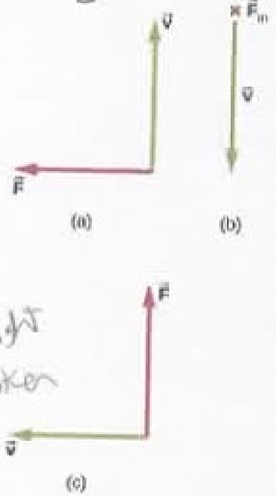
For A and B when I did the Right hand rule the in and out of the page results were flipped so IDK my right hand is broken



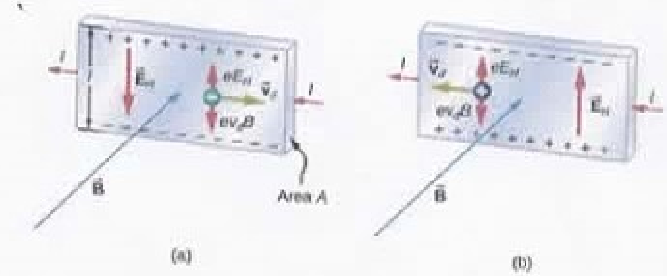


Figure 1: (Left) A current I experiences a force F in a B-field.

2 Chapter 11: Magnetic Forces and Fields

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

a.) $\hat{B} = \hat{F} \times \hat{V}$

$\hat{B} = -\hat{i} \times \hat{j} = -\hat{k}$

$\boxed{\text{Into the Page}}$

b.) $\hat{B} = -\hat{k} \times (-\hat{j}) = -\hat{i}$

$\boxed{\text{Left}}$

c.) $\hat{B} = \hat{j} \times (-\hat{i}) = \hat{k}$

$\boxed{\text{Out the Page}}$

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.

$F_E = F_B$

a.) $qVB\sin\theta$

$\theta = 90° \leftarrow 1$

$qE = qVB \Rightarrow E = VB$

$\boxed{V = \frac{E}{B}}$

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

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

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

Drift velocity, $V_d = \frac{I}{n q_e A}$

$\boxed{\Delta V = \frac{B(\Delta x)I}{n q_e A}}$

Plug in

Cm→m

$\Delta V = \frac{1.33(2\times10^{-2})(10)}{(2\times10^{28}\frac{1}{m^3})(1.6\times10^{-19}C)(1\times10^{-3})^2}$ mm→m

$\boxed{\Delta V = 8.31\times10^{-5}\,V}$

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.)

Torque $= I\,\vec{A}\times\vec{B}$ $\quad A = \pi r^2 = (3.1415926)(0.65\times10^{-15})^2 = 1.33\times10^{-30}\,m^2$

$= (1.05\times10^4 A)(\cancel{0.65\times10^{-15}} m)(2.50T) = \boxed{3.49\times10^{-26}\,Nm}$

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?

$n = N/L = 500/1 = 500$ $\quad I$

A.) $B = \mu_0 n I$

$B = (4\pi\times10^{-7})(500)(.3) = \boxed{1.88\times10^{-4}T}$

B.) $B = 5000(\mu_0)(500)(.3)$

$= 1.88\times10^{-4}(5000)$

$= \boxed{0.94T}$

B out of Page
$V \longrightarrow$ to right

$F_e + F_m = 0$

$F_e = q\vec{E}$

$F_m = q(\vec{v}\times\vec{B})$

$q|\vec{E} + \vec{v}\times\vec{B}| = 0$

$\frac{q|E - vB| = 0}{q}$

$E - VB = 0$
$-E \quad -E$
$\frac{-VB}{B} = \frac{-E}{B}$

$\boxed{V = \frac{E}{B}}$

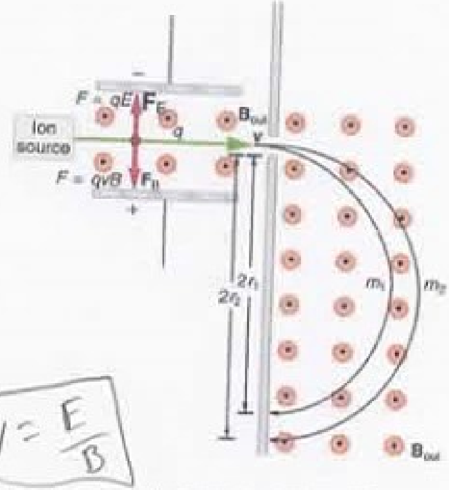


Figure 2: A basic diagram of a *toroid*, which is a solenoid wrapped into a circular tube.

