid at its center:

Magnetic field inside a solenoid that carries a current I , and with a total number of turns N , and height (length) L :

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

The direction is found by the right-hand rule.



Magnetic Forces

Magnetic force on a charged particle inside a magnetic field:

Magnetic force on a moving charge:

$F_{\text{magnetic}} = qvB \sin \theta$, for direction, use the right-hand rule.

Example: A proton enters a region of uniform magnetic field as shown. The magnetic field (B) is perpendicularly into the plane of this page. The proton is moving on the plane of the page. Determine the trajectory of the beam.

Magnetic force on a current-carrying wire inside a magnetic field:

Magnetic force on a current-carrying wire:

$F_{\text{magnetic}} = ILB \sin \theta$, for direction, use the right-hand rule.

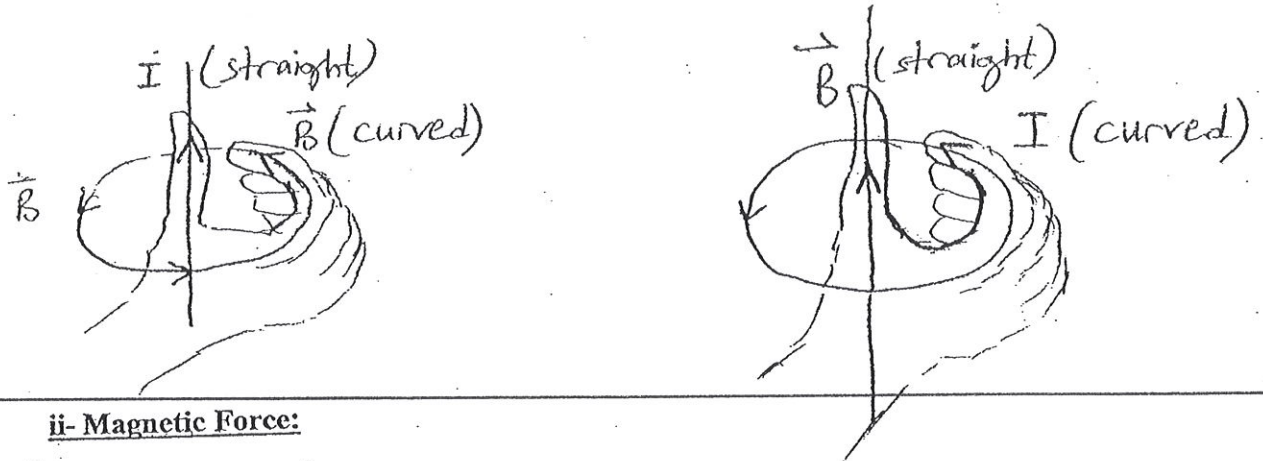
Example: A straight wire segment of length 20 cm carries a current of 3 A. The wire segment is placed in a region where there is a uniform magnetic field of magnitude 10 mT. Calculate the magnetic force on the wire if

- The wire makes 30 degrees with the direction of the magnetic field.
- The wire is parallel to the direction of the magnetic field.

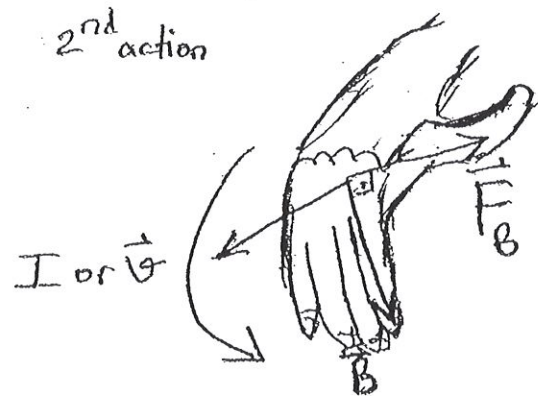
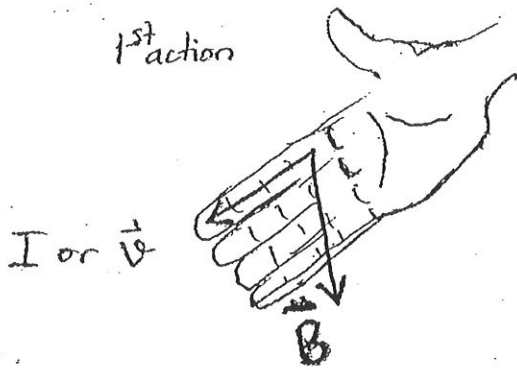
Right-Hand-Rule Summary:

There are two ways we use it

i-Current-Magnetic Field:



ii- Magnetic Force:



Enter with your fingers
in the direction of I or v

then

curve your fingers toward
 B . Your thumb will give you F

Another Option for the second usage is:

