

17

Magnetism and Electromagnetic Induction

17-1 Magnetic Forces and Fields

Vocabulary

Magnetic Field: An area of influence around a moving charge. The size of the field is related to the amount of magnetic force experienced by the moving charge when it is at a given location in the field.

$$\text{magnetic field} = \frac{\text{force}}{(\text{charge})(\text{speed})} \quad \text{or} \quad B = \frac{F}{qv}$$

The SI unit for magnetic field is the tesla (T), which equals one newton per amp · meter (N/A · m).

When solving for the magnetic force, rewrite this equation as $F = qvB$.

The magnitude of the magnetic force can also be written in terms of the current, I , flowing through a length of wire, L .

$$\text{force} = (\text{current})(\text{length of wire})(\text{magnetic field}) \quad \text{or} \quad F = ILB$$

Unlike gravitational force or electric force, magnetic force is perpendicular to the plane formed by the field and the moving charge, and is greatest when the magnetic field and the current are perpendicular to each other.

The easiest way to detect a magnetic field is with a compass.

Solved Examples

Example 1:

A proton speeding through a synchrotron at 3.0×10^7 m/s experiences a magnetic field of 4.0 T that is produced by the steering magnets inside the synchrotron. What is the magnetic force pulling on the proton?

Solution: Remember, the charge of a proton or an electron is 1.60×10^{-19} C.

Given: $q = 1.60 \times 10^{-19}$ C
 $v = 3.0 \times 10^7$ m/s
 $B = 4.0$ T

Unknown: $F = ?$
Original equation: $F = qvB$

Solve: $F = qvB = (1.60 \times 10^{-19} \text{ C})(3.0 \times 10^7 \text{ m/s})(4.0 \text{ T}) = 1.9 \times 10^{-11} \text{ N}$

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