Answer on Question #54318-Physics-Electromagnetism

An ion of mass $m = 1.8 \cdot 10^{-25}\ kg$ carrying a charge $q = 4 \cdot 10^{-16} c$ after being accelerated through a potential difference of $U = 400V$ enters a uniform magnetic field of intensity $B = 2 \cdot 10^{-2} T$ perpendicular to its direction of motion. Calculate the radius of path described by the ion.

Solution

The magnetic force is a centripetal force. We can calculate the relationship between radius, charge, speed and magnetic field:

$$F_m = F_c \to qvB \sin\theta = \frac{mv^2}{r}.$$

In our case $\theta = \frac{\pi}{2}$. So, $\sin\theta = 1$. Thus,

$$qvB = \frac{mv^2}{r}.$$

The radius of path described by the ion is

$$r = \frac{mv}{qB}.$$

After being accelerated through a potential difference of $U = 400V$ the ion have kinetic energy

$$\frac{mv^2}{2} = qU.$$

The speed of ion is

$$v = \sqrt{\frac{2qU}{m}}.$$

So,

$$r = \frac{m}{qB}\sqrt{\frac{2qU}{m}} = \sqrt{\frac{2mU}{qB^2}} = \sqrt{\frac{2 \cdot 1.8 \cdot 10^{-25} \cdot 400}{4 \cdot 10^{-16} \cdot (2 \cdot 10^{-2})^2}} = 3000\ m = 3\ km.$$

Answer: $3\ km$.