Student Notes #27

Force on a wire segment

Wire has $n$ charges per unit volume; a total number of charges $N = \underline{\quad}$; a total charge $q = \underline{\quad}$.

$$\vec{F} = q\vec{v} \times \vec{B}$$

$\vec{F} =$ Force on a wire carrying current in a magnetic field.

Torque on a straight wire segment

Each piece of wire has equal magnitude and direction force acting acting on it $d\vec{F}_1 = d\vec{F}_2$. Recall $\vec{\tau} = \underline{\quad}$, so the torque acting on each piece points in $\underline{\quad}$ directions, but has $\underline{\quad}$ magnitude. Sum pieces of torque $\Sigma \vec{\tau} = \underline{\quad}$

The total torque acts as if it were applied at the $\underline{\quad}$ of the segment.

In a constant magnetic field, $\vec{B}$, the force on a piece of wire is on the total wire: $\vec{F} =$
A. A semicircular wire segment with radius \( a \) lies in the x y plane in a uniform B-field, \( \vec{B} \). The current in the loop is \( I \). What is the force on the wire?

\[
a = 2.54 \text{ cm} \\
I = 1.35 \text{ A} \\
\vec{B} = (2.95 \times 10^{-5} \text{T}) \hat{j} - (4.76 \times 10^{-5} \text{T}) \hat{k} \\
\vec{I} = \\
\vec{F} = \\
\]

* Force of one wire segment on another

\[
\vec{B}_1 = \quad \text{at the second wire} \\
\text{Force on wire 2 from wire 1:} \\
d\vec{F} =
\]
\[ \frac{dF}{dl} = \] Force is attractive if current flows in... direction. Force is... if current flows in the opposite direction.

* Force and torque on current loops

Q: A square current loop, with sides \( a \), is placed in a uniform magnetic field that makes an angle \( \theta \) with the normal to the loop. Find the net force acting on the loop and the net torque about its center.

A. Side view

\[ \vec{B} = \]

\[ \frac{l \times |l| = }{l^2} \]

Calculate force on each segment of wire using... then sum.

\[ \vec{F}_{AB} = \]

\[ \vec{F}_{CO} = \]

\[ \vec{F}_{AO} = \]

\[ \vec{F}_{CB} = \]

\[ \vec{F}_{AB} = \]

\[ \vec{F}_{CO} = \]

\[ \vec{T} = \]

\[ \vec{T} = \]

\[ \vec{T} = \]

The torque on a loop tends to align the dipole moment of the loop with the field.