Chapter 20: Magnetic Forces

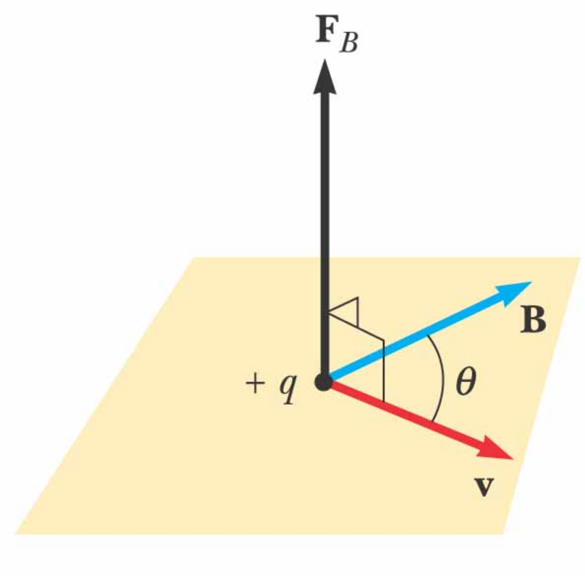
- We know that an "electric" charge produces an electric field $\vec{E} = \dfrac{k_e q}{r^2}\hat{r} = \dfrac{\vec{F}_e}{q_0}$

- which can be related to the force on a test "electric" charge q_0

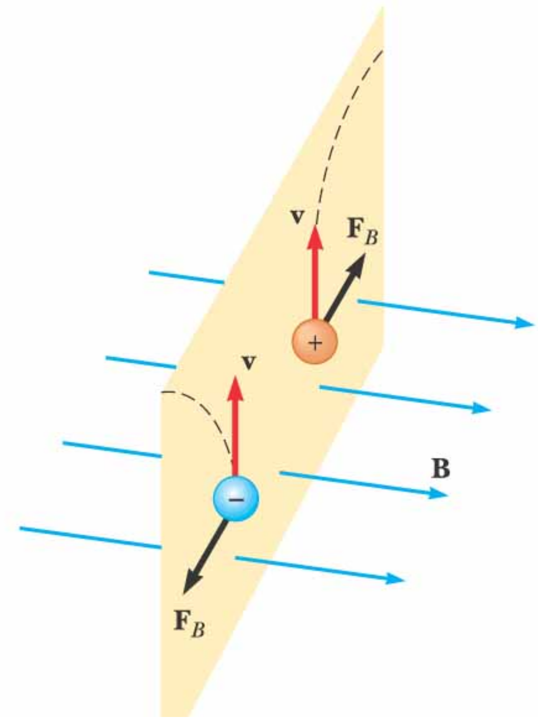
- However, isolated "magnetic charges", magnetic monopoles, do not exist. So, we cannot define a magnetic force in a similar way.

- We define a magnetic interaction with field, **B**, by considering the force $\mathbf{F}_B$ that it exerts on an electrical charge q moving with velocity **v**

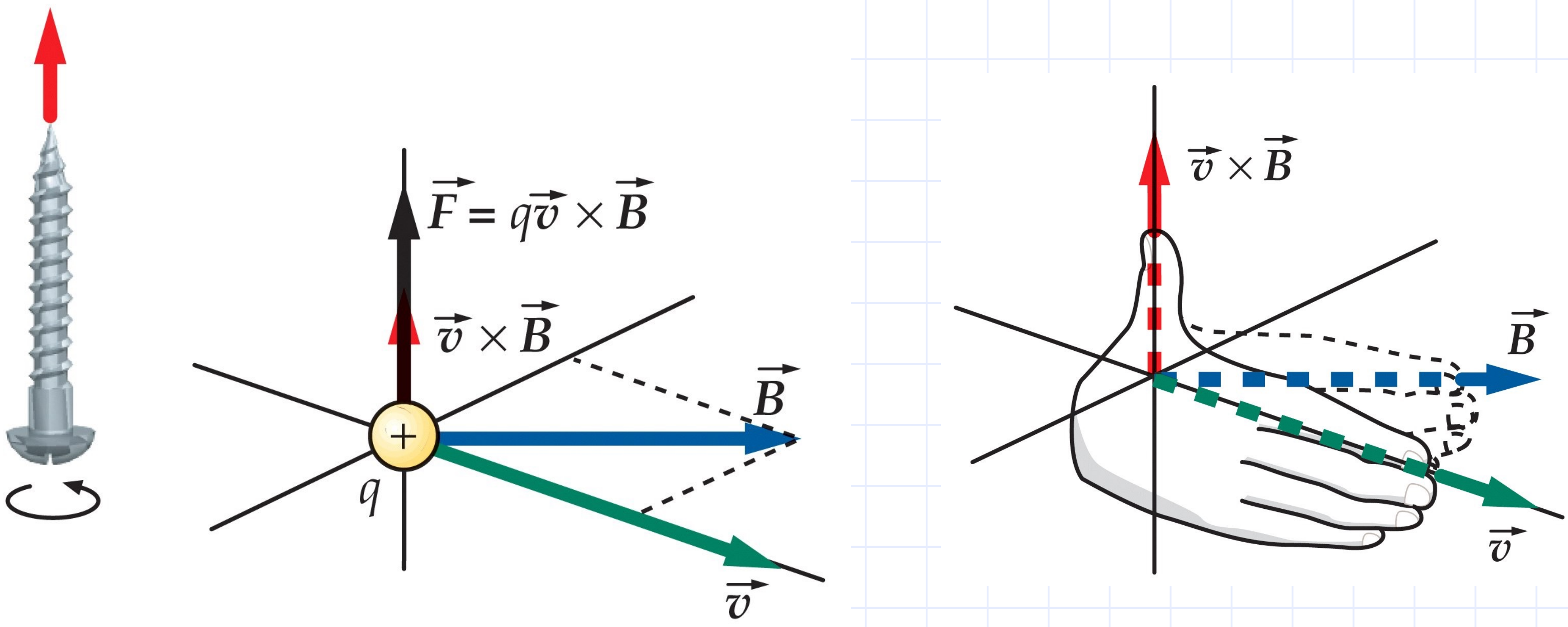
- Many experiments have shown the following relation to hold $$\vec{F}_B = q\vec{v} \times \vec{B}$$
- From the definition of the cross product, the magnitude is $$|\vec{F}_B| = |q||v||B|\sin\theta$$
- Consider a uniform magnetic field



