15-Phys-202

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Quiz 5 Name _____

Useful formulae and constants:

$$\overrightarrow{F}_B = q\overrightarrow{v} \times \overrightarrow{B}$$

$$F = \frac{mv^2}{r}$$

$$e = 1.60 \times 10^{-19} \text{ C}$$

$$m_e = 9.11 \times 10^{-31} \text{ kg}$$

1. An electron moves along a circle in a region of uniform magnetic field of magnitude $B = 4.00$ mT. It experiences a magnetic force of magnitude 3.20×10^{-15} N. What are

   (a) the particle's speed,

   (b) the radius of the circle,

   (c) the period of the motion?

   Solution

   The magnetic (Lorentz) force is given by

   $$F_B = evB$$

   whereof

   $$v = \frac{F_B}{eB} = \frac{3.20 \times 10^{-15}}{(1.60 \times 10^{-19})(4.00 \times 10^{-3})} = 5 \times 10^6 \text{ m/s}$$

   This force produces the centripetal acceleration and, by the Newton's law,

   $$F_B = \frac{mv^2}{r} = \frac{m(F_B/eB)^2}{r}$$

   whereof

   $$r = \frac{mF_B}{(eB)^2} = \frac{(9.11 \times 10^{-31})(3.20 \times 10^{-15})}{((1.60 \times 10^{-19})(4.00 \times 10^{-3}))^2} = 7.12 \times 10^{-3} \text{ m} = 7.12 \text{ mm}$$

   or , alternatively,

   $$r = \frac{mv^2}{F_B} = \frac{(9.11 \times 10^{-31})(5 \times 10^6)^2}{(3.20 \times 10^{-15})} = 7.12 \times 10^{-3} \text{ m}$$

   The period is

   $$T = \frac{2\pi r}{v} = \frac{2\pi(7.12 \times 10^{-3})}{5 \times 10^6} = 8.94 \times 10^{-9} \text{ s}$$