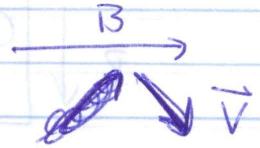
Former Exam Physics 152

Magnetic fields, forces, & Maxwell's eq.

1)



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

$$= q\begin{pmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1\,m/s & -1\,m/s & 0 \\ 0.1T & 0 & 0 \end{pmatrix}$$

$$= q\begin{pmatrix} 0 \\ 0 \\ +0.1\,m/s\,T \end{pmatrix} = q\,0.1\tfrac{m}{s}T\,\hat{k}$$

This force will have no impact on V_x so the ptcl will continue w/ ~~v_x~~ $= 1\,m/s$, forever in the other directions (y,z) it will spin in a circle (the whole motion in x, y, z will be a helix)

$$F = ma = \frac{mv^2}{R}$$

~~$q\,1\,m/s\,B = mv$~~

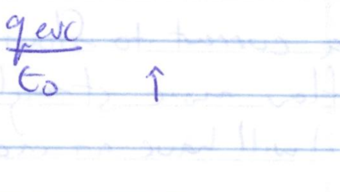
$$q\,V_y B = \frac{mV_y^2}{R}$$

$$R = \frac{mV_y}{qB} = \frac{9.11\times10^{-31}kg}{1.6\times10^{-19}C}\,\frac{1\,m/s}{0.1T}$$

$$= 5.7\times10^{-11}m$$

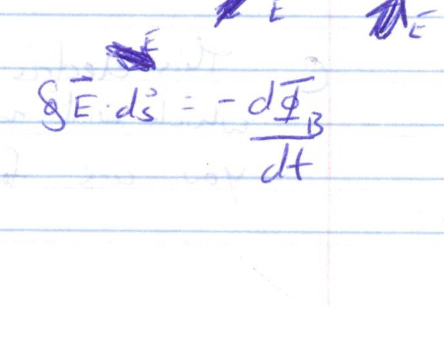
a very tight spiral of radius $\approx 6\times10^{-11}m$.

2) a



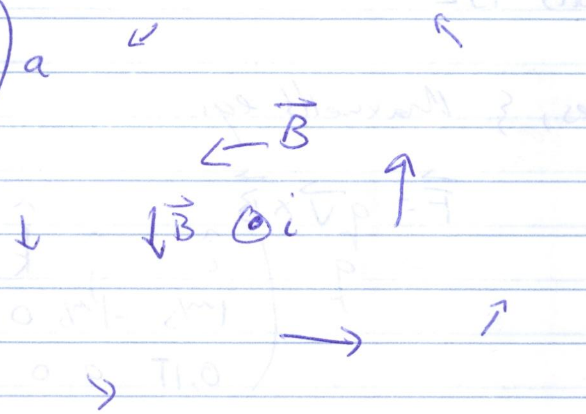
$$\oint \vec{E}\cdot dA = \frac{q_{enc}}{\epsilon_0}$$

b



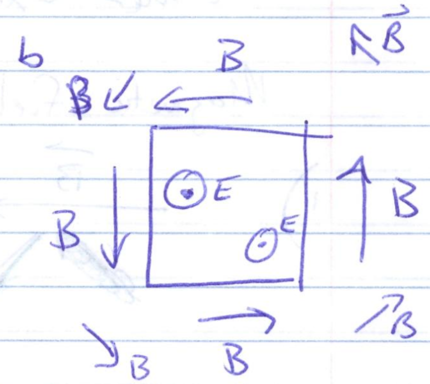
$$\oint \vec{E}\cdot d\vec{s} = -\frac{d\Phi_B}{dt}$$

3) a



$\oint \vec{B} \cdot d\vec{s} = \mu_0 i_{enc}$

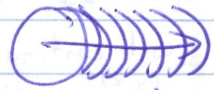
b



$\oint \vec{B} \cdot d\vec{s} = \mu_0 \epsilon_0 \frac{d\Phi_E}{dt}$

4)

a)



$\vec{B} = \mu_0 n i$

$= 4\pi \times 10^{-7} \frac{T s}{mC} \; 10^5 \; 10 \text{Amps}$

$= 0.4\pi \; T = B_0$

b)

$\mathcal{E} = -\frac{d\Phi_B}{dt}$

or

$E \, 2\pi R = \pi R^2 \frac{(B_0 - 0)}{\Delta t}$

$E = \frac{R}{2} \frac{B_0}{\Delta t}$

$\Delta t = \frac{R B_0}{2E} = \frac{0.01m \;\; 0.4\pi T}{2 \;\; 10^{-3} V/m} = 2s$

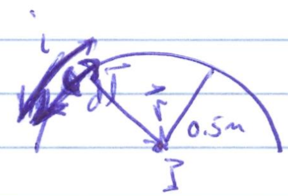
C This electric field will cause a current to flow which will make the current flow more strongly than you are forcing it too, i.e. it will have an induced current.

5) While the magnetic field is constant, the orientation of the coils is not & so $\Phi_B \neq$ constant

and $\frac{d\Phi_B}{dt} \neq 0$

$\Rightarrow$ $\mathcal{E} \neq 0$ and so a current will flow.

6)



$$d\vec{B} = \frac{\mu_0}{4\pi} \frac{i \, d\vec{l} \times \vec{r}}{r^3}$$

$$\vec{B} = \frac{\mu_0}{4\pi} i \int \frac{d\vec{l} \times \vec{r}}{r^3} = \frac{\mu_0 i}{4\pi r^2} \int_0^{\pi} r\,d\theta$$

const. direction and $= |d\vec{l}||\vec{r}|$

$|d\vec{l}| = r\,d\theta$

$$= \frac{\mu_0 i}{4r} \text{ out of page.}$$