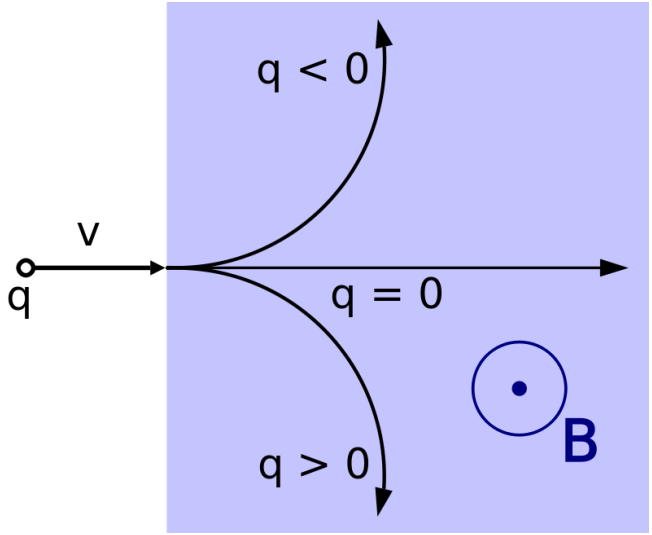
Electromagnetic force - Lorentz force

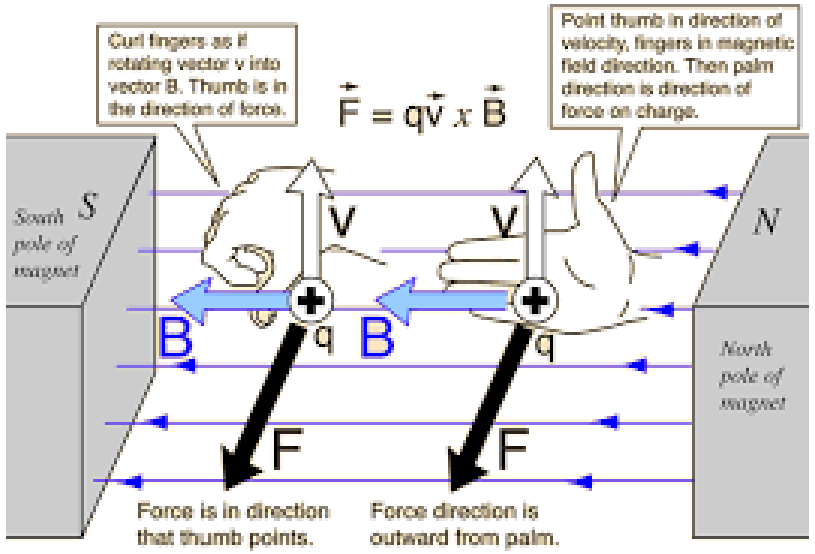
Force on a point charge *Q*:

Electric Force: $\mathbf{F_{elec}} = Q\mathbf{E}$

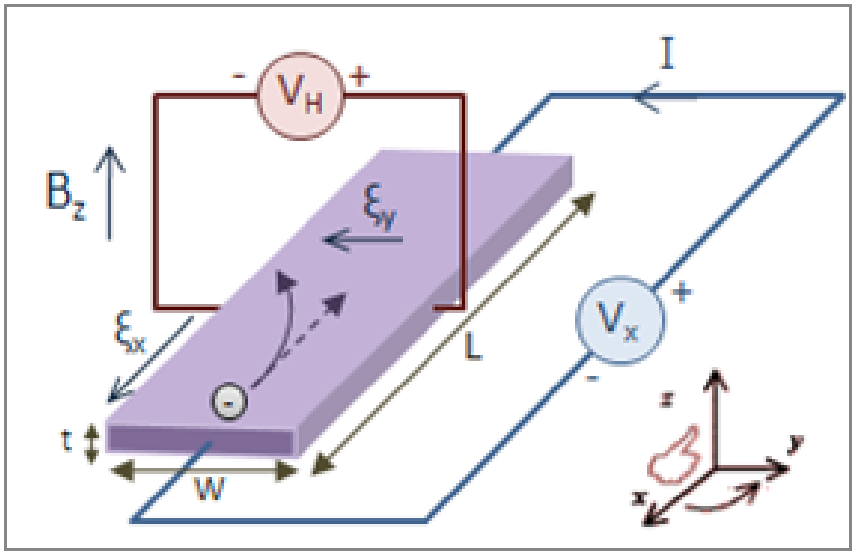
Magnetic Force: $\mathbf{F_{mag}} = Q(\mathbf{v} \times \mathbf{B})$ **Lorentz Force Law**

