Measuring the Strength of a Magnetic Field

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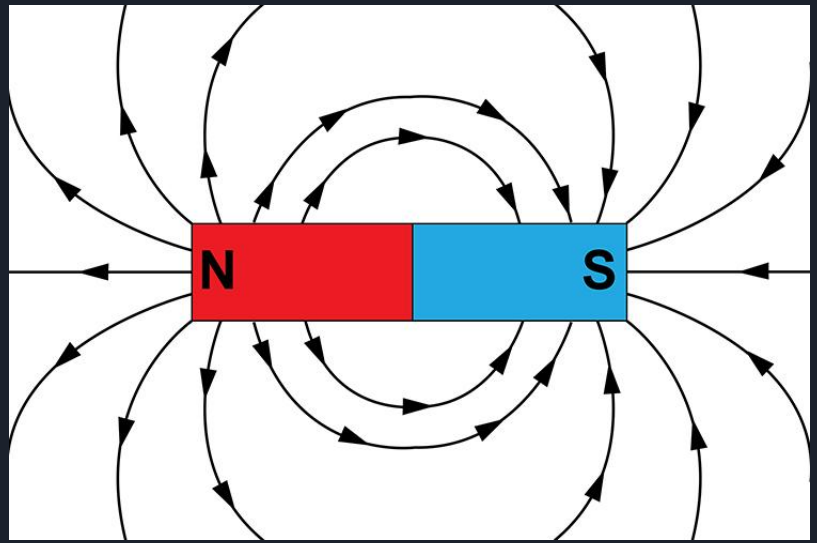
Background

Magnetic field: a vector that describes the magnetic influence on electric charges, electric currents, and magnetic materials



The Problem

A cosmic ray proton moving toward the Earth at 7.00 x 10^7 m/s experiences a magnetic force of 2.10 x 10^-16 N.

What is the strength of the magnetic field if there is a 45° angle between it and the proton's velocity?

From Chapter 22.4 Magnetic Field Strength: Force on a Moving Charge in a Magnetic Field

What We Know

F is the force

q is the charge

v is the velocity

B is the magnetic field strength

θ is the angle between the direction of velocity and the magnetic field strength

Step 1

Using the equation for the magnitude of force,

$$F = qvB\sin\theta$$

we are going to rewrite the equation in terms of magnetic field strength

$$B = F / qv\sin\theta$$

Step 2

We are then going to plug in our information into the equation & solve

F = 2.10 x 10^-16 N q = 1.60 x 10^-19 C v = 7.00 x 10^7 m/s

B = (2.10 x 10^-16 N) / ((1.60 x 10^-19 C)(7.00 x 10^7 m/s)(sin 45°))

This substitution gives us the answer

B= 2.65 x 10^-5 T

Conclusion

We found that the strength of the magnetic field is 2.65 x 10^-5 T.

We know that the strength of the Earth's magnetic field ranges from 25 to 65 uT because of the different areas.

As a result, our answer is consistent with the known strength of the magnetic field on surface.