8.022 Lecture Notes Class Test#2 - 11/6/2006

Qualitative

-special relativity

- space/time separation
- Minkowski diagrams
- time dilation/length contractions
- Twins Paradox
- Pole in barn paradox

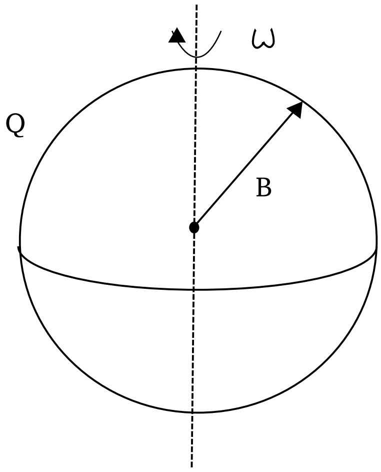
- diamagnetism and paramagnetism

Quantitative

- Lorentz Force Law
- Biot-Savart
- Ampere
- Divergence , curl of $\vec{B}$
- Vector potential $\vec{A}$
- Magnetic moment ; dipole
- Magnetostatic boundary conditions

$\vec{x} \rightarrow (r, \theta, \phi) r\hat{r} + \theta\hat{\theta}\phi\hat{\phi}$

$$\vec{x} \times \vec{J} = \frac{Q}{\frac{4}{3}\pi R^3} \omega r \sin\theta(-rJ\hat{\theta} + \theta J\hat{r})$$



Magnetic Moment Problem

$$\frac{Q}{\frac{4}{3}\pi R^3}\omega r \sin\theta\hat{\phi} = \vec{J}$$

$$\int_{\text{sphere}} d^3x(-rJ\hat{\theta} + \theta J\hat{r})$$

$$\begin{aligned} & \int_{\text{sphere}} d^3x(-rJ\hat{\theta} + \theta J\hat{r}) \\ = & \int_0^{\pi}\int_0^{2\pi}\int_0^{R}(-rJ\hat{\theta} + \theta J\hat{r})r^2\sin\theta drd\theta d\phi \\ = & \frac{Q\omega}{\frac{4}{3}\pi R^3}\int_0^{\pi}\int_0^{2\pi}\int_0^{R}(-r\hat{\theta} + \theta\hat{r})r^3\sin^2\theta drd\theta d\phi \\ = & \frac{Q\omega}{\frac{2}{3}\pi R^3}\int_0^{\pi}\int_0^{R} -r^4\sin^2\theta drd\theta \end{aligned}$$