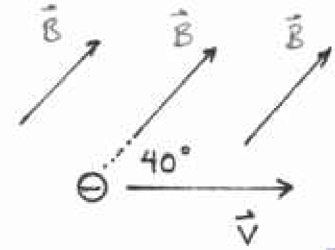
Units? Units?

Name______________________

Phys 2120, Section 3
Quiz #4 — Spring 2003

1. a) An electron moves with a speed of $5.00 \times 10^5 \frac{\text{m}}{\text{s}}$ in the direction shown; there is a uniform magnetic field of magnitude 0.200 T in the direction shown. Both the velocity and the magnetic field are *in the plane of the page*.



Give the magnitude and direction of the force on the electron.

$\Rightarrow \phi = 40°$

$|q| = e$
$= 1.602\times10^{-19}\text{C}$

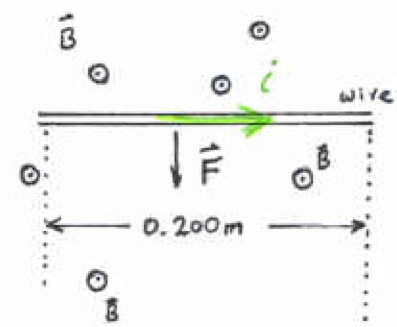
Magnitude of the force is

$F = |q| v B \sin\phi = (1.602\times10^{-19}\text{C})(5.00\times10^5 \frac{\text{m}}{\text{s}})(0.200\text{T}) \sin 40°$

$= \boxed{1.03\times10^{-14}\text{N}}$

By RHR for cross-prods, $\vec{v}\times\vec{B}$ points out of page but since q is negative, the force on the electron points $\boxed{\text{into the page.}}$

2. A current flows through a wire section of length 0.200 m. A uniform magnetic field of magnitude 0.100 T points out of the page. There is a force on the wire of magnitude 0.100 N directed as shown ("down").



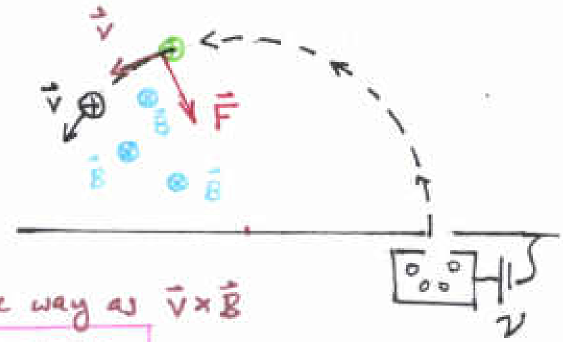
a) Indicate the direction in which the current flows in the wire. Since $\vec{F} = I\vec{L}\times\vec{B}$ & $\vec{F}$ points down, then $\vec{L}$ (and hence the current) must go from $\boxed{\text{Left to Right}}$.

b) What is the current in the wire?

Since $\vec{L} \perp \vec{B}$ then $F = iLB$, so

$$i = \frac{F}{LB} = \frac{(0.100\text{N})}{(0.200\text{m})(0.100\text{T})} = \boxed{5.0\text{ A}}$$

3. A proton moves in a circular path in a plane perpendicular to a uniform magnetic field. The radius of the proton's path is 15.0 cm and the strength of the magnetic field is 0.250 T.



a) If the orbit is as drawn here, does the magnetic field point into or out of the page? (Be sure to *give your reasoning* here.)

The centripetal force on the proton points to the center of the circle. The charge is positive so $\vec{F}$ points the same way as $\vec{v}\times\vec{B}$ and this can only be true if $\vec{B}$ points $\boxed{\text{into the page.}}$

b) What is the speed of the proton?

Use the relation for circ. orbits in a $\perp$ $\vec{B}$ field: $\frac{mv}{r} = qB$. Then:

$$v = \frac{qBr}{m} = \frac{(1.602\times10^{-19}\,\mathrm{C})(0.250\,\mathrm{T})(0.150\,\mathrm{m})}{(1.673\times10^{-27}\,\mathrm{kg})} = \boxed{3.6\times10^{6}\,\tfrac{\mathrm{m}}{\mathrm{s}}}$$

c) If before entering the field the proton was accelerated starting from rest through some potential difference $\mathcal{V}$, what is $\mathcal{V}$?

KE of proton is

$$K = \tfrac{1}{2}mv^2 = \tfrac{1}{2}(1.673\times10^{-27}\,\mathrm{kg})(3.6\times10^{6}\,\tfrac{\mathrm{m}}{\mathrm{s}})^2 = 1.08\times10^{-14}\,\mathrm{J}\left(\frac{\mathrm{eV}}{1.6\times10^{-19}\,\mathrm{J}}\right)$$

$$= 6.73\times10^{4}\,\mathrm{eV} = q\Delta V \quad \text{w/ } q=e$$

So the potential difference was

$$\boxed{\Delta V = 6.7\times10^{4}\,\mathrm{V}}$$

You must show all your work and include the right units with your answers!

$$e = 1.602\times10^{-19}\ \mathrm{C} \qquad m_{\mathrm{elec}} = 9.109\times10^{-31}\ \mathrm{kg} \qquad m_{\mathrm{prot}} = 1.6726\times10^{-27}\ \mathrm{kg}$$

$$K = \tfrac{1}{2}mv^2 \qquad 1\ \mathrm{eV} = 1.602\times10^{-19}\ \mathrm{J} \qquad \Delta U = q\Delta V$$

$$V = iR \qquad \tau = RC \qquad q(t) = C\mathcal{E}e^{-t/\tau} \qquad i(t) = \frac{\mathcal{E}}{R}e^{-t/\tau}$$

$$\mathbf{F} = q\mathbf{v}\times\mathbf{B} \qquad \mathbf{F} = I\mathbf{L}\times\mathbf{B} \qquad \frac{mv}{r} = qB$$