1- The **magnetic force** acting on a charge q traveling at a velocity $\vec{v}$ in a magnetic field $\vec{B}$ is given by:

$$\vec{F}_B = q\vec{v} \times \vec{B}$$

The magnitude is:

$$|\vec{F}_B| = |q||\vec{v}||\vec{B}| \sin\theta$$

2- The magnetic force $d\vec{F}_B$ generated by a small portion of current I of length $d\vec{s}$ in a magnetic field $\vec{B}$ is:

$$d\vec{F}_B = Id\vec{s} \times \vec{B}$$

Thus for a straight segment:

$$\vec{F}_B = I\vec{L} \times \vec{B}$$

where $\vec{L}$ is a vector that points in the direction of the current I and has a magnitude equal to the length L of the segment. In general: **the net magnetic force acting on any closed current loop in a uniform magnetic field is zero.**

Direction

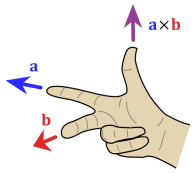

Figure 1:

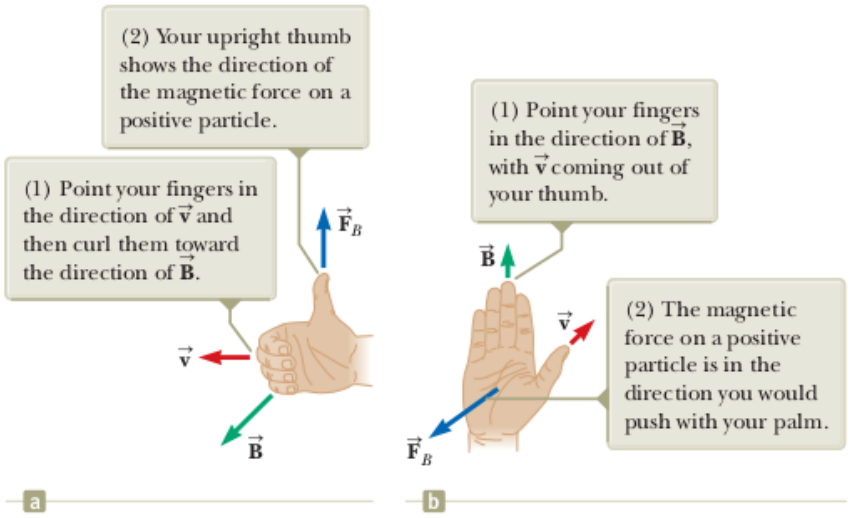

Figure 29.5 Two right-hand rules for determining the direction of the magnetic force $\vec{F}_B = q\vec{v} \times \vec{B}$ acting on a particle with charge q moving with a velocity $\vec{v}$ in a magnetic field $\vec{B}$. (a) In this rule, the magnetic force is in the direction in which your thumb points. (b) In this rule, the magnetic force is in the direction of your palm, as if you are pushing the particle with your hand.

Figure 2:

Unit

$$1T = 1\frac{N}{C \cdot m/s} = 1\frac{N}{A \cdot m} = 10^4 G$$

Exercises

1) Determine the initial direction of the deflection of charged particles as they enter the magnetic fields:

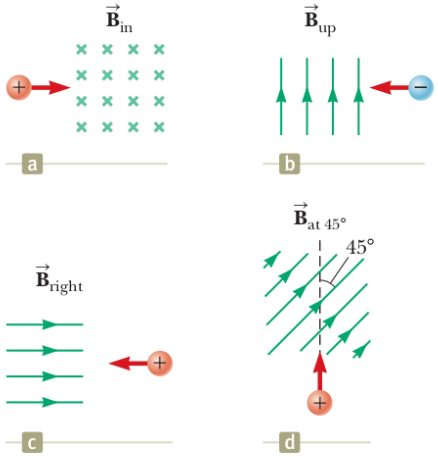

Figure P29.2

Figure 3:

2) A 0.200-kg metal rod carrying a current of 10.0 A glides on two horizontal rails 0.500 m apart. If the coefficient of kinetic friction between the rod and rails is 0.100, what vertical magnetic field is required to keep the rod moving at a constant speed? **Answer: 39.2mT**

3) A wire bent into a semicircle of radius R forms a closed circuit and carries a current I. The wire lies in the xy plane, and a uniform magnetic field is directed along the positive y axis as in the figure below. Find the magnitude and direction of the magnetic force acting on the straight portion of the wire and on the curved portion.

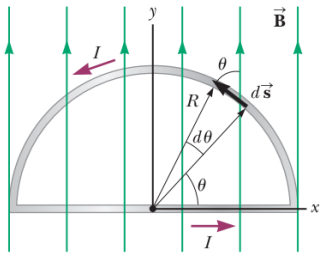

Figure 4:

4) A rod with a mass m and a radius R is mounted on two parallel rails of length a separated by a distance l , as shown in the Figure below. The rod carries a current I and rolls without slipping along the rails which are placed in a uniform magnetic field $\vec{B}$ directed into the page. If the rod is initially at rest, what is its speed as it leaves the rails?

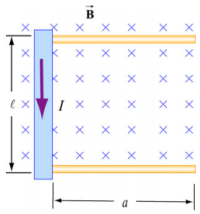

Figure 5: