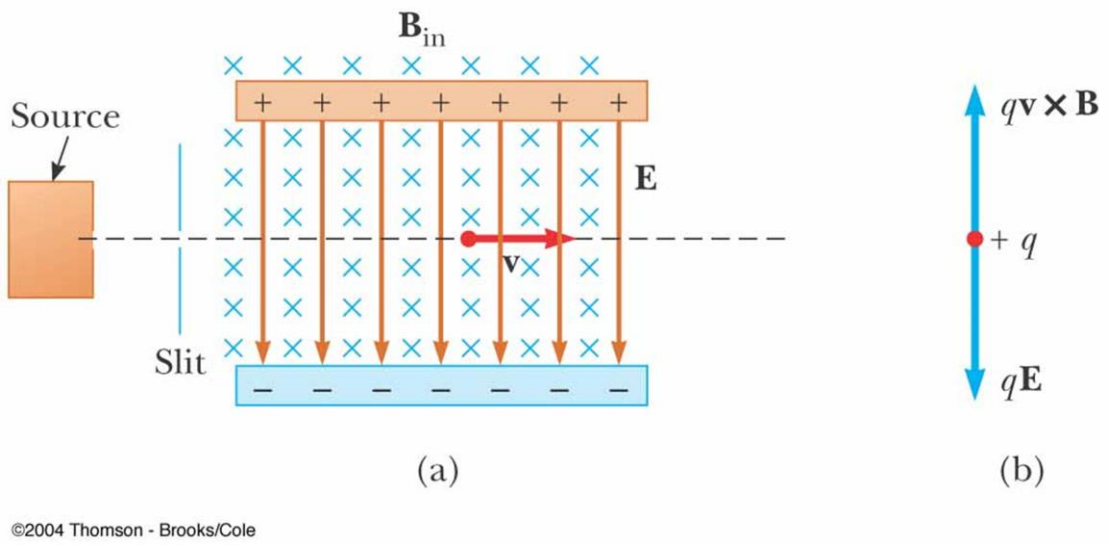
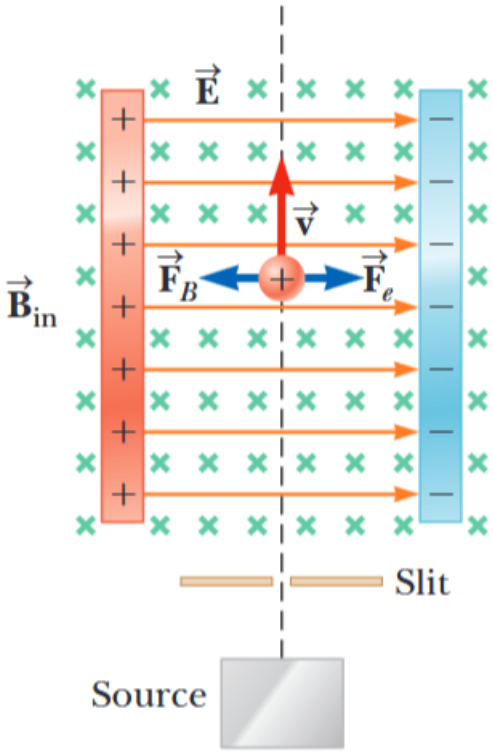
29.5 Applications involving charged particle moving in a magnetic field:

In the following figure, a charged particle experiences electric force and magnetic force due to the presence of an electric field and magnetic field. **Then, the total force acting on the particle is written as,**

$$\vec{F} = q\left(\vec{E} + \vec{v}x\vec{B}\right) \qquad 29.4$$

This force is called "Lorentz force".





Velocity Selector:

If the charge q is positive and the velocity v is upward, the magnetic force is to the left and the electric force is to the right. When the particle in equilibrium the magnitude if the two fields are chosen so that,

$$qE=qvB$$

then, $$v = \frac{E}{B} \qquad 29.5$$

Only those particles having speed v *pass un-deflected through the mutually perpendicular* electric and magnetic fields. The magnetic force exerted on particles moving at speeds greater than this is stronger than the electric force, and the particles are deflected upward. Those moving at speeds less than this are deflected downward.

Examples:

Example-1 An electron moves parallel to a magnetic field, B = 4 mT, with a speed 5×104 m/s; accordingly, the electron acceleration is:

Example 2: What is the condition for a charged particle to pass undeflected through a velocity selector?

Example-3 A velocity selector uses an electric field of 3.0×104 V/m and a magnetic field of 0.20 T. What speed of particles will pass through the selector without deflection?

Example-4 If in a velocity selector, the magnetic field is doubled while keeping the electric field constant, what happens to the velocity of selected particles?