Dhiraj Kameti

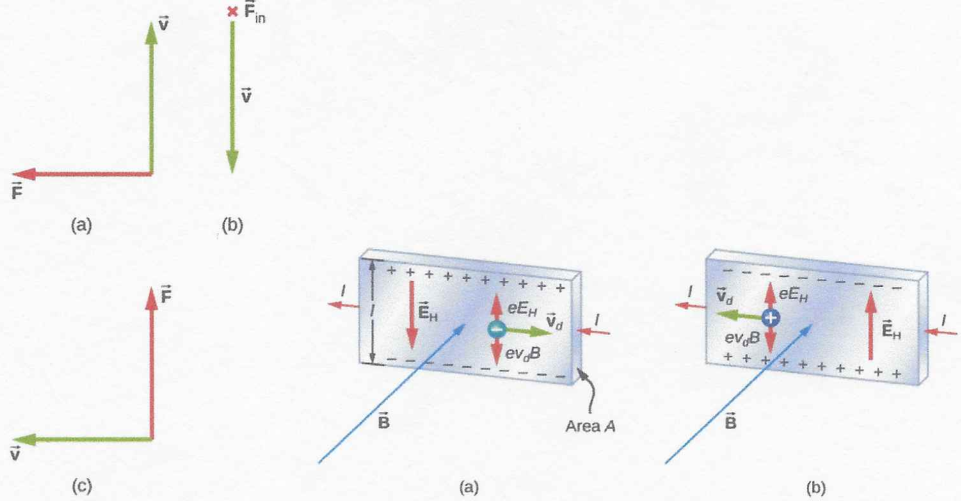

Figure 1: (Left) A current I experiences a force F in a B-field.

2 Chapter 11: Magnetic Forces and Fields

1. Consider Fig. 1 (left). In each of the three cases, determine the direction of the B-field given that F is the Lorentz force.
   - a: into the page
   - b: to the left
   - c: Out of the page

2. Consider Fig. 1 (right). **The Hall Effect**. An E-field exists in the vertical direction and a B-field is perpendicular to the direction of charge velocity. (a) Show that if the E-field force on a charge balances the Lorentz force on a charge, that $v = E/B$. (b) If the E-field is constant, $E = \Delta V/\Delta x$. Show that

$$\Delta V = \frac{B\Delta x I}{n q_e A} \tag{1}$$

where n is the charge carrier density, q_e is the electron charge, A is the cross-sectional area of the conductor, and I is the current. Plug in $B = 1.33$ T, $\Delta x = 2$ cm, $I = 10$ A, $n = 2 \times 10^{28}$ m^{-3}, $A = 1$ mm^2, and q_e is the charge of an electron.

a. $F = qE$

$F = qvB$

$B = \frac{F}{qv}$

$v = \frac{\frac{F}{q}}{\frac{F}{qv}}$

$\boxed{V = V}$

b. $\Delta V = E(\Delta x)$

$\Delta V = vB(\Delta x)$

$\Delta V = B(\Delta x)\frac{I}{nq_eA}$

$\Delta V = \frac{B(\Delta x)I}{nq_eA}$

$= \frac{(1.33)(0.02)(10)}{(2\times10^{28})(1.6\times10^{-19})(0.001)^2} = 8.3\times10^{-5}\ V$

3. A proton has a magnetic field due to its spin. The field is similar to that created by a circular current loop 0.65×10^{-15} m in radius with a current of 1.05×10^4 A. Find the maximum torque on a proton in a 2.50-T field. (This is a significant torque on a small particle.)

$T_{max} = (1.05\times10^4)(\pi)(0.65\times10^{-15})^2(2.5)$

$= 3.5\times10^{-26}$ Nm

$A = \pi r^2$

$T_{max} = NIAB,\ N=1$

$T_{max} = IAB$

$T_{max} = I\pi(r^2)B$

3 Chapter 12: Sources of Magnetic Fields

1. (a) What is the B-field inside a solenoid with 500 turns per meter, carrying a current of 0.3 A? (b) Suppose we insert a piece of metal inside the solenoid, boosting μ_0 by a factor of 5000. What is the new B-field?

a. $B = \mu_0 n I$

$= (4\pi\times10^{-7})(0.3)(500)$

$= 1.8\times10^{-4}\ T$

b. $B = \mu_0 n I \cdot 5000$

$= (1.8\times10^{-4})(5000)$

$= 0.942$

$= 9.4\times10^{-1}\ T$