1. **PSE6 29.P.012** A wire carries a steady current of 4.90 A. A straight section of the wire is 0.750 m long and lies along the x axis within a uniform magnetic field, \( B = 2.20 \text{ kT} \). If the current is in the +x direction, what is the magnetic force on the section of wire?

\[
\vec{F} = I L \times \vec{B} = 4.90 \times 0.750 \times 2.20 \hat{j} = -8.085 \hat{j} \text{ N}
\]

2. **PSE6 29.P.004** A proton travels with a speed of \( 3.00 \times 10^6 \text{ m/s} \) at an angle of 67.0° with the direction of a magnetic field of 0.520 T in the +y direction.

(a) What are the magnitude of the magnetic force on the proton?

\[
\vec{F} = 1.6 \times 10^{-19} \times 3.00 \times 10^6 \times 0.520 \times \sin 67.0°
\]

\[
= 2.3 \times 10^{-13} \text{ N}
\]

(b) What is its acceleration?

\[
\vec{F} = m \frac{\vec{v}}{t}
\]

\[
\vec{a} = \frac{\vec{F}}{m} = \frac{2.3 \times 10^{-13}}{1.67 \times 10^{-27}} = 1.377 \times 10^{14} \text{ m/s}^2
\]
3. A conductor suspended by two flexible wires as in Figure P29.14 has a mass per unit length of 0.0200 kg/m. What current must exist in the conductor in order for the tension in the supporting wires to be zero when the magnetic field is 4.00 T into the page?

\[ I = 0.049 \text{ A} \]

What is the required direction for the current?

- to the right

\[ BIL = IBLg \]

\[ I = \frac{mg}{B} \]

\[ = \frac{0.02 \times 9.8}{4} = 0.049 \text{ A} \]

To the right.
4. PSE6 29.P.057. (3177B1) A positive charge \( q = 3.2 \times 10^{-19} \) C moves with a velocity \( \mathbf{v} = (2 \mathbf{i} + 3 \mathbf{j} - 5 \mathbf{k}) \) m/s through a region where both a uniform magnetic field and a uniform electric field exist.

(a) Calculate the total force on the moving charge (in unit-vector notation) taking \( \mathbf{B} = (2 \mathbf{i} + 4 \mathbf{j} + 4 \mathbf{k}) \) T and \( \mathbf{E} = (1 \mathbf{i} - 1 \mathbf{j} - 2 \mathbf{k}) \) V/m.

\[
\mathbf{F} = \left( \frac{1056 \times 10^{-7}}{i} + \left[ -6.08 \times 10^{-8} \right] + 0 \mathbf{k} \right) \mathbf{N}
\]

(b) What angle does the force vector make with the positive x axis?

\( 330^\circ \) (counterclockwise from the +x axis)

\[
\begin{align*}
\mathbf{a)} \quad \mathbf{F} &= q \mathbf{E} + q \mathbf{v} \times \mathbf{B} \\
&= q \left[ (1 \mathbf{i} - 1 \mathbf{j} - 2 \mathbf{k}) + (2 \mathbf{i} + 3 \mathbf{j} - 5 \mathbf{k}) \times (2 \mathbf{i} + 4 \mathbf{j} + 4 \mathbf{k}) \right] \\
&= q \left[ (1 \mathbf{i} - 1 \mathbf{j} - 2 \mathbf{k}) + (12 + 20) \mathbf{i} + (-5 \times 2 - 2 \times 4) \mathbf{j} + (2 \times 4 - 3 \times 2) \mathbf{k} \right] \\
&= q \left[ 33 \mathbf{i} - 19 \mathbf{j} + 0 \mathbf{k} \right] \\
&= 3.2 \times 10^{-19} \times 33 \mathbf{i} - 19 \mathbf{j} + 0 \mathbf{k} \\
&= \left( 1056 \times 10^{-17} \mathbf{i} - 6.08 \times 10^{-18} \mathbf{j} + 0 \mathbf{k} \right) \mathbf{N}
\end{align*}
\]

\[
\mathbf{b)} \quad \mathbf{F} \\
\theta = 360 - \arctan \frac{6.08}{1056}
\]

\( 330^\circ \)
5. A 40.0 cm length of wire carries a current of 48.0 A. It is bent into a loop and placed with its normal perpendicular to a magnetic field with a magnitude of 0.660 T.

(a) What is the torque on the loop if it is bent into an equilateral triangle?
\[ 0.244 \text{ N} \cdot \text{m} \]

(b) What is the torque if the loop is a square?
\[ 0.317 \text{ N} \cdot \text{m} \]

(c) What is the torque if the loop is a circle?
\[ 0.404 \text{ N} \cdot \text{m} \]

(d) Which torque is greatest?
- circle
- triangle
- square

\[ a) \ \tau = B l S \\
= 0.66 \times 48.0 \times \left( \frac{240}{\sqrt{3}} \right) \times \frac{0.40}{3} \times \frac{1}{2} \times \frac{\sqrt{3}}{2} \\
= 0.244 \text{ N} \cdot \text{m} \]

\[ b) \ \tau = B l S \\
= 0.66 \times 48.0 \times \frac{0.40}{4} \times \frac{0.40}{4} \\
= 0.317 \text{ N} \cdot \text{m} \]

\[ c) \ \tau = B l S \\
= 0.66 \times 48 \times \left( \frac{0.40}{2} \right)^2 \times \frac{1}{\pi} \\
= 0.404 \text{ N} \cdot \text{m} \]

\[ d) \ \text{circle} \]
6. A cyclotron designed to accelerate protons has a magnetic field of magnitude of 0.250 T over a region of radius 2.20 m.

(a) What is the cyclotron frequency?
\[ T = \frac{2\pi m}{eB} \]
\[ \approx 2.39 \times 10^7 \text{ rad/s} \]

(b) What is the maximum speed acquired by the protons?
\[ \frac{eVB}{m} = \frac{1.6 \times 10^{-19} \times 0.25}{1.67 \times 10^{-27}} \]
\[ = 5.27 \times 10^7 \text{ m/s} \]