

CURRENT LOOP IN A MAGNETIC FIELD

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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

$$\mathbf{F} = I \int d\mathbf{l} \times \mathbf{B} \quad (1)$$

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

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

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

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