Question #74894, Physics / Electromagnetism |

A particle moves in a circle of diameter 0.1cm under the action of a magnetic field of 0.40Tesla. An electric field of 200 V/m makes the path straight. Find the charge /mass ratio of the particle.(1) 2.5 × 100000 C/kg (2)2.5 ×1000000 C/kg (3) 2.5×10000 C/kg (4)2.5×10000000 C/kg

Need to find:

$\frac{q}{m}$ – ?

$\boldsymbol{d} = 0.1\ cm = \ 10^{-3}\ m$

$\boldsymbol{B} = 0.4\ T$

$\boldsymbol{E} = 200\ \frac{V}{m}$

Solution:

The force from the magnetic field, gives the centripetal acceleration of particle. The electric field only changes the velocity of the particle in the direction of the lines of the magnetic field.

Then, kinetic energy of particle: $\boldsymbol{qU = qdE = \frac{mv^2}{2} \rightarrow v = \sqrt{\frac{2qdE}{m}}}$.

Magnetic field: $\boldsymbol{F_L = qvB \rightarrow qvB = m\frac{v^2}{R}}$, but $\boldsymbol{d = 2R \rightarrow R = \frac{d}{2}}$, therefore $\boldsymbol{\frac{2mv}{d} = qB \rightarrow v = \frac{dqB}{2m}}$.

Then, $\boldsymbol{\sqrt{\frac{2qdE}{m}} = \frac{dqB}{2m} \rightarrow \frac{2dqE}{m} = \frac{d^2q^2B^2}{4m^2} \rightarrow \frac{q}{m} = \frac{8E}{dB^2}}$

Let's calculate unit and value:

Unit: $\boldsymbol{\left(\frac{q}{m}\right) = \frac{V/m}{m \cdot T^2} = \frac{V}{m^2 \cdot T^2} = \frac{V \cdot m^2}{V^2 \cdot s^2} = \frac{m^2}{V \cdot s^2} = \frac{m^2}{s^2 J/C} = \frac{m^2 \cdot C}{s^2 N \cdot m} = \frac{C \cdot m}{s^2 \cdot kg \cdot m/s^2} = \frac{C}{kg}}$

Value: $\boldsymbol{\frac{q}{m} = \frac{8 \cdot 200}{0.001 \cdot 0.4^2} = 2.5\text{x}10000000}$

Answer: (4) $\boldsymbol{\frac{q}{m} = 2.5\text{x}10000000\ C/kg}$