

Flashcards for Exam 3: Part 2

3.

Write down the expression for the force on a charge q moving with velocity \vec{v} in a magnetic field \vec{B} .

$$\vec{F} = q \vec{v} \times \vec{B}$$

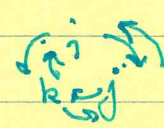
Express the Tesla in terms of other constants.

$$1 \text{ T} = \frac{1 \text{ N}}{1 \text{ C } 1 \text{ m/s}} = \frac{\text{N s}}{\text{C m}}$$

What is the force \vec{F} on an electron moving at $5 \times 10^5 \text{ m/s } \hat{i}$ in a magnetic field of $-2.5 \text{ T } \hat{k}$?

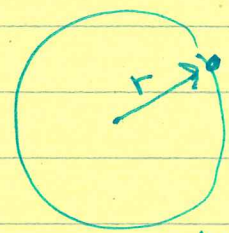
electron

$$\vec{F} = -(1.6 \times 10^{-19} \text{ C})(5 \times 10^5)(2.5)(\hat{i} \times (-\hat{k}))$$


 $\hat{i} \times \hat{k} = -\hat{j}$
 $\hat{i} \times (-\hat{k}) = +\hat{j}$

$$= -20 \times 10^{-14} \text{ N } \hat{j}$$

What is the radius of curvature for a proton with speed $5 \times 10^5 \text{ m/s}$ moving in the x - y plane in a magnetic field $\vec{B} = 1 \times 10^{-4} \text{ T } \hat{k}$?



$$q v B = \frac{m v^2}{r}$$

$$r = \frac{m v}{q B}$$

$$r = \frac{(1.67 \times 10^{-27} \text{ kg})(5 \times 10^5)}{(1.6 \times 10^{-19} \text{ C})(1 \times 10^{-4})}$$

$$\approx 5 \times 10^{-27+5+19+4} = 50 \text{ m}$$

What is the frequency for a proton moving in a circle in a magnetic field of $1 \times 10^{-4} \text{ T}$?

$$q v B = \frac{m v^2}{r}$$

$$\frac{v}{r} = \omega = \frac{q B}{m} = \frac{(1.6 \times 10^{-19})(1 \times 10^{-4})}{(1.67 \times 10^{-27})}$$

$$\approx 1 \times 10^{-23+27} = 1 \times 10^4 \text{ rad/s}$$

$$f = 1 \times 10^4 \frac{\text{rad}}{\text{s}} \times \frac{1 \text{ rev}}{2\pi \text{ rad}} \approx 1.6 \times 10^3 \text{ Hz}$$