SAMPLE PROBLEM A

Particle in a Magnetic Field

PROBLEM

A proton moving east experiences a force of 8.8×10^{-19} N upward due to the Earth's magnetic field. At this location, the field has a magnitude of 5.5×10^{-5} T to the north. Find the speed of the particle.

SOLUTION

Given: $q = 1.60 \times 10^{-19}$ C $\quad B = 5.5 \times 10^{-5}$ T

$F_{magnetic} = 8.8 \times 10^{-19}$ N

Unknown: $v = ?$

Use the definition of magnetic field strength. Rearrange to solve for v.

$$B = \frac{F_{magnetic}}{qv}$$

$$v = \frac{F_{magnetic}}{qB}$$

$$v = \frac{8.8 \times 10^{-19}\ \text{N}}{(1.60 \times 10^{-19}\ \text{C})(5.5 \times 10^{-5}\ \text{T})} = 1.0 \times 10^{5}\ \text{m/s}$$

TIP

The directions given can be used to verify the right-hand rule. Imagine standing at this location and facing north. Turn the palm of your right hand upward (the direction of the force) with your thumb pointing east (the direction of the velocity). If your palm and thumb point in these directions, your fingers point directly north in the direction of the magnetic field, as they should.

PRACTICE A

Particle in a Magnetic Field

1. A proton moves perpendicularly to a magnetic field that has a magnitude of 4.20×10^{-2} T. What is the speed of the particle if the magnitude of the magnetic force on it is 2.40×10^{-14} N?
2. If an electron in an electron beam experiences a downward force of 2.0×10^{-14} N while traveling in a magnetic field of 8.3×10^{-2} T west, what is the direction and magnitude of the velocity?
3. A uniform 1.5 T magnetic field points north. If an electron moves vertically downward (toward the ground) with a speed of 2.5×10^{7} m/s through this field, what force (magnitude and direction) will act on it?