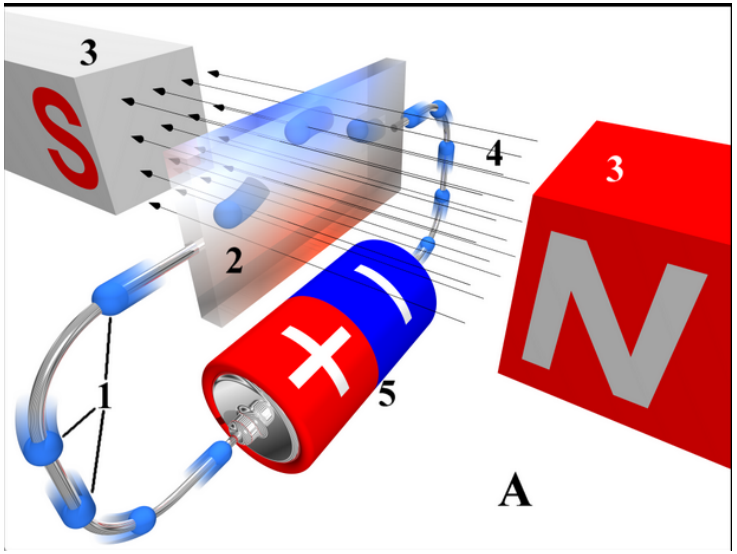
Total Force: $\mathbf{F} = \mathbf{F_{elec}} + \mathbf{F_{mag}} = Q(\mathbf{E} + \mathbf{v} \times \mathbf{B})$





Hall effect

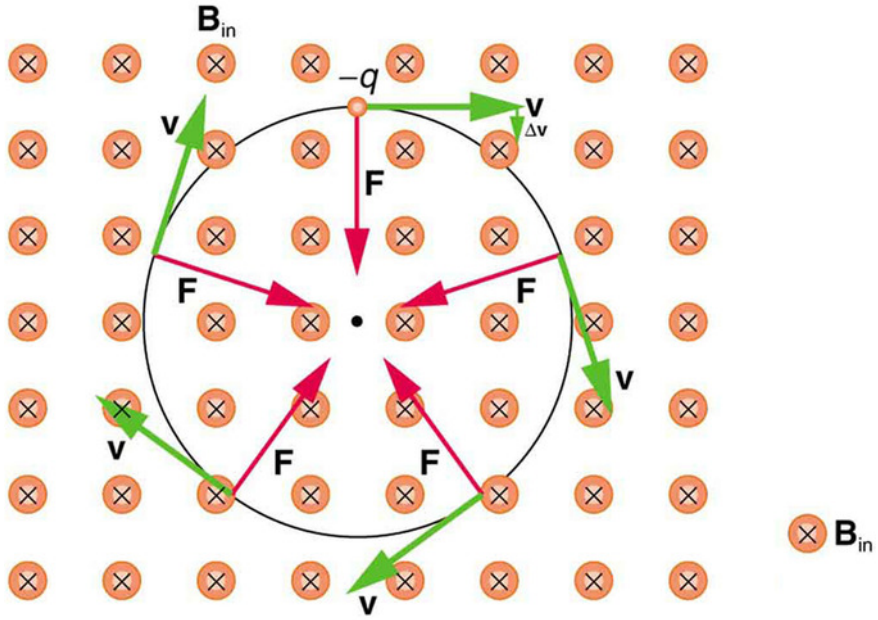




Circular motion of charged particle in magnetic field

- A negatively charged particle moves in the plane of the page in a region where the magnetic field is perpendicular into the page (represented by the small circles with x's—like the tails of arrows).
- The magnetic force is perpendicular to the velocity, and so velocity changes in direction but not magnitude. **Uniform circular motion results.**
- The centripetal force is given by

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



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- The Lorentz magnetic force supplies the centripetal force, so $qvB = \frac{mv^2}{r}$

  solving for r yields $r = \frac{mv}{qB}$

- Here, *r* is called the gyroradius or cyclotron radius, is the radius of curvature of the path of a charged particle with mass *m* and charge *q*, moving at a speed *v* perpendicular to a magnetic field of stre
- The frequency of the circular motion is $f = \frac{v}{2\pi r} = \frac{qB}{2\pi m}$ Or, $\omega = \frac{qB}{m}$