2. Consider Fig. 2. **Mass spectrometer**. Suppose that the velocity of the charged particles moving to the right is $v = E/B$. (a) Show that if $v = E/B$, $F_{net} = 0$ in the region in the top left[1]. (b) Recall that the centripetal force on a particle of mass m is mv^2/r. Set this equal to the magnitude of the Lorentz force to prove that

$$r = \frac{mE}{qB^2} \tag{2}$$

The mass of an oxygen nucleus is 16 times that of a proton (mass of proton: 1.67×10^{-27} kg). Suppose oxygen ions with the charge of 1 proton are sent through the mass-sepctrometer. The E-field is 10 V/m, and the B-field is 0.01 T. What is the distance r?

b.) $r = \frac{(16 \times 1.67\times10^{-27}\,\text{kg})(10\,\frac{V}{m})}{(1.602\times10^{-19})(0.01)^2} = \boxed{0.017\,m}$

4 Chapter 13: Electromagnetic Induction

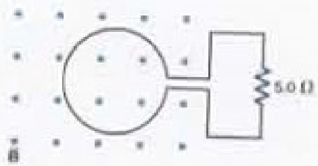


Figure 3: A voltage is induced on a loop by a changing B-field.

1. The magnetic field in Fig. 3 flows out of the page through a single ($N = 1$) loop, and is tuned to follow the form

$$B(t) = B_0\left(\frac{1}{2} + \frac{2}{\pi}\sin(2\pi f t) + \frac{2}{3\pi}\sin(6\pi f t) + \frac{2}{5\pi}\sin(10\pi f t)\right) \tag{3}$$

The loop has a radius r. (a) In terms of the given variables, what is the induced voltage in the circuit? (b) If $B_0 = 0.1$ T, $r = 0.1$ m, and $f = 10^3$ Hz, what is the induced emf at $t = 0$? (c) What is the current through the resistor at $t = 1$ ms?

a.) $e = \frac{\partial BA}{\partial t}$ $\quad e = A\frac{dB}{dt}$

$\boxed{e = \pi r^2 (B_0)\left(\left(\frac{2}{\pi}\sin(2\pi f t)\right) + \left(\frac{2}{3\pi}\sin(6\pi f t)\right) + \left(\frac{2}{5\pi}\sin(10\pi f t)\right) + \frac{1}{2}\right)}$

B.) $t = 0$ all $\sin = 0$ s.

$e = \pi(0.1)^2(0.1)(\frac{1}{2})$ $\boxed{e = 0.016\,\frac{J}{C}}$

C.)

0.58778

$e = \pi(0.1\,m)^2(0.1)\left(\frac{2}{\pi}\sin(2\pi\cdot10^3\cdot(0.1)) + \frac{2}{3\pi}\sin(6\pi\cdot10^3\cdot0.1) + \frac{2}{5\pi}\sin(10\pi\cdot10^3\cdot0.1) + \frac{1}{2}\right)$ $\quad 0.951 \quad 0$

$= \pi(0.001)(0.374 + 0.202 + 0.5)$

$I = \frac{e}{R}$ $\quad e = 0.000338$, $R = 5.0\,\Omega$ $\quad \boxed{I = 6.8\times10^{-5}\,A}$

[1]Molecules that do not have this velocity will hit the sides of this portion of the instrument.

5 Chapter 14: Inductance

1. What is (a) the rate at which the current though a 0.50-H coil is changing if an emf of 0.150 V is induced across the coil?

$$\frac{dI}{dt} \quad \frac{emf}{L} = \frac{0.150V}{0.50H} = \boxed{0.30\frac{A}{s}}$$

2. When a camera uses a flash, a fully charged capacitor discharges through an inductor. In what time must the 0.100-A current through a 2.00-mH inductor be switched on or off to induce a 500-V emf?

$$\mathcal{E} = L\frac{dI}{dt}$$

$$\Downarrow$$

mH → H

$$dt = \frac{L}{\mathcal{E}}dI \rightarrow \frac{(2.00mH)(10^{-3})}{500V}(0.100A) = \boxed{4.00\times10^{-7}s}$$