CURRENT LOOP IN A MAGNETIC FIELD

Link to: physicspages home page.

To leave a comment or report an error, please use the auxiliary blog.

Reference: Griffiths, David J. (2007) Introduction to Electrodynamics, 3rd Edition; Prentice Hall - Problem 5.40.

The generalization of the Lorentz force law to the case of a current-carrying wire in a magnetic field is

$$\mathbf{F}=I\int d\mathbf{l}\times\mathbf{B} \tag{1}$$

where the integral is taken along the path of the wire. In the case of a constant field, this becomes

$$\mathbf{F}=I\left(\int d\mathbf{l}\right)\times\mathbf{B} \tag{2}$$

That is, the field comes outside the integral and the integral is just the vector sum of segments along the path, so the result of the integral is $\mathbf{w}=\int d\mathbf{l}$ which is the vector pointing from the start to the end of the path. For a closed loop entirely within a constant field, $\mathbf{w}=0$ and there is no force. For a loop (of any shape; it doesn't even have to be flat) that is partially within a constant field (that is, one continuous portion of the loop is within the field, while the remainder of the loop lies outside the field), $\mathbf{w}$ is the vector pointing from the point on the wire where the wire enters the field to the point where it leaves it. If the field is perpendicular to $\mathbf{w}$, then the force is perpendicular both to the field and to $\mathbf{w}$. The magnitude of the force in this case is $F=IwB$.

PINGBACKS

Pingback: Dropping loops through magnetic fields