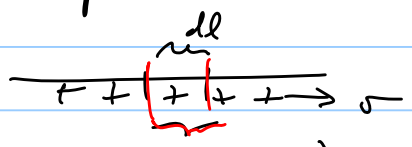
Lecture 25

Note Title 3/17/2006

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

dl or $dx = v\,dt$



$$dQ = \lambda\, dl = \lambda v\, dt$$

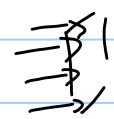
$$\vec{I} = \frac{dQ}{dt} = \lambda \vec{v}$$

Charge moving in a volume

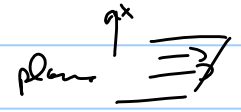
$$dQ = \rho\, dA \underbrace{dx}_{v\,dt} = \rho\, dA\, v\, dt$$

$\frac{dQ}{dA\,dt}$ flux of charge (current density)

$$\vec{J} = \rho \vec{v}$$ 3-D



$\vec{J} = \rho \vec{v}\, \delta(x - x_0) \Rightarrow \sigma \vec{v}$

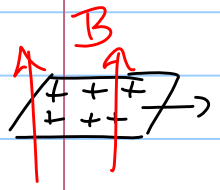


$\vec{J} = \rho v\, \delta(x - x_0)\, \delta(y - y_0) \Rightarrow \lambda \vec{v}$ wire

$$dq = \rho\, d\tau \rightarrow \sigma\, da \rightarrow \lambda\, dl$$

$$d\vec{F} = dq\,\vec{v}\times\vec{B} \rightarrow \rho\, d\tau\,\vec{v}\times\vec{B} = \vec{J}\times\vec{B}\,d\tau$$

($\vec{J}$)

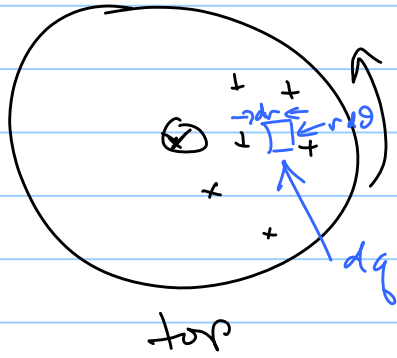


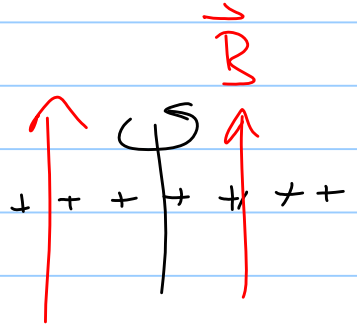
$$\rightarrow \sigma\, da\,\vec{v}\times\vec{B} = \vec{K}\times\vec{B}\,da$$

($\vec{K}$; $\sigma\, da = dq$)

$$\rightarrow \lambda\, dl\,\vec{v}\times\vec{B} = I\,d\vec{l}\times\vec{B}$$

($\lambda\, dl$)





$$d\vec{F} = dq\,\vec{v}\times\vec{B} = \vec{K}\times\vec{B}\,da$$

($\sigma\vec{v}$)

$$\vec{K} = \sigma\omega r\,\hat{\theta}$$

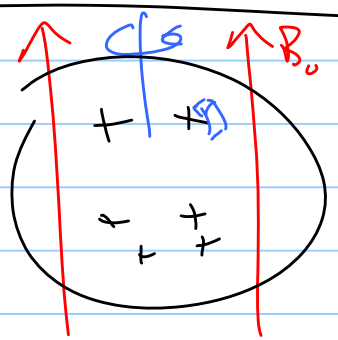
$$\vec{K}\times\vec{B} = \sigma\omega r B_0\,\hat{r}$$

$$da = r\,d\theta\,dr$$

$$\int d\vec{F} = \int \vec{K} \times \vec{B}\, da = \int \sigma \omega r B_0 \, r \, d\theta \, dr \, \hat{r}$$

↓ cartesian unit vectors before integrating

$$-\hat{x} + -\hat{y}$$



uniformly charged sphere ρ

force on sphere is

$r^2 \sin\theta \, d\theta \, d\varphi$

$$\vec{J} \times \vec{B}\, d\tau$$

$$= \rho \vec{v} \times B_0 \hat{z}$$

$$= \rho \omega r \sin\theta \, \hat{\varphi} \times B_0 \hat{z}$$

$$= \frac{Q}{\frac{4}{3}\pi R^3} \omega r \sin\theta \, \hat{\varphi} \times B_0 \hat{z}$$

$$\hat{r} \to -\hat{x} + -\hat{y}$$

$$\hat{\varphi}$$