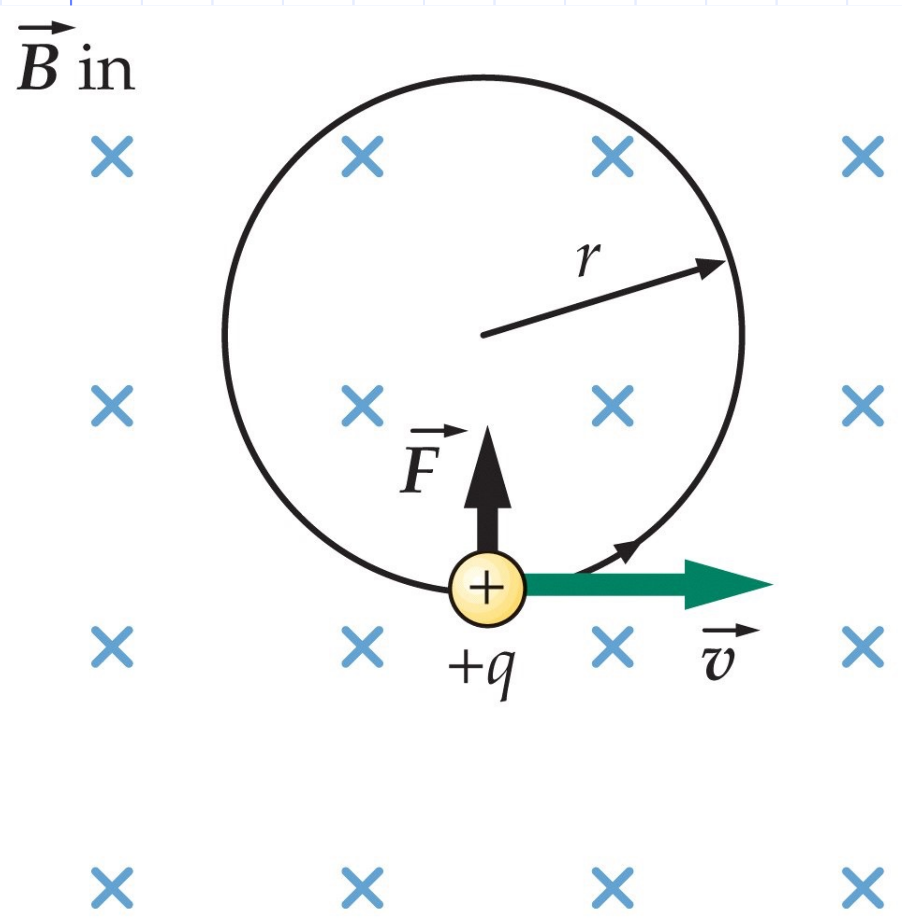
(a)

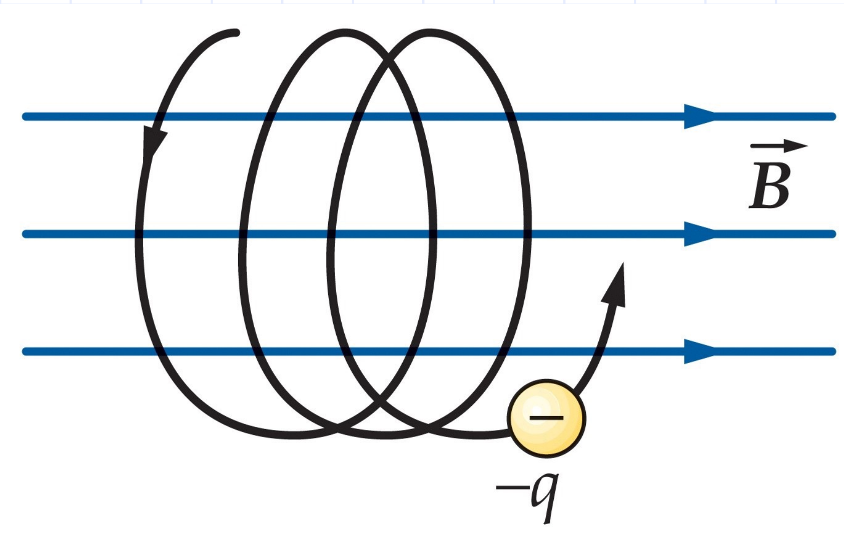


- Magnetic field lines are drawn the same as electric field lines – and the density of lines is proportional to the magnitude of the field
- However, the direction of the force is always perpendicular to the plane defined by **B** and **v**



The motion of charge particles in uniform B fields





Example Problem

- An electron is accelerated through 2400 V from rest and enters a uniform 1.70-T magnetic field. What are (a) the maximum and (b) the minimum values of the magnetic force this charge experiences?

Example Problem

- An electron moves in a circular path perpendicular to a constant magnetic field of magnitude 1.00 mT. The angular momentum of the electron about the center of the circle is 4.00×10^{-25} Js. Determine (a) the radius of the circular path and (b) the speed of the electron.

Examples