

## PHY 712 – Problem Set # 26

Continue reading Chapter 9 of **Jackson**. This problem is due Wed. Apr. 22, 2009.

1. Suppose that you have a source with the following charge and current density distributions:

$$\rho(\mathbf{r}, t) = \frac{2Dze^{-r^2/R^2}}{R^5\pi^{3/2}}e^{-i\omega t}.$$

$$\mathbf{J}(\mathbf{r}, t) = \hat{\mathbf{z}}\frac{-i\omega De^{-r^2/R^2}}{R^3\pi^{3/2}}e^{-i\omega t}.$$

In this expression, the constant  $D$  denotes the dipole moment,  $R$  is a length parameter, and  $\omega$  is the (constant) harmonic frequency.

- (a) Show that this source is consistent with the continuity equation.
- (b) Write an expression for the scalar and vector potentials  $\Phi(\mathbf{r}, t)$  and  $\mathbf{A}(\mathbf{r}, t)$ , evaluating as many of the integrals as is feasible.
- (c) Write the forms of  $\Phi(\mathbf{r}, t)$  and  $\mathbf{A}(\mathbf{r}, t)$  for distances  $r \gg R$ .
- (d) Find the electric and magnetic fields  $\mathbf{E}(\mathbf{r}, t)$  and  $\mathbf{B}(\mathbf{r}, t)$  for distances  $r \gg R$ .
- (e) Find the time averaged Poynting vector for this source for distances  $r \gg R$ .