1. For the two vectors shown below, mark the direction of the third vector in the cross product relationship expressed by $\mathbf{F} = q\mathbf{v} \times \mathbf{B}$. (Pay close attention to the sign of $q$ given in each picture.

   a) \[ \mathbf{v} \quad (+q) \quad \mathbf{B} \quad (-q) \quad \mathbf{F} \]
   b) \[ \mathbf{v} \quad (+q) \quad \mathbf{B} \quad (-q) \quad \mathbf{F} \]
   c) \[ \mathbf{v} \quad (+q) \quad \mathbf{B} \quad (-q) \quad \mathbf{F} \]
   d) \[ \mathbf{v} \quad (+q) \quad \mathbf{B} \quad \text{no force} \]
   e) \[ \mathbf{v} \quad (+q) \quad \mathbf{B} \quad (-q) \quad \mathbf{F} \]

2. For the examples given, mark the direction of the current induced in each loop by the current flow shown.

   a) $I$ increasing
   b) $I$ decreasing
   c) $I$ decreasing
   d) no current

3. A wire hangs from support threads as shown. The direction of the constant $B$ field is shown and the angle of the support threads is $2^\circ$ from the vertical. The magnitude of $B$ is .5 tesla. Find the current in the wire which has a linear mass density of 2 grams per meter.

   $T_y = mg = plg$
   $T = \frac{T_y}{\cos 2^\circ}$
   $T_x = IB = Ta \sin 2^\circ$
   $IB = T_y \frac{\sin 2^\circ}{\cos 2^\circ}$
   $IB = plg \tan 2^\circ$
   $I = \frac{plg \tan 2^\circ}{15}$
   $I = 1.3 \times 10^{-3} \text{ amp.}$
5. Two isotopes of carbon, one with a mass 12 times the proton mass \((12 \times 1.67 \times 10^{-27} \text{ kg.})\) the other with 14 times the proton mass, are singly ionized (charge is \(+1.6 \times 10^{-19} \text{ C}\)) are accelerated through the same voltage. They enter a magnetic field region, \(B=2.5T\), perpendicular to the field. The C\(_{12}\) hits the screen 1.5 cm. from the entry hole.

a) through what potential was the charged ion accelerated?

\[ 2r = 0.015 \text{ m} \quad r = 0.0075 \text{ m} \quad \frac{mv}{qB} = \frac{qV}{r} \]

\[ r = \frac{mv}{qB} \quad v = \frac{qB}{m} = \frac{(1.6 \times 10^{-19})(0.0075)(2.5)}{12(1.6 \times 10^{-27})} = 1.497 \times 10^5 \text{ m/s} \]

b) where would the C\(_{12}\) hit?

\[ v = \sqrt{\frac{2qV}{m}} \quad \Delta V = \frac{v^2 - m}{2q} \]

\[ v_{14} = \sqrt{\frac{2(1.6 \times 10^{-19})(1.943)}{14(1.67 \times 10^{-27})}} = 1.39 \times 10^5 \text{ m/s} \]

\[ r = \frac{(14)(1.67 \times 10^{-27})(1.39 \times 10^5)}{(1.6 \times 10^{-19})(2.5)} = 0.08 \text{ m} \quad 2r = 0.16 \text{ m} \]

4. A coil is made from 100 meters of wire with a total resistance of 2.5 ohms, wrapped around a cylinder with radius 10 cm. The coil is held at a constant position in space but the B field, which is at an angle of 30° from the plane of the loop, is varied uniformly from a maximum value to 0 in .01 seconds. A current of 4 amperes is measured in the coil. What is the value of the maximum B field?

\[ \text{Circumference} = 2\pi(0.1) = 0.628 \text{ meters} \]

\[ \frac{100}{0.628} = N = 159 \text{ turns} \quad \Theta = 90 - 30° - 60° \]

\[ \varepsilon_{\text{emf}} = NA\cos \Theta \frac{\Delta B}{\Delta t} \quad I = \frac{\varepsilon_{\text{emf}}}{2.5} \]

\[ \varepsilon_{\text{emf}} = 159(\pi)(0.1)^2 \cos 60° \frac{\Delta B}{0.01} \quad \Phi = \frac{\varepsilon_{\text{emf}}}{2.5} \]

\[ \frac{159(\pi)(0.1)^2 \cos 60°}{0.01} = \Delta B = B_{\text{max}} = 0.04 \text{ T} \quad \varepsilon_{\text{emf}} = 10 \]
1. For the two vectors shown below, mark the direction of the third vector in the cross product relationship expressed by \( F = qv \times B \). (Pay close attention to the sign of \( q \) given in each picture.

