SAMPLE PROBLEM B

Force on a Current-Carrying Conductor

PROBLEM

A wire 36 m long carries a current of 22 A from east to west. If the magnetic force on the wire due to Earth's magnetic field is downward (toward Earth) and has a magnitude of 4.0×10^{-2} N, find the magnitude and direction of the magnetic field at this location.

SOLUTION

Given: $\ell = 36$ m $\quad I = 22$ A $\quad F_{magnetic} = 4.0 \times 10^{-2}$ N

Unknown: $B = ?$

Use the equation for the force on a current-carrying conductor perpendicular to a magnetic field.

$$F_{magnetic} = BI\ell$$

Rearrange to solve for B.

$$B = \frac{F_{magnetic}}{I\ell} = \frac{4.0 \times 10^{-2}\ \text{N}}{(22\ \text{A})(36\ \text{m})} = 5.0 \times 10^{-5}\ \text{T}$$

Using the right-hand rule to find the direction of **B,** face north with your thumb pointing to the west (in the direction of the current) and the palm of your hand down (in the direction of the force). Your fingers point north. Thus, Earth's magnetic field is from south to north.

PRACTICE B

Force on a Current-Carrying Conductor

1. A 6.0 m wire carries a current of 7.0 A toward the $+x$ direction. A magnetic force of 7.0×10^{-6} N acts on the wire in the $-y$ direction. Find the magnitude and direction of the magnetic field producing the force.
2. A wire 1.0 m long experiences a magnetic force of 0.50 N due to a perpendicular uniform magnetic field. If the wire carries a current of 10.0 A, what is the magnitude of the magnetic field?
3. The magnetic force on a straight 0.15 m segment of wire carrying a current of 4.5 A is 1.0 N. What is the magnitude of the component of the magnetic field that is perpendicular to the wire?
4. The magnetic force acting on a wire that is perpendicular to a 1.5 T uniform magnetic field is 4.4 N. If the current in the wire is 5.0 A, what is the length of the wire that is inside the magnetic field?