

# PHYS4210 Electromagnetic Theory Spring 2009

Posted Problem for Homework Due Thursday 27 April 2009

Starting with Maxwell's Equations and the definitions of  $\mathbf{E}(\mathbf{r}, t)$  and  $\mathbf{B}(\mathbf{r}, t)$  in terms of the potential functions  $\mathbf{A}(\mathbf{r}, t)$  and  $\phi(\mathbf{r}, t)$ , as we did in class for  $\mathbf{A}(\mathbf{r}, t)$ , show that  $\phi(\mathbf{r}, t)$  satisfies the wave equation with a source term, in this case dependent on the charge density  $\rho(\mathbf{r}, t)$ , if we enforce the Lorentz Gauge condition. That is, show that

$$\frac{1}{c} \frac{\partial \phi}{\partial t} + \nabla \cdot \mathbf{A} = 0$$

implies that

$$\frac{1}{c^2} \frac{\partial^2 \phi}{\partial t^2} - \nabla^2 \phi = 4\pi \rho$$