   a) \[
   \begin{array}{c}
   \text{\( F \)} \\
   \text{\( \times \)} \\
   \text{\( \langle +q \rangle \)} \\
   \end{array}
   \]

   b) \[
   \begin{array}{c}
   \text{\( \times \)} \\
   \text{\( \langle -q \rangle \)} \\
   \end{array}
   \]

   c) \[
   \begin{array}{c}
   \text{\( \times \)} \\
   \text{\( \langle -q \rangle \)} \\
   \end{array}
   \]

   d) \[
   \begin{array}{c}
   \text{\( \times \)} \\
   \text{\( \langle +q \rangle \)} \\
   \end{array}
   \]

   e) \[
   \begin{array}{c}
   \text{\( \times \)} \\
   \text{\( \langle -q \rangle \)} \\
   \end{array}
   \]

2. For the examples given, mark the direction of the current induced in each loop by the changing current shown.

   a) \[
   \begin{array}{c}
   \text{\( \text{\( I \)} \)} \\
   \text{\( \text{increasing} \)} \\
   \end{array}
   \]

   b) \[
   \begin{array}{c}
   \text{\( \text{\( I \)} \)} \\
   \text{\( \text{decreasing} \)} \\
   \end{array}
   \]

   c) \[
   \begin{array}{c}
   \text{\( \text{\( I \)} \)} \\
   \text{\( \text{decreasing} \)} \\
   \end{array}
   \]

3. A negatively charged particle, \( q = -2 \times 10^{-9} \text{ C} \) is moving as shown in the three examples. Show the direction and compute the magnitude of the force due to the current in the wire if in each case the velocity is \( 2 \times 10^6 \text{ m/sec} \), directed as shown, and each is \( 1 \text{ cm} \) from the wire which carries 100 amperes.

   \[ I = 100 \text{ amp} \]

   a) \[
   \begin{array}{c}
   \text{\( \langle -q \rangle \)} \\
   \text{\( \text{\( I \)} \)} \\
   \text{\( \text{\( 1 \text{ cm} \)} \)} \\
   \end{array}
   \]

   b) \[
   \begin{array}{c}
   \text{\( \text{\( I \)} \)} \\
   \text{\( \text{\( 1 \text{ cm} \)} \)} \\
   \end{array}
   \]

   c) \[
   \begin{array}{c}
   \text{\( \text{\( I \)} \)} \\
   \text{\( \text{\( 1 \text{ cm} \)} \)} \\
   \end{array}
   \]
1. Given the two vectors shown below find the third vector direction in the $\mathbf{v} \times \mathbf{B} = \mathbf{F}$ relationship. Make all vectors perpendicular.

15

2. A magnet is placed inside a coil of wire with the north pole in the coil as shown. The magnet is removed by pulling it to the left. Is the magnet attracted to the coil or repelled by it as it is being removed?

5

5. A closed loop of wire 1.5 meters long is formed into a circle and oriented such that a constant .5 tesla field points at $55^\circ$ from the plane of the loop. During a short period of .01 seconds, the loop is pulled from opposite edges to completely flatten the loop. If the resistance of the wire is $5 \ \Omega$, what is the total electrical energy dissipated in the wire during this time.

15
4. Two isotopes one with a mass 16 times the proton mass (16 x 1.67 x 10^{-27} \text{ kg.}) the other with an unknown mass are singly ionized (charge is +1.6 \times 10^{-19}\text{C}) are accelerated through the same voltage, 3000 volts. They pass through a hole into a chamber with a magnetic field region perpendicular to the field. The known mass hits the screen 2.00 cm. from the entry hole, while the unknown isotope hits at 2.25 cm from the screen. Both hit below the hole.

a) what is the magnitude and direction of the B field (show a diagram)

b) what is the mass of the second isotope? (This may not match any known species, since I didn't work it out in advance)

2. For the examples given, mark the direction of the current induced in each loop by the current flow shown.