ADONIS RIVERA

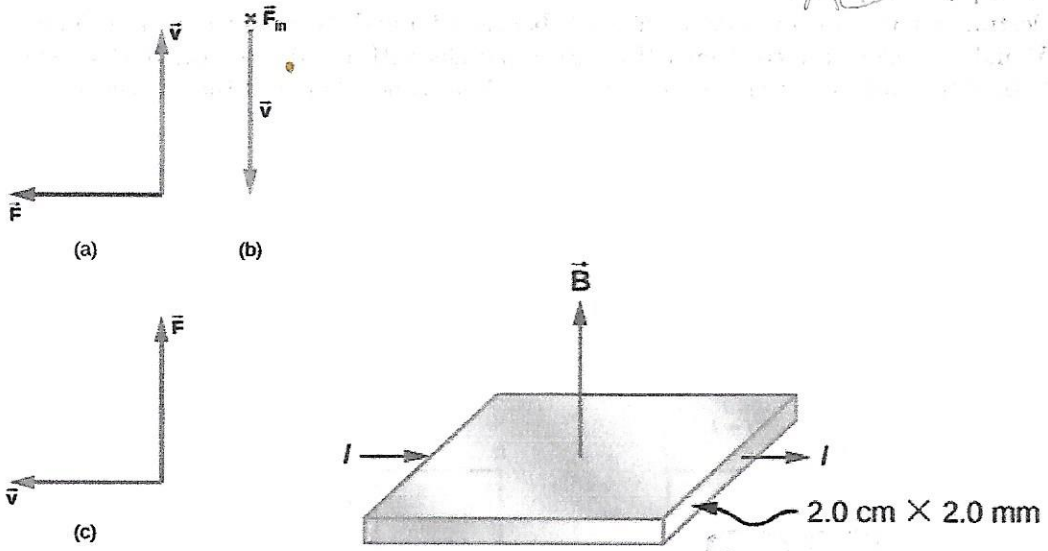

Figure 1: (Left) A current I experiences a force F in a B-field.

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: $B = F \times V = -i \times j = -k$ into the page
   - b: $B = F \times V = -k \times -i = -j$ to the left
   - c: $B = F \times V = j \times i = k$ out 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) $F_B = F_E$
$qE = qVB\sin\theta$
$\theta = 90$
$E = VB \rightarrow E = VB$

b) $\Delta V = \frac{B(\Delta x) I}{n q_e A}$
$\frac{(1.33)(2\times10^{-2})\times10}{2\times10^{28}(1.6\times10^{-19})\times(1\times10^{-3})^2}$
$\Delta V = 8.31 \times 10^{-5}$ 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.)

$\tau = NIAB\sin\theta$
$A = \pi r^2 \rightarrow A = \pi(0.65\times10^{-15})^2 = 1.33\times10^{-30}$
$\tau = 1(1.05\times10^4)(1.33\times10^{-30})(2.50)\times(\sin 90)$
$\tau = 3.48\times10^{-26}$ N m

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) $B = \mu_0 I = 4\pi\times10^{-7}\times500\times3$
$= 1.88\times10^{-4}$ T

b) $5000\times\mu_0 nI = 5000\times1.88\times10^{-4}$
$= 0.941$