Applied Physics

Assignment 03

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Q1 $B = 7.00\,mT = 7\times10^{-3}\,T$

$F = 3.20\times10^{-15}\,N$

(a) speed $= v = ?$

(b) radius of circle $= r = ?$

(c) period of motion $= T = ?$

Sol:-

The particle is electron (out of the page ; counter clockwise)

(a) We know that

$$F = qvB\sin\theta$$

$$v = \frac{F}{qB\sin\theta}$$

$$v = \frac{(3.20\times10^{-15})}{(1.6\times10^{-19})(7\times10^{-3})\sin 90^\circ}$$

$$\boxed{v = 5\times10^{6}\,ms^{-1}}$$

(b) $r = \frac{mv}{qB}$

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

$$r = \frac{(9.1\times10^{-31})(5\times10^{6})^2}{(3.20\times10^{-15})}$$

$$r = 7.116\times10^{-3}\,m$$

A $\boxed{r = 7.116\,mm}$

c) $\omega = \frac{2\pi}{T}$

$\because v = r\omega \Rightarrow \omega = \frac{v}{r}$

$\frac{v}{r} = \frac{2\pi}{T}$

$\Rightarrow T = \frac{(2\pi)(r)}{v}$

$T = \frac{(2)(3.141)(7.116\times10^{-3})}{(5\times10^{6})}$

$T = 8.94\times10^{-9}\,s$

or

$\boxed{T = 8.94\,ns}$

Q2

$t = 130\,ns$

$T = 2t = 2(130) = 260\times10^{-9}\,s$

(a) $B = ?$

(b) $t = ?$ (when sent with double kinetic energy)

Sol:

particle is proton (out of the page; clockwise)

(a) $\because r = \frac{mv}{qB}$ —(A)

$v = \frac{2\pi r}{T}$

(A) $\Rightarrow \cancel{r} = \frac{(m)(2)(\pi)(\cancel{r})}{(T)(q)(B)}$

$B = \frac{(2)(\pi)(m)}{(q)(T)}$

$$B = \frac{(2)(\pi)(1.67\times10^{-27})}{(1.6\times10^{-19})(260\times10^{-9})}$$

$$\boxed{B = 0.252 \text{ Tesla}}$$

(b) When kinetic energy is doubled

$$K.E = 2K.E$$

$$\frac{1}{2}\cancel{m}v^2 = (\cancel{2})\frac{1}{\cancel{2}}\cancel{m}v'^2$$

$$v^2 = 2v'^2$$

$$\boxed{v = \sqrt{2}\, v'}$$

Thus ~~velocity~~ speed become $\sqrt{2}$ times

$$v = \sqrt{\frac{2K}{m}}$$

$T = \frac{2\pi m}{qB}$ doesnot depends upon speed, Therefore time remains same.

Q3 $m = 13.0g = 0.013kg$

$l = 62.0cm = 0.62m$

$B = 0.440\,T$

(a) magnitude of current $= I = ?$

(b) direction of current $= ?$

Sol:-

(a) Since the wire is suspended, $F = mg$

$\because F = BIl\sin\theta$

$mg = BIl\sin\theta$

$$I = \frac{mg}{Bl\sin\theta} \qquad \because g = 9.8\,ms^{-2}$$

$$I = \frac{(0.013)(9.8)}{(0.440)(0.62)\sin 90^\circ} = \boxed{0.467 \text{ Amperes}}$$

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(b) The direction of current is from left to right.

Q4 initial velocity $= (12.0\hat{j} + 15.0\hat{k})$ km/s

constant acceleration $= \vec{a} = (2.00\times10^{12}\ m/s^2)\hat{i}$

$\vec{B} = (7.00\mu T)\hat{i}$

Electric field $= \vec{E} = ?$

Sol:

charge of electron is -1.6×10^{-19} coulombs,

mass of electron is 9.11×10^{-31} kg

$$\because F = q(\vec{E} + \vec{v}\times\vec{B}) \quad -(A)$$

also

$$F = ma$$

$$(A) \Rightarrow ma = q(\vec{E} + \vec{v}\times\vec{B})$$

$$\frac{ma}{q} = \vec{E} + \vec{v}\times\vec{B}$$

$$E = \frac{ma}{q} - (\vec{v}\times\vec{B}) \quad -(B)$$

$$\vec{v}\times\vec{B} = (12.0\times10^{3}\hat{j} + 15.0\times10^{3}\hat{k})\times(7.00\times10^{-6}\,\hat{i})$$

$$= -4.8\hat{k} + 6\hat{j}$$

$$(B) \Rightarrow E = \frac{(9.11\times10^{-31})(2\times10^{12}\hat{i})}{-1.6\times10^{-19}} - (-4.8\hat{k} + 6\hat{j})$$

$$\boxed{E = (-11.38\,\hat{i} - 6\hat{j} + 4.8\hat{k})\ N/C}$$

Q5 $l = 150\mu m = 150\times10^{-6} m$

$w = 7.5mm = 7.5\times10^{-3} m$

$\vec{B} = 0.65$ Tesla

$i = 23$ Amperes

Potential difference $= V = ?$

$n = 8.47\times10^{28}$ electrons/m^3

Sol:-

$$\because n = \frac{iB}{Vle}$$

$$V = \frac{iB}{nle}$$

$$V = \frac{(23)(0.65)}{(8.47\times10^{28})(150\times10^{-6})(1.6\times10^{-19})}$$

$$\boxed{V = 7.35\times10^{-6} \text{ volts}}$$

Q6 In all three figures timeperiod will be same as $T = \frac{2\pi m}{qB}$

it does not depends upon velocity

(a) time period will be same in all cases

(b) $f = \frac{1}{T}$

since, timeperiod remains unchanged therefore frequency also remains unchanged.

(c) The expression for pitch is $\frac{2\pi m v \cos\theta}{qB}$

pitch $\propto \cos\theta$

$\because \cos\theta$ decreases with increase in 'θ' therefore;

pitch in fig 3 > fig 2 > fig 1