Electrodynamics II: Assignment 3.
Due February 1 at 11:00am in class or 10:45am in the instructor's mailbox.

1. Show that if the Hertz electric vector potential Π_e satisfies a wave equation with source **P**/ε_0, then the ordinary vector and scalar potentials satisfy their usual wave equations with charge and current sources. You can presume the source is purely electric since showing the magnetic case is basically the same. You can if you wish provide details to the discussion of this (Jackson p281) as your solution, but there is a much more straightforward solution.

2. Consider a nearly monochromatic oscillating point electric dipole $\mathbf{p}e^{-i\omega t}$. Find the corresponding electric Hertz vector $\Pi_e(\mathbf{r},\boldsymbol{\omega})$ and thereby find the electric and magnetic fields. The point-dipole assumption introduces a great simplification as we mentioned in class. Use spherical coordinates with the dipole aligned along the z-axis. You can ignore terms that don't contribute to the radiation field (this are terms that don't contribute to the outward Poynting flux on a spherical surface at a very large distance in terms of size of the source and free-space wavelength). We will later study the related problem of the "infinitesimal electric dipole wire antenna" radiation.

3. The gradient term in Jackson equation 6.162 comes from evaluating the closed line integral of figure Jackson 6.9. We have seen this in a couple of other contexts (the magnetic scalar potential for instance). Show this is sensible by solving Jackson problem 5.1.

4. Duality.
a. Show verify that the duality transformation (Jackson eqns 6.151-2) indeed leave the generalized Maxwell equations (Jackson eqn 6.150) in the same form.
b. Show that the duality transformation leaves quadratic forms, for instance **E•D** + **H•B**, form invariant.

[ver 31jan19 09:00]