Answer on Question 62184, Physics, Electromagnetism

Question:

A horizontal, straight wire carrying $12.0\ A$ current from west to east is in the Earth's magnetic field B. At this place, B is parallel to the surface of the Earth, points to the north and its magnitude is $0.04\ mT$. Determine the magnetic force on $1.0\ m$ length of the wire. If mass of this length of wire is $50\ g$, calculate the value of current in the wire so that its weight is balanced by the magnetic force.

Solution:

a) We can calculate the force exerted on the wire from the equation $\boldsymbol{F}_B = I\boldsymbol{L} \times \boldsymbol{B}$, where $\boldsymbol{F}_B$ is the magnetic force, I is the current in the wire, $\boldsymbol{L}$ is a vector that points in the direction of the current I and has a magnitude equal to the length L of the wire, $\boldsymbol{B}$ is the magnetic field. Therefore, the magnitude of this force is:

$$F = ILB = 12.0\ A \cdot 1.0\ m \cdot 0.04 \cdot 10^{-3} T = 4.8 \cdot 10^{-4} N.$$

b) Because the weight of the wire is balanced by the magnetic force, we get:

$$F = W = mg,$$

$$ILB = mg.$$

From the last equation we can calculate the value of the current in the wire so that its weight is balanced by the magnetic force:

$$I = \frac{mg}{LB} = \frac{0.05\ kg \cdot 9.8\ \frac{m}{s^2}}{1.0\ m \cdot 0.04 \cdot 10^{-3} T} = 12250\ A.$$

Answer:

a) $F = 4.8 \cdot 10^{-4} N.$

b) $I = 12250\ A.$