Answer on Question #69085, Physics / Electromagnetism

A 10 eV electron is circulating in a plane at right angles to a uniform magnetic field of 1.0×10^{-4} T. Calculate the orbital radius of the electron, cyclotron frequency, period of revolution, and the direction of circular motion of the electron as viewed by an observer looking along the magnetic field.

Solution:

The electron starts from rest (near enough) so the kinetic energy gained is given by 1/2 mv^2 where m is its mass and v is its speed.

So we can say that:

$$\frac{1}{2}mv^2 = eV$$

The mass of the electron is m = 9 x 10^{-31}k g

The electronic charge is e = 1.6 x 10^{-19}C

$$v = \sqrt{\frac{2eV}{m}} = \sqrt{\frac{2 \cdot 10 \cdot 1.6 \cdot 10^{-19}}{9 \cdot 10^{-31}}} = 1.886 \cdot 10^6\ m/s$$

The Lorentz magnetic force supplies the centripetal force, so:

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

Thus, the radius is

$$r = \frac{mv}{qB} = \frac{9 \cdot 10^{-31} \cdot 1.886 \cdot 10^6}{1.6 \cdot 10^{-19} \cdot 1.0 \cdot 10^{-4}} = 0.106\ m = 10.6\ cm$$

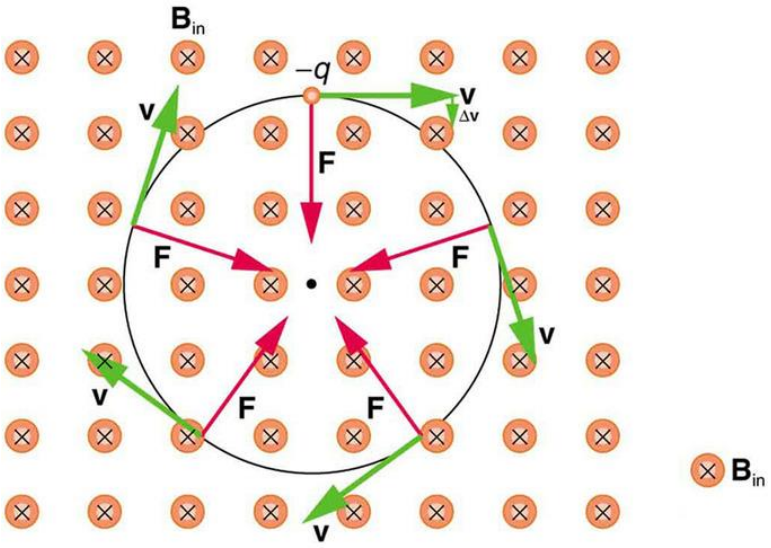
The cyclotron frequency is given in radians per second by

$$\omega_{cyclotron} = \frac{2\pi}{T} = \frac{q}{m}B$$

$$\omega_{cyclotron} = \frac{1.6 \cdot 10^{-19}}{9 \cdot 10^{-31}} \cdot 1.0 \cdot 10^{-4} = 1.778 \cdot 10^7\ rad/s$$

The time to complete one orbit is:

$$T = \frac{2\pi}{\omega_{cyclotron}} = \frac{2\pi}{1.778 \cdot 10^7} = 3.53 \cdot 10^{-7}\ s$$



A negatively charged particle moves in the plane of the page in a region where the magnetic field is perpendicular into the page (represented by the small circles with x's—like the tails of arrows). The magnetic force is perpendicular to the velocity, and so velocity changes in direction but not magnitude.

Direction of rotation is **clockwise**.

Answer: $r = 0.106\ m;$

$\omega_{cyclotron} = 1.78 \cdot 10^{7}\ rad/s$

$T = 3.53 \cdot 10^{-7}\ s$

clockwise

Source: https://www.boundless.com/physics/textbooks/boundless-physics-textbook/magnetism-21/motion-of-a-charged-particle-in-a-magnetic-field-158/circular-motion-556-6050/

Answer provided by https://www.AssignmentExpert.com