Answer on Question #74893, Physics / Electromagnetism

A 10 g bullet having a charge of 4.00 micro coulomb is fired at a speed of 270 m/s in a horizontal direction. A vertical magnetic field of 500micro Tesla exist in the space. Find the deflection of the bullet due to the magnetic field as it travels through 100 m. (1) 3.7 /10000 m (2) 3.7 /100000 m (3) 3.7/1000000 m (4)3.7/10000000 m.

Solution:

The Lorentz force law gives the magnitude of the force on the bullet at any time:

$$F = qvB$$

$$a = \frac{F}{m} = \frac{qvB}{m}$$

At the first instant, the acceleration of the bullet is (neglecting gravity) a= $1.9 \times 10^{-8} ms^{-2}$

$$a = \frac{4 \times 10^{-6} C \times 270 \frac{m}{s} \times 500 \times 10^{-6}\ T}{10\ \times 10^{-3} kg} = 5.410\ \times 10^{-5} ms^2$$

As this acceleration is very small it leads to a negligible change in velocity so approximate the 100 m as being in the original direction of travel and the force as being constant, due to a constant velocity of 270 m/s. The time taken to cross 100 m is:

$$t = \frac{s}{v}$$

t = 100 / 270 s = 0.37 s

In this time, the sideways pushing magnetic force will lead to a small sideways deflection, x:

$$x = \frac{1}{2} at^2$$

$$x = \frac{1}{2} \times 5.410\ \times 10^{-5} ms^2 \times (0.37\ \text{s})^2 = 3.7 \times 10^{-6}\ m$$

Answer: $3.7 \times 10^{-6}\ m$