Answer on Question 66509, Physics, Electric Circuits

Question:

Arthur Jeffries finds that a proton moving with a velocity of $1.45 \cdot 10^6\ m/s$ in a particular uniform magnetic field experiences a force of $5.11 \cdot 10^{-17}\ N$. If the direction of the velocity vector is at a right angle to the direction of the magnetic field, calculate the magnitude of the magnetic field and express your answer in units of gauss (recall that $10^4\ G = 1\ T$).

Solution:

Let's write the magnetic force that acts on the proton travelling with a velocity v in a magnetic field B:

$$\boldsymbol{F} = q(\boldsymbol{v} \times \boldsymbol{B}),$$

$$F = qvBsin\theta,$$

here, $q = 1.6 \cdot 10^{-19}\ C$ is the charge of the proton, v is the velocity of the proton, B is the magnitude of the magnetic field, θ is the angle between the velocity and the magnetic field (since the proton moves perpendicularly to the magnetic field, it means that $\theta = 90^\circ$).

Then, from the previous formula, we can find the magnitude of the magnetic field:

$$B = \frac{F}{qvsin\theta} = \frac{5.11 \cdot 10^{-17}\ N}{1.6 \cdot 10^{-19}\ C \cdot 1.45 \cdot 10^6\ \frac{m}{s} \cdot sin90^\circ} = 2.2 \cdot 10^{-4}\ T = 2.2\ G.$$

Answer:

$B = 2.2\ G.$