Electrodynamics II: Assignment 3
Due January 31 at 11:00 am in class
(don't submit it to the instructor's mailbox).

1. For a static point charge, do potentials $\Phi(\mathbf{r}) = 0$ $\mathbf{A}(\mathbf{r}, \mathrm{t}) = -\frac{1}{4\pi\epsilon_0}\frac{Q}{r^2}t\hat{\mathbf{r}}$ arise from a legitimate gauge choice? Explain. Is the gauge choice that of Coulomb gauge or Lorentz gauge? Explain.

2. Consider a localized current density $\mathbf{J}(\mathbf{r}, t) = \mathbf{J_0}(\mathbf{r})e^{-i\omega t}$ oscillating at a nearly-monochromatic frequency ω. Show that the resulting magnetic field everywhere consists of a field falling as $1/r^2$ (the "induction" or "reactive" field) in the manner of Jackson equation 5.14, plus a field falling as 1/r (the "radiation" field). Why did I add the caveat "nearly"? The same is true for the electric field, but it's more difficult to show.

3. Consider the retarded charge density $[\rho(\mathbf{r}', t')]_{\mathrm{ret}}$ appearing in Jackson chapter 6. Does the volume integral $\iiint [\rho(\mathbf{r}', t')]_{\mathrm{ret}}\ dv'$ represent the total of the distributed-charge of the system? Explain. (This is the "census-taker" problem in another context.) Does your reasoning apply even to a system consisting of a lone point charge? Explain.

4. Jackson problem 6.3 parts a, b & c. Comments: Part c seems ill-posed. I seem to need more restrictive assumptions to demonstrate it. So, make some additional assumptions for part c to arrive at the result. Don't do part d, there are obvious counter-examples, so it, too, seems ill-posed.

[ver 24Jan20 